Seabridge Gold Inc.

KSM PROJECT
2009 Fish and Fish Habitat Baseline Report

SEABRIDGE GOLD

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Executive Summary

The purpose of the 2009 KSM (Kerr-Sulphurets-Mitchell) Fish and Fish Habitat Baseline Program was to provide baseline information on fish and fish habitat, within the Project area, that may be impacted by the proposed mine and infrastructure development. This report describes sampling procedures and results of the KSM Fish and Fish Habitat Baseline Program conducted in 2009. Baseline data collection took place within study area boundaries, and includes tributaries of Teigen Creek, Treaty Creek, and the Unuk River. The results presented in this report are a continuation of the 2008 Fisheries Baseline Report.

Access Roads

Stream classifications, along the proposed access roads, were determined using various habitat criteria including: channel width, gradient, and fish presence. Of the 106 sites classified as streams, the majority of sites (92 sites, 54%) were considered non-fish bearing due to habitat limiting conditions; such as high channel gradient (>30%), natural barriers, and poor quality fish habitat present to support the various fish life history stages. There were a total of 24 fish bearing crossings along the proposed access road routes. Seven of these crossings were fisheries sensitive zones and the remaining crossings were streams.

Tailing Management Facility and Plant Site

Within South Teigen Watershed, a total of 15.4 km/6.8 ha of stream fish habitat was mapped and assessed within the footprint of the proposed tailing management facility (TMF), of which 7.6 km/4.9 ha was the mainstem and 7.8 km/1.9 ha was tributaries. A total of 5.0 km/6.0 ha of South Teigen Creek was mapped and assessed downstream of the TMF to the confluence with Teigen Creek.

Within North Treaty Watershed, a total of 8.3 km/2.4 ha of stream fish habitat was mapped and assessed within the TMF, of which 2.8 km/1.7 ha was the mainstem and 5.5 km/0.7 ha was tributaries. A total of 1.2 km/0.9 ha of North Treaty Creek was mapped and assessed downstream of the TMF to the confluence with a large tributary from the eastern hillslope.

Within South Teigen and North Treaty watersheds, a total 0.2 ha and 0.9 ha of wetland fish habitat was mapped and assessed within the TMF, respectively.

Dolly Varden was the only species present in North Treaty and South Teigen creeks within the TMF. Dolly Varden, bull trout, mountain whitefish, and rainbow trout were present in South Teigen Creek downstream of a 2.5 m falls and outside of the TMF. No salmon species are present within South Teigen Creek based upon sampling data, spawning surveys, and habitat assessments. Fair or better Dolly Varden rearing habitat quality was observed at a high percentage of South Teigen and North Treaty watersheds. North Treaty Watershed possessed higher quality rearing habitat because of greater habitat diversity and fish habitat cover compared to South Teigen Watershed. Mean Dolly Varden population densities were higher in North Treaty Creek compared to South Teigen Creek. Mean Dolly Varden population densities were higher in North Treaty tributaries compared to South Teigen tributaries. South Teigen tributaries provide the majority of Dolly Varden fry and parr rearing habitat within South Teigen Watershed. North Treaty Creek provides suitable rearing habitat for Dolly Varden fry and parr.

South Teigen Creek provided none to poor suitable spawning habitat. The high composition of glacial fine substrates and high flows during the spawning season do not provide suitable spawning habitat for Dolly Varden. South Teigen tributaries provided suitable spawning habitat. North Treaty Creek and tributaries provided good and abundant Dolly Varden spawning habitat due to suitable substrate and habitat characteristics, suitable flow, and good water quality.

All reaches of South Teigen and North Treaty creeks provide good over-wintering habitat for Dolly Varden. The tributaries of these creeks provide over-wintering in certain stream reaches. All reaches of South Teigen and North Treaty creeks provided important fish habitat for Dolly Varden. Important habitat quality was observed at 68 % for South Teigen tributaries and 59 % for North Treaty tributaries.

Stream 1010, above a series of cascades, was classified as non-fish bearing because sufficient sampling effort demonstrated no fish present. Therefore, all streams above the cascades and in the location on the proposed plant site were classified as non-fish bearing.

<u>Receiving Environment – Stream and Wetland Habitat</u>

Teigen, Treaty and Unuk Watersheds

For the purposes of data analysis and comparison, three watersheds were selected for detailed fish and fish habitat analysis. The three watersheds were Teigen Creek, Treaty Creek, and the Unuk River.

Dolly Varden was the most widely distributed species within Teigen, Treaty and Unuk watershed reaches. Dolly Varden and bull trout coexist in Teigen Creek. Teigen and Treaty creeks support summer run populations of steelhead. Pacific salmon species, such as coho and Chinook are present in Treaty and Teigen creeks. Sockeye salmon are only present in Teigen Creek.

Salmon species are present in the Unuk River, with the majority of salmon spawning and rearing occurring in the lower 39 km of the Alaska section. Chinook and coho salmon are known to extend as far upstream as Storie Creek, which is approximately 15 km east of Sulphurets Creek confluence with the Unuk River. Only Dolly Varden was captured, in this study and others, within the Unuk River upstream of Storie Creek.

In Teigen Creek, Chinook salmon fry were the most abundant and rainbow trout/steelhead fry were the second most abundant species present. Chinook parr were not present in Teigen Creek Watershed. Rainbow trout/steelhead fry had a high abundance in the upper watershed on Teigen Creek, upstream of Hodkin Creek confluence. Rainbow trout/steelhead parr were distributed throughout the mainstem. Dolly Varden parr and adults were present throughout the mainstem, although the species abundance was less compared to Treaty Creek and the Unuk River. Bull Trout parr and adults were more abundant in the mainstem compared to Dolly Varden. Coho salmon fry and parr were most abundant species present within side channels and off channel wetlands of Teigen watershed. Dolly Varden fry, parr and adults also occupied the side channels and off channel wetlands.

In Treaty Creek, Dolly Varden parr and adults were the most abundant and present throughout the mainstem. Rainbow trout/steelhead parr were the second most abundant species present; however the species distribution was restricted to downstream of the Todedada Creek confluence. Mountain whitefish were present downstream of the Todedada Creek confluence. Dolly Varden fry, parr and adults were most abundant species present within side channels and off channel wetlands throughout Treaty watershed. Based upon previous fisheries assessments, coho salmon fry and parr also occupied the side channels and off channel wetlands, downstream of Todedada Creek confluence.

In the Unuk River, Dolly Varden parr and adults were the most abundant species and present throughout the mainstem. Coho fry were the second most abundant species present in the mainstem downstream of the Storie Creek confluence. Sockeye fry were present in the mainstem downstream of the Harymel Creek confluence.

Other Watersheds

A number of other watersheds, within the study area, were assessed for fish and fish habitat values. These other watersheds were: Bowser, South Unuk and Bell-Irving rivers, Oweegee, Snowbank, West Teigen, Sulphurets, and Coulter creeks.

There are a number of fish species present in the Bell-Irving River, Oweegee and Snowbank creeks. There are a number of fish species present in the Bowser River; however only Dolly Varden were present in the glacial headwaters at site BR1 in the upper reaches of the Bowser River. Only Dolly Varden were present in West Teigen Creek and were significantly longer and heavier compared to populations in other watersheds.

Dolly Varden were present in Sulphurets Creek below a 200 m cascade, which was approximately 300 m upstream from the Unuk River. Sulphurets Creek, above the cascade, was classified as non-fish bearing because sufficient sampling effort demonstrated no fish present. Therefore, all streams above the cascades were classified as non-fish bearing.

Dolly Varden and coho salmon were present below a large falls in Coulter Creek. Coulter Creek, above the falls, was classified as non-fish bearing because sufficient sampling effort demonstrated no fish present. Therefore, all streams above the falls were classified as non-fish bearing.

<u>Receiving Environment – Lake Habitat</u>

The three assessed lakes were: West Teigen Lake, Sulphurets Lake, and Todedada Lake. Dolly Varden was caught in West Teigen Lake. Dolly Varden and rainbow trout were caught in Todedada Lake. No fish were caught in Sulphurets Lake for a total of 45 hrs gillnetting effort and 235 hrs minnow trap effort. Sulphurets Lake was sampled in 2008 and no fish were caught, therefore Sulphurets Lake was classified as non-fish bearing.

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Acronyms and Abbreviations

ANCOVA	Analyses of Covariance
ANOVA	Analyses of Variance
BCIFM	British Columbia Instream Flow Methodology
CPUE	Catch-per-unit-effort
DFO	Department of Fisheries and Oceans
EPA	Environmental Protection Agency
FCA	Factorial Correspondence Analysis
FDIS	Field Data Inventory System
FHAP	Fish Habitat Assessment Procedure
FISS	Fisheries Information Summary System
FSZ	Fisheries Sensitive Zone
GLM	General Linear Model
GPS	Global Positioning System
ICP-MS	Inductively Coupled Plasma – Mass Spectroscopy
ILP	Interim Locational Point
KSM	Kerr-Sulphurets-Mitchell
LWD	Large Woody Debris
MDL	Method Detection Limits
MOE	Ministry of Environment
MOF	Ministry of Forests
MMER	Metal Mining Effluent Regulations
NCD	Non-Classified Drainage
NTL	Northwest Transmission Line
NVC	No Visible Channel
PCA	Principle Component Analysis
QA/QC	Quality Assurance/Quality Control
RISC	Resource Inventory Standards Committee
SHIM	Sensitive Habitat Inventory Mapping
TMF	Tailing Management Facility
UBC	University of British Columbia

1. KSM Project Location

The KSM Project is a gold/copper project located in the mountainous terrain of northwestern British Columbia, approximately 950 km northwest of Vancouver, British Columbia, and approximately 65 km northwest of Stewart, British Columbia (Figure 1-1). The proposed Project lies approximately 20 km southeast of Barrick Gold's recently-closed Eskay Creek Mine and 30 km northeast of the Alaska border. The proposed processing plant and tailing management facility will be located about 15 km southwest of the community of Bell II on Highway 37.

The north and west parts of the Project area drain towards the Unuk River, which crosses into Alaska and enters the Pacific Ocean at Burroughs Bay. The eastern part of the Project area drains towards the Bell-Irving River, which joins the Nass River and empties into the Canadian waters of Portland Inlet. Elevations in the Project area range from under 240 m at the confluence of Sulphurets Creek with the Unuk River, to over 2,300 m at the nearby peak of the Unuk Finger.

FIGURE 1-1

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KSM Project Location

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2. Introduction

2.1 PROJECT PROPONENT

The proponent for the KSM (Kerr-Sulphurets-Mitchell) Project is Seabridge Gold Inc. (Seabridge), a publicly traded junior gold company with common shares trading on the Toronto Stock Exchange in Canada and on the American Stock Exchange in the United States.

2.2 KSM PROJECT DESCRIPTION

The KSM Project is a large proposed gold-copper mining project. Reserve figures released in a preliminary feasibility study announced on March 31, 2010 include 1.6 billion tonnes of ore containing 30.2 million ounces of gold, 7 billion pounds of copper, 133 million ounces of silver and 210 million pounds of molybdenum in the proven and probable categories. This environmental baseline study was designed to address a wide range of alternatives that have been assessed from engineering and cost perspective at various times during the baseline studies. The following project description is the base case for the March 2010 Preliminary Feasibility Study. Maps in subsequent sections of this baseline report may depict slightly different footprint configurations relating to earlier designs that prevailed at the time the fieldwork was completed.

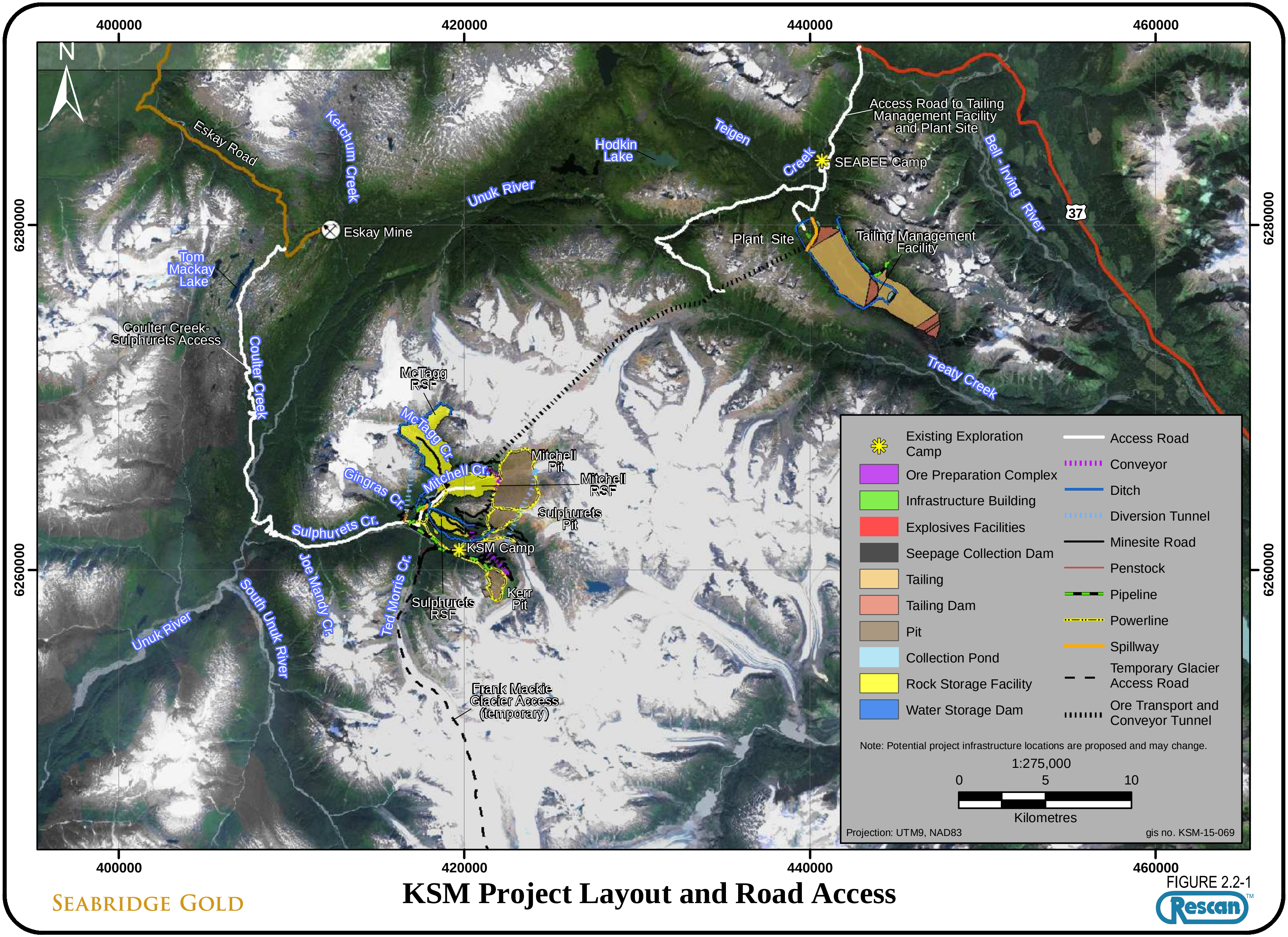
The proposed Project as defined for the purposes of this environmental baseline study will be comprised of two distinct and geographically separate areas (the mining area and processing plant and tailing management area), shown in Figure 2.2-1. The proposed mining area is located in the drainage basin of Sulphurets Creek, a major tributary of the Unuk River. The proposed location of the processing plant and tailing management facility is in the headwaters of tributaries of Teigen and Treaty Creeks, which flow to the Bell-Irving River. The two areas will be connected by a pair of parallel tunnels. An overview of these proposed mine components is provided in the following two Sections.

2.2.1 Mining Area

It is proposed that the mining area will be accessed by a new road to be constructed from the current Eskay Creek mine road. The access road will be used to transport personnel, heavy mining equipment, mining supplies, and explosives. This new road will trend southwestwards to the headwaters of Coulter Creek and then follow the general course of Coulter Creek to the Unuk River. After crossing the Unuk River it will follow the north side of the Sulphurets Creek Valley and cross Mitchell Creek. The Unuk River is considered navigable water under the *Navigable Waters Protection Act*. Branch roads will lead to each of the Kerr, Sulphurets and Mitchell deposits. Another branch road will head south parallel to Ted Morris Creek towards the toe of the north flowing tongue of Frank Mackie Glacier to provide access to the explosives manufacturing plant and related explosives magazines.

The support facilities for the mining area are proposed in the vicinity of the confluence of Sulphurets and Mitchell creeks. They will include accommodation for mine employees and administration and maintenance facilities.

The ore deposits will be bulk mined with large shovels and trucks and will use conventional drilling and blasting methods. The Kerr deposit is located on a ridge south of Sulphurets Lake. It is proposed that ore and non-ore mined rock will be transported from the Kerr deposit by conveyor to a tunnel portal (Sulphurets Mitchell tunnel) on the north side of Sulphurets Creek. These materials will be transported through the tunnel by conveyor to the Mitchell Creek Valley where they will be transported to the ore preparation complex or the Mitchell-McTagg rock storage facilities, respectively.



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KSM Project Layout and Road Access

FIGURE 2.2-1

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The Sulphurets deposit is located on the south side of the ridge north of Sulphurets Lake. It is proposed that ore will be transported by truck to the Sulphurets Mitchell tunnel and then by conveyor to the ore preparation complex. Non-ore mined rock will be transported to the Sulphurets rock storage facility on the south side of the ridge between the Mitchell Creek and Sulphurets Creek valleys, or to the Mitchell-McTagg rock storage facilities.

The Mitchell deposit straddles the Mitchell Creek Valley in an area recently exposed by the recession of the Mitchell Glacier. Mining of the deposit is proposed on both sides of the valley and to a depth of over 400 m below the current valley bottom. Seabridge proposes to construct a diversion tunnel from near the toe of the Mitchell Glacier, southwards towards the Sulphurets Creek Valley upstream of Sulphurets Lake to divert the flow of Mitchell Creek away from the proposed open pit area. It is proposed that the significant hydraulic head created by this tunnel will be used to drive a hydro-electric plant to generate a small portion of the electricity requirements of the Project.

Large volumes of low grade or barren rock will be removed in order to access the ore in each of the deposits. Non-ore rock removed to access ore will consist of both potentially acid generating (PAG) and not potentially acid generating (not PAG) rock. Rock storage areas have been defined in the Mitchell Creek and McTagg Creek valleys and on the south-facing side of the ridge between Sulphurets Creek and Mitchell Creek valleys. Runoff and seepage from the rock storage areas will be collected in a water storage facility contained behind a dam, to be located in the lower reaches of Mitchell Creek, and treated prior to discharge to the environment. The piped flow from the storage facility to the water treatment plant may be used to drive a hydro-electric plant.

A second diversion tunnel is proposed to direct the flow of McTagg Creek to the Sulphurets Creek Valley, thus avoiding the rock storage areas. The discharge from this tunnel will be available to drive a hydro-electric plant.

A run-of-river hydro-electric plant is proposed to harness the hydraulic head of the cascade in the lower reaches of Sulphurets Creek.

Ore from the deposits will be transported to an ore preparation complex, consisting of crushing and grinding facilities and related ore storage stockpiles, located on the north side of the Mitchell Creek Valley west of the Mitchell pit. Prepared ore will be mixed with water and pumped through one of two parallel 23 km-long tunnels to the process plant, proposed to be located in the drainage of a north-flowing tributary of Teigen Creek. The tunnels will daylight for a short distance near the divide between the Unuk River drainage and Treaty Creek before proceeding to the plant site in the Teigen Creek drainage. They will accommodate two pipelines to transport ore slurry as well as a return water pipeline, a diesel fuel pipeline, and a transmission line. The tunnels will slope towards Mitchell Creek so that all drainage can be controlled at the mine site and treated as necessary prior to release to the environment.

2.2.2 Processing and Tailing Management Area

The tunnel from the Mitchell Creek Valley will terminate on the south side of the valley formed by a north flowing tributary of Teigen Creek (South Teigen Creek) and a south flowing tributary of Treaty Creek (North Treaty Creek Tributary), adjacent to the plant site.

The plant will use a conventional grinding and flotation flowsheet to produce separate copper/gold and molybdenum concentrates, gold doré and tailing. It will process up to 120,000 tonnes per day of ore to produce an average of 1,200 tonnes per day of concentrate. The concentrate will be dried and transported to the port of Stewart by truck. It is anticipated that approximately 20 to 30 round trips per day will be required using 40 tonne payload trucks.

Vehicle access to the plant site will be by a 14 km long road along Teigen Creek from Highway 37. This road will require bridges to cross Teigen creek, which may be considered to be navigable water, and smaller tributaries.

The tailing will be pumped through pipelines to the tailing management facility located in the upper reaches of the Teigen Creek Valley, extending southeast over the divide into a tributary of the Treaty Creek drainage. The facility will be constructed in two phases: the north cell will be developed between a north dam, to be located across the valley of the south tributary of Teigen Creek near the plant site, and a south dam, to be located near the crest of the valley floor; and a south cell that will be retained by a southeast dam, to be located in the headwaters of the north tributary of Treaty Creek. The proposed facility will have storage capacity for the life of the Project within an area about 8 km long and 1.5 km wide. Seepage from the south and southeast dams will be pumped back into the impoundment to reduce any potential impact on the Treaty Creek drainage. Water diversion channels will be constructed on both flanks of the impoundment, where feasible, to divert clean water away from the impoundment. Supernatant water will be recovered from the impoundment using barge mounted pumps and recycled to the plant for process water. In the event that discharge is required, the excess water in the impoundment will be pumped over the northern dam towards the Teigen Creek drainage. Treatment of discharge water may be required to meet permit conditions.

It is assumed that electricity to power the plant and mine site will be obtained from the provincial electricity grid. A secondary transmission line will be constructed from a switching station, to be located near the point where Highway 37 crosses Snowbank Creek. The secondary line will follow the general alignment of the access road, to the plant site, and then pass through the tunnel to the mine site.

3. Objectives

The Unuk and Bell-Irving rivers are large river systems that provide spawning migration routes for all five species of Pacific salmon and anadromous rainbow trout (known as steelhead trout), as well as habitat for resident trout (cutthroat and rainbow), resident char (Dolly Varden and bull trout) and whitefish.

The purpose of the 2009 KSM Fish and Fish Habitat Baseline Program was to provide baseline information on fish and fish habitat within the Project area that may be impacted by the proposed mine and infrastructure development. The objectives were as follows:

- Determine fish presence, community, distribution and barriers to fish movement for watercourses within the study area, with an emphasis on non-fish bearing stream reaches identified in 2008;
- Assess the quantity and quality of fish habitat in watercourses within the study area, with a detailed emphasis on streams within the footprint of the proposed TMF;
- Determine fish community composition and fish habitat quality of lakes and wetlands within the study area; and
- Measure whole-body fish tissue metals concentrations, fish diet, fish health and fish energy and reproductive investments at potential monitoring sites that may be required under the MMER.

These objectives were achieved through field work in 2009 and review of 2008 baseline data and relevant background information about fish and fish habitat distribution, abundance and habitat use within the study area.

4. Study Area

The fish and fish habitat study area encompasses three major watersheds: Unuk, Bell-Irving and Bowser rivers. The resulting study area is based upon the locations of the proposed mine development infrastructure. A number of smaller sub-watersheds are included within the study area (Table 4.1-1 and Figure 4.1-1).

Table 4.1-1. Watersheds within the Fisheries Study Area, 2009

Unuk River Watershed	Bell-Irving River Watershed	Bowser River Watershed
Coulter Creek	Snowbank Creek	Bowser River
Mitchell Creek	Teigen Creek	Scott Creek
McTagg Creek	South Teigen Creek	
Tom McKay Creek	Treaty Creek	
South Unuk River	North Treaty Creek	
Sulphurets Creek	Bell-Irving River	
Ted Morris Creek		
Unuk River		

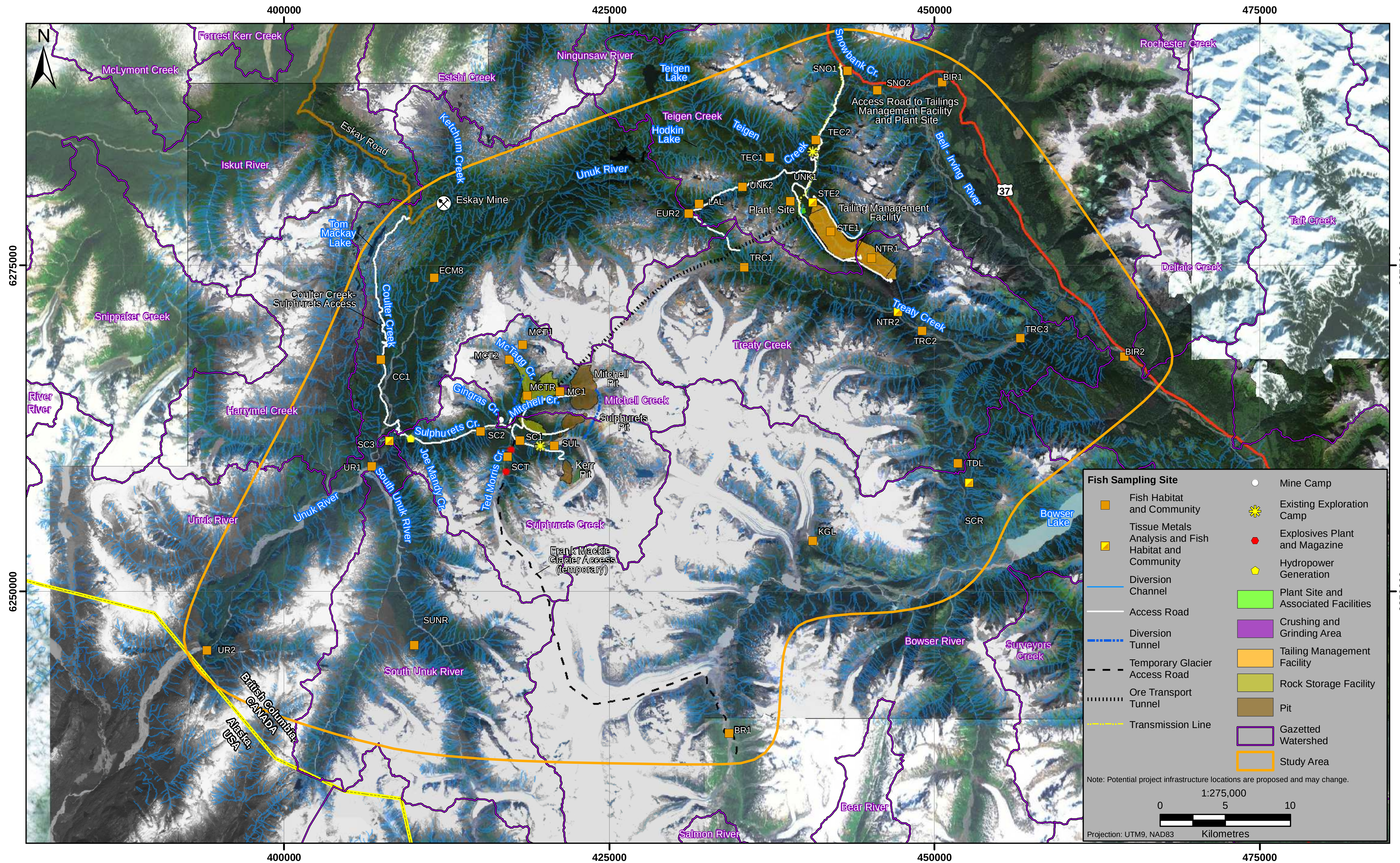

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FIGURE 4.1-1

KSM Fisheries Study Area, 2009

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5. Methods

5.1 FISH HABITAT COMPONENTS

Fish habitat was separated into three distinct components for the purposes of this report: streams, lakes and wetlands. Streams were defined as watercourses that flow seasonally or perennially, possess a continuous channel bed that is scoured by water and which contain observable deposits of mineral alluvium (MOF 1998). Lakes were defined as an open waterbody with depths greater than 2 m and with less than 25% of its surface area covered with wetland vegetation (RISC 1999a). Wetlands were defined as any waterbody that is classified as lentic (i.e., still water as opposed to lotic, which means flowing water) with depths less than 2 m (RISC 1999a).

Fish habitat assessment and fish sampling methodologies differed between each habitat component, therefore each component was separated for the purposes of analysis and reporting.

For the purpose of this program, assessed sites were divided into three categories: proposed access roads, proposed TMF and plant site and receiving environment. The access road category included all streams crossed by the proposed road alignments. The TMF and plant site category was defined as all watersheds (i.e., South Teigen and North Treaty) associated within the TMF and plant site footprint. Receiving environment was defined as all watersheds downstream of the proposed project infrastructure within the study area.

5.2 ACCESS ROADS

5.2.1 Study Design

There are three proposed access roads for KSM. Sites along the proposed roads consisted of streams that may potentially be affected by road development. For the purpose of comparing fish and fish habitat in the study area, the streams assessed were grouped with their respective access roads.

The proposed access roads lie within a number of watersheds. They are as follows:

- Teigen Access and Plant Site Road – Snowbank, Teigen and South Teigen creeks;
- Tunnel Divide Portal Spurs Road – West Teigen Creek and Unuk River; and
- Coulter Creek Access Road – Coulter, Tom MacKay, Sulphurets and Mitchell creeks and Unuk River.

Streams crossing the access road corridors were assessed from July 6 to 18 and from September 8 to 19, 2009. The objectives of the stream assessments were to confirm fish presence, describe fish habitat, rank fish habitat suitability and determine “end of fish use” in a standardized approach.

5.2.2 Fish Habitat

The location of the proposed access roads were ground-truthed and flagged by surveyors prior to the start of the fisheries fieldwork. Field crews ground-truthed the proposed access road alignments for locations of streams, non-classified drainages (NCD) and no visible channels (NVC). Stream sites were classified as “true streams” if they met the definition of a stream – a continuous, defined channel for at least 100 m. Sites with partial or discontinuous channelization were categorized as NCDs. Sites where water seeped or flowed overland, or where water pooled at a potential road crossing but where no channelization was apparent, were classified as NVC. For NCDs and NVCs, photos were taken facing upstream and downstream, GPS coordinates (+/- 10 m) were obtained and sites were flagged.

For all site classifications (i.e., NVC, NCD or stream), a unique identifying site number, or Interim Locational Point (ILP), was assigned.

At each stream crossing location, streams were assessed using methods based on the *Reconnaissance 1:20,000 Fish and Fish Habitat Inventory Protocol* (RISC 2001) and the *Reconnaissance 1:20,000 Fish and Fish Habitat Inventory: Site Card Field Guide* (RISC 1999b). This protocol involved characterizing fish habitat over a 100 m section of stream by measuring physical attributes (e.g., channel width, gradient, temperature and water quality), characterizing cover types and substrate (dominant and subdominant cover and substrate type, cover abundance and location) and describing stream morphology. Table 5.2-1 presents a complete list of attributes measured at each stream crossing. Based on the attributes collected at the stream crossing in the field, professional expertise was used to rank habitat suitability for each fish life history stage (i.e., spawning, rearing and over-wintering) and overall habitat quality. Table 5.2-2 presents habitat suitability and overall habitat quality ranks and their corresponding criteria.

A minimum of two photographs were taken to document each site, one each facing upstream from the crossing and on facing downstream from the crossing. Additional photographs were taken of barriers or features. GPS coordinates were obtained and the site was flagged.

Table 5.2-1. Attributes Measured during Habitat Assessments at Stream Crossing Sites, 2009

Substrate	Physical Measurements	Habitat	Cover
Dominate type	Bankfull width (m)	Stream morphology	Total amount
Sub-dominant type	Wetted width (m)	Presence of bars	Dominant, sub-dominant and trace cover types
D (cm)	Residual pool depth (cm)	Presence of islands	Cover location
D95 (cm)	Bankfull depth (m)	Bank shape	Canopy closure (%)
Bank texture	Gradient (%)	Stream pattern	Riparian vegetation
	Temperature (°C)	Confinement	Riparian vegetation stage
	Conductivity (µS/cm)	Hillslope coupling	
	pH (log units)	Spawning, rearing, overwintering suitability	
	Turbidity	Overall habitat quality	
		Riparian function	

D = largest stone that will move in a normal flood period (measured along the intermediate axis; cm) (RISC 2001).
D95 = stone that is in the top 5th percentile (by size) (measured along the intermediate axis; cm) (RISC 2001).
Turbidity was visually estimated.

5.2.3 Fish Community

5.2.3.1 Community Composition

Streams were sampled using backpack electrofishers *following RISC Fish Collection Methods and Standards* (RISC 1997), *Reconnaissance (1:20,000) Fish and Fish Habitat Inventory: Standards and Procedures* (RISC 2001) and the *Reconnaissance (1:20,000) Fish and Fish Habitat Inventory: Fish Collection Field Guide* (RISC 1999c). The primary objective of fish sampling was to confirm fish presence and the secondary objective was to determine the fish community composition (MOF 1998). Fish sampling occurred in the same locations where the habitat assessments occurred.

Table 5.2-2. Life History Habitat Suitability and Overall Habitat Quality Criteria Assessed at Stream Crossing Sites

Life Stage Suitability	
Ranks	**Criteria**
None	No habitat present for any life history stage
Poor	Most of the necessary physical/biological components of the habitat for this life history stage are missing or severely deficient
Fair	Some of the necessary physical/biological components of the habitat for this life history stage are present, but a key component is missing
Good	All of the necessary physical/biological components of the habitat for this life history stage are present
Overall Habitat Quality	
Ranks	**Criteria**
None	No habitat present at crossing
Marginal	Low productive capacity
Important	Common habitat which supplies needs of fish – typically rearing/over-wintering and some potential and commonly observed spawning substrate
Critical	Rare or exceptionally productive or unusual habitat with very high habitat values which are of uncommon and/or highly valuable production

Electrofishing was conducted over a minimum 100 m-long stream section (50 m both upstream and downstream of each crossing site); and for approximately 500 electrofishing seconds at each site. Only one electrofishing pass was made and no stop nets were used to prevent fish movement. Electrofishing in spawning areas during fish spawning activity was avoided to reduce the chance of harming fish and impacting spawning activities.

Biological information was collected on captured fish including species and length (to the nearest 1 mm). All fish were then returned live to the stream.

5.2.3.2 Stream Classification

A defensible, systematic approach was adopted to classify the fish bearing status of a stream at a road crossing. Streams were classified according to the *Forest Practices Code of British Columbia Fish-Stream Identification Guidebook* (MOF 1998). Under this procedure, streams were classified based on mean channel width (m) and fish-bearing status, as measured from surveys conducted in 2008 (Rescan 2009) and 2009 (this report). A summary of stream classes are presented in Table 5.2-3. The guidebook provides criteria for classifying streams as either fish bearing (i.e., Classes S1, S2, S3, S4) or non-fish bearing (i.e., S5 and S6). The guidebook classifies streams as non-fish bearing if the average gradient is greater than 20%. However, it is recognized that Dolly Varden and bull trout have the ability to move upstream in channels gradients up to 30% if adequate step pools are present (MOF 1998; McPhail and Lindsey 1970). Therefore, stream reaches were “confirmed” as non-fish bearing using gradient criteria alone if the average channel gradient was greater than 30%, channels were not defined, step-pool morphology is absent, pools are shallow and void of alluvial deposits (i.e., over-wintering habitat is absent), habitat was exceptionally marginal and no lakes were present in the headwaters.

Table 5.2-3. Forest Practices Code Stream Classification Width Criteria

Stream Classification	Mean Channel Width (m)	Fish Present?
S1	> 20.0	Yes
S2	5.0 to 20.0	Yes
S3	1.5 to 5.0	Yes
S4	< 1.5	Yes
S5	> 3.0	No
S6	≤ 3.0	No

Barrier searches and assessments were conducted on streams downstream of the road crossing. The presence of falls greater than 2 m high and steep cascades can restrict fish dispersal upstream and may "confirm" non-fish bearing status to the upstream reaches if falls are permanent and adequate sampling effort is conducted. Adequate sampling effort (based upon habitat features), in connection with habitat assessments, was conducted to confirm streams as non-fish bearing.

The rationale for changing stream classifications from "default" fish bearing to "confirmed" fish bearing included the following criteria:

- previous records showed fish present at crossing;
- fish were observed or sampled at or upstream of the crossing;
- fish were observed or sampled downstream of the crossing:
  - TRIM map gradients demonstrated that no part of the drainage downstream of the crossing flowed through gradients greater than 30%; and
- fish were present downstream of a man-made obstruction (e.g., hanging culvert) and there was an absence of natural barriers upstream of the obstruction.

5.3 TAILING MANAGEMENT FACILITY AND PLANT SITE

5.3.1 Study Design

The TMF and plant site category was defined as all watersheds associated within the TMF and plant site footprint (Figure 4.1-1). Stream and wetland habitat within the TMF and plant site footprint was mapped and assessed from July 6 to 18 and from August 4 to 16. Streams and wetland habitat fish community sampling, within the TMF and plant site footprint, was assessed from July 6 to 18, August 4 to 16 and September 8 to 19.

5.3.2 Fish Habitat

5.3.2.1 Sensitive Habitat Inventory Mapping

All streams and wetlands located within the proposed TMF and plant site footprint were ground-truthed and mapped, and habitat was assessed, through the implementation of the Sensitive Habitat Inventory Mapping (SHIM) protocol. In addition, the SHIM was conducted for South Teigen Creek downstream of the proposed TMF north dam to the confluence with Teigen Creek, and for North Treaty Creek downstream of the proposed TMF south dam to its confluence with the large tributary from the east. The SHIM method is intended by the BC Ministry of Environment (MOE) to be a standard for watercourse and fish habitat mapping in British Columbia (Mason and Knight 2001). This method attempts to ensure the collection and mapping of reliable, high quality, current and spatially accurate information about fish habitats and watercourses.

Streams and wetlands were located in the field and their locations were mapped with a differential GPS unit (+/- 1 m). Moving in an upstream direction, streams were mapped, barriers were identified and habitat assessments were conducted. The presence of falls greater than 2 m high, steep cascades and channel gradients greater than 30% were determined as the point of “end of fish use”. The “end of fish use” for each stream was further validated with fish sampling (Section 5.3.3.1).

Detailed fish habitat data was collected in the field as streams and wetlands were mapped. The spatial data was tied to fish habitat data collected in the field. Habitat data collected was a combination of the *Reconnaissance (1:20,000) Fish and Fish Habitat Inventory: Standards and Procedures* (RISC 2001) and *BC Watershed Restoration Protocol* (Johnston and Slaney 1996) data. Table 5.3-1 presents the types of habitat data that were collected and mapped for each stream segment.

5.3.2.2 Fish Habitat Assessment Procedures

Detailed fish habitat assessments (FHAP) were conducted at representative sites for each stream and reach (Johnston and Slaney 1996). FHAP assessment lengths were 100 m for South Teigen and North Treaty creek mainstems and 50 m for all other tributaries. At each site, UTM coordinates were recorded with a differential GPS unit. Temperature (°C), pH, and conductivity (μS/cm) were recorded using electronic meters.

FHAP assessments involved differentiating the stream into separate habitat units such as riffles, cascades, glides and pools, and then recording an array of habitat attributes for each unit. These attributes included data on substrate composition, cover for fish and fish habitat type. A complete list of the attributes measured is presented in Table 5.3-2. Data were collected with a measuring tape, metre stick, or visual estimation. Stream habitat within these sites were separated into the following habitat units:

- pool – low velocity area with smooth, non-turbulent flow, low gradient (near 0%), and a concave bottom;
- glide – an area of smooth, non-turbulent flowing water with moderate velocity and gradient less than 4%;
- riffle – an area of turbulent, fast-flowing water with a gradient less than 4%; and
- cascade – high gradient (>4%) area of turbulent, fast-flowing water.

5.3.3 Fish Community

5.3.3.1 Stream Rearing Habitat

In August, tributary streams mapped, excluding South Teigen and North Treaty creek mainstems, were sampled to confirm fish presence and validate rearing habitat quality ranks. Sampling crews commenced electrofishing at the tributary confluence, with South Teigen or North Treaty creek mainstems, upstream beyond the point of “end of fish use”. For each stream segment sampled, sampling crews recorded the number of fish caught and electrofishing effort (s), and provided a rearing habitat quality summary for each stream. Fish caught, effort and habitat summary data was reviewed and changes were made to the rearing habitat quality segments, if required.

Table 5.3-1. Fish Habitat Attributes Assessed and Mapped for Each Stream Segment

	Channel Characteristics		Riparian Habitat Characteristics		Habitat Quality Characteristics	
Locational and Physical Data	**Attribute**	**Descriptors**	**Attribute**	**Descriptors**	**Attribute**	**Descriptors**
Stream # (ILP)	Channel Morphology	Riifle-Pool	Bank Stability	Stable - Undercut	Spawning/Rearing/Over-Wintering Habitat Quality	Good
Reach #		Cascade-Pool		Stable - No Undercut		Fair
Segment #		Step-Pool		Aggrading		Poor
Wetted Width (m)		Large Channel		Eroding		None
Bankfull Width (m)	Dominant/Sub-Dominant Bed Substrate	Organics	Riparian Type	None	Potential Spawning Habitat	Abundant
Gradient (%)		Fines		Natural Wetland		Moderate
		Gravel		Shrubs		Micropatches
		Cobble		Coniferous Forest		None
		Boulder		Deciduous Forest	Overall Habitat Quality	Critical
		Bedrock		Mixed Forest		Important
	Dominant Bank Substrate	Organics	Riparian Structural Stage	Low Shrub (<2m)		Marginal
		Fines		Tall Shrub (2-10m)		
		Gravel		Sapling (>10m)		
		Cobble		Young Forest		
		Boulder		Mature Forest		
		Bedrock		Old Growth Forest		
	Water Stage	High	Crown Closure	0		
		Moderate		1-20%		
		Low		21-40%		
	Water Turbidity	High		41-70%		
		Moderate		71-90%		
		Low		>90%		
		Clear				

Table 5.3-2. FHAP Attributes Assessed and Measured at Stream Sites

Habitat Type	Substrate Type	Physical Measurements	Habitat	Cover
% Pool	% Sand	Length (m)	Pool Type	% Deep Pool
% Riffle	% Gravel	Wetted Depth (m)	Pool Residual Depth (m)	% Boulder
% Glide	% Cobble	Bankfull Depth (m)	Fish Passage Barriers	% Instream Vegetation
% Cascade	% Boulder	Wetted Width (m)	Off Channel Type	% Overhanging Vegetation
	% Bedrock	Bankfull Width (m)	Islands/Bars	% Undercut Bank
		Gradient (%)	Functional LWD Size Distribution	% LWD
		Bank Height (m)		% SWD
		Temperature (°C)		
		pH		
		Conductivity (µS/cm)		

LWD = large woody debris
SWD = small woody debris

Biological information was collected on captured fish including species, length (to the nearest 1 mm) and wet weight (to the nearest 0.01 g with an Ohaus 200 g scale. Aging structures (scales and pelvic fin rays) were collected from all fish greater than 90 mm in length.

Age analyses were conducted by North/South Consultants of Winnipeg, MB. Fish age was assessed primarily through the use of first two to three leading fin rays, with scales used as a secondary measurement whenever possible. This introduced a measure of inaccuracy into the results, because collecting scales from immature fish of certain species with small scales (e.g., Dolly Varden) was difficult and scales were not always obtained, while taking otoliths for aging requires sacrificing the fish. Fish age was assessed with otoliths only for individuals that died during capture and handling or that were sacrificed for tissue metals analysis.

Age of individual fish was estimated from fin rays, scales or otoliths by counting the number of annuli (or yearly rings). In the laboratory, fin rays were cross-sectioned, each section was attached to a glass slide, and annuli were counted using a compound microscope. Scales were attached directly to plastic fiches and scale annuli were counted using a microfiche reader. Otoliths were placed in a shallow dish filled with a clearing medium such as oil of wintergreen and the annuli were counted using a dissecting microscope and reflected light. A small number of structures were aged as replicate samples, using different structures where possible, and the estimate with the highest confidence was assigned to the sample.

5.3.3.2 Wetland Rearing Habitat

In July and August, mapped wetlands were sampled to confirm fish presence. Baited minnow traps were randomly set in wetlands overnight. Biological information was collected on captured fish including species, length (mm) and wet weight (g). Aging structures (i.e., scale and pelvic fin ray) were collected from a sub-set of fish greater than 90 mm in length.

5.3.3.3 *Spawning Habitat*

Dolly Varden spawning surveys were conducted in mapped streams within the TMF from September 17 to 19. In addition, spawning surveys were conducted for South Teigen Creek downstream of the proposed TMF north dam to the confluence with Teigen Creek, and for North Treaty Creek downstream of the proposed TMF south dam to the confluence with the large tributary from the East.

Spawning surveys were conducted to confirm Dolly Varden spawning locations and validate spawning habitat quality ranks. In tributaries, field crews commenced surveys at the tributary confluence, with South Teigen or North Treaty creek mainstems, upstream beyond the point of “end of fish use”. In South Teigen and North Treaty creek mainstems, field crews conducted spot surveys in stream segments. For each stream segment surveyed, sampling crews recorded water clarity, temperature (°C), number of fish observed spawning, number of redds observed, the UTM location of these observations and a habitat summary. Field crews used the methods and data cards from the *Redd Enumeration Field Guide* (RISC 2003), if redds were observed. Fish spawning survey and habitat summary data was reviewed and changes were made to the spawning habitat quality segments, if required.

5.3.3.4 *Population Density*

Dolly Varden population density assessments were conducted in mapped North Treaty and South Teigen tributary streams within the TMF, North Treaty Creek, and West Teigen Creek (reference stream) in August. Density assessments could not be conducted in South Teigen Creek in August due to high flows; therefore assessments were delayed and conducted in early September.

Density sites were randomly selected within stream reaches that were deemed to be representative of the stream reach habitat composition (i.e., riffle, pool, glide or cascade). The multiple removal/depletion method was adopted (Johnson et al. 2007) to determine density instead of mark/recapture methods due to the remote location and difficult accessibility of streams. Site length was 50 m for tributary streams and 25 m for mainstem streams. Stop nets were installed at upstream and downstream site boundaries. The entire bankfull width of the site was blocked to prevent fish immigration and emigration of the site; except South Teigen Creek mainstem. Due to the large bankfull width and discharge of South Teigen Creek, the bankfull width of the site could not be closed off; however currents were utilized to coral fish into the stop nets and the entire site was effectively sampled.

Three passes were conducted using a backpack electrofisher from the downstream stop net in an upstream direction then returning downstream. Electrofishing effort varied among sites; but was relatively consistent within site passes. The entire wetted area within the site was electrofished. Fish were enumerated, processed in a standardized manner and released downstream of the site after each pass. Biological information was collected on captured fish including species, length (mm) and wet weight (g). Aging structures (i.e., scales and pelvic fin rays) were collected from a sub-set of fish greater than 90 mm in length.

5.3.3.5 *Dolly Varden Genetics*

A Dolly Varden genetic study was conducted within Teigen and Treaty watersheds. Dolly Varden was present in South Teigen Creek above and below a potential barrier to fish movement. Dolly Varden was present in North Treaty Creek, and there exists a potential for headwater exchange between watersheds during high flood events. The objectives of the study were to answer the following questions:

- Are there significant genetic differences in Dolly Varden between Teigen and Treaty watersheds?
- Are there significant genetic differences in Dolly Varden within Teigen and Treaty watersheds?
- Are there significant genetic differences between the South Teigen Creek Dolly Varden population, above the barrier, and Dolly Varden populations throughout the Province?

During August and September, samples of adipose fin were taken and preserved in 95% ethanol from a subset of Dolly Varden captured from four areas: upstream of South Teigen Creek falls (Teigen Watershed); downstream of South Teigen Creek falls (Teigen Watershed); North Treaty Creek within the TMF (Treaty Watershed); and Treaty Creek (Treaty Watershed). Genetic analyses were performed by Dr. Eric Taylor at the University of British Columbia (UBC) in Vancouver, BC.

Dolly Varden and bull trout coexist in Teigen and Treaty watersheds. Natural hybridization between bull trout and Dolly Varden is known to occur in these watersheds, as identified in the 2008 baseline studies (Rescan 2009) and in other watersheds (Baxter et al. 1997). Therefore, samples were initially screened at two microsatellite markers – Sfo-18 and Omm-1128 – to obtain a broad overview of the species status and distribution of char within different watersheds. If the two markers were 100% diagnostic for either Dolly Varden or bull trout, then no additional markers were assayed. If either (or both) of the markers displayed species differences, or were comprised of alleles from both species (i.e., hybrid at that given marker), then the remaining markers – Sco-216, MTB and FOK223 – were screened to verify and/or add to the results of the first two markers. Char sampled were scored as either homozygous bull trout, homozygous Dolly Varden or heterozygote (hybrid) at each of the diagnostic genetic markers. Individuals that were identified as homozygous at the markers were categorized as pure-type for that species. First generation (F1) hybrid fish would be expected to be heterozygous at all markers screened, while backcross and higher-order hybrids were those individuals with a mix of homozygous and heterozygous markers.

Tests for differences in allele frequencies, pooled across loci, were conducted using Weir and Cockerham’s (1984) θ statistic, with significance tested using permutation analyses. This analysis was completed using GENETIX (Belkhir et al. 2004). The relative similarity among samples was visualized using Factorial Correspondence Analysis (FCA) and population means were compared, in microsatellite allele frequency space, using GENETIX. FCA is a type of factor analysis that finds the best linear combination of variables (in this case allele frequencies at different loci) to describe variation between individual observations (fish). In general terms, FCA is best suited for categorical (rather than continuous) data and determines the first K axis of an orthogonal number of axes that describe the most variance from a “cloud” of observations.

For tests of population differentiation within creek, the Bayesian, model-based clustering algorithm contained in the program STRUCTURE (version 2.3.2) was used (Pritchard et al. 2000). This algorithm does not assume any population structure a priori and uses a likelihood approach to find the most likely number of K populations in the total data set that minimizes departures from Hardy-Weinburg equilibrium and linkage equilibrium. Such deviations are common when a single sample of individuals actually consists of a mixture of fish from two or more genetically differentiated populations.

5.4 RECEIVING ENVIRONMENT

5.4.1 Stream Habitat

5.4.1.1 Study Design

Receiving environment was defined as all watersheds downstream of the proposed project infrastructure within the study area. Reference sites were selected and could potentially be used in the future to determine if any changes observed at sites downstream of mine features were due to mining activities or to natural changes in the environment. Streams sites were assessed from July 6 to 18, from August 4 to 16 and from September 8 to 19.

5.4.1.2 Fish Habitat

Fish habitat assessments were based on the *Reconnaissance (1:20,000) Fish and Fish Habitat Inventory: Standards and Procedures* (RISC 2001), *Reconnaissance 1:20,000 Fish and Fish Habitat Inventory: Site Card Field Guide* (RISC 1999b) and the detailed *Fish Habitat Assessment Protocol* (Johnston and Slaney 1996). Reconnaissance fish habitat assessments were conducted in accordance to the methods described in Section 5.2.2. Detailed FHAP assessments were conducted within study area watersheds and sites were 200 m in length. At each site, UTM coordinates were recorded at the beginning and end of each site with a hand-held GPS receiver (+/- 10 m). Data was collected in a similar manner as previously discussed in Section 5.3.2.

5.4.1.3 Fish Community

Fish sampling was conducted at the same location as the FHAP assessment sites. Electrofishing was conducted over a minimum 200 m-long stream section and for a total of approximately 1,000 electrofishing seconds. Only one electrofishing pass was made, and no stop nets were used to prevent fish movement. Biological data was collected in the same manner as stated in Section 5.3.3.

5.4.1.4 Whole-Body Fish Tissue Metals

Dolly Varden were collected from three receiving environment sites: SC3 (downstream of the proposed mine), STE2 (downstream of the proposed TMF northern dam) and NTR2 (downstream of the proposed TMF southern dam). Dolly Varden were collected from one reference environment site – SCR – in Scott Creek. Eight whole-body fish samples, from a range of fork lengths, were selected from each of the sites. Sex and maturity was determined through an examination of internal sex organs and gonads (RISC 1997). Maturity was classified as one of six stages of sexual maturity (i.e., immature, maturing, mature, spawning, spent and resting). Gonad, liver, and stomach samples were weighed using an Ohaus 200 g scale, with weights reported with two decimal points.

Fish stomachs were removed and preserved in 10% formalin for diet analysis. Developed ovaries were removed and preserved in 10% formalin for fecundity analysis. Whole fish were weighed and stored in labeled plastic bags and immediately frozen. Frozen samples were sent to ALS Environmental in Vancouver, BC, for analysis according to standardized procedures adapted from the United States' Environmental Protection Agency (EPA) guidelines. At ALS Environmental, samples were dried and moisture content was measured. Samples were then homogenized and digested in acid. Total concentrations of 30 metals in the processed samples were measured by Inductively Coupled Plasma – Mass Spectroscopy (ICP-MS). Total concentrations of mercury were measured with Cold Vapour Atomic Spectrophotometry. Metal concentrations were reported as mg/kg wet weight (wwt). Detection limits for the 30 metals are listed in Table 5.4-1.

Table 5.4-1. Whole-Body Fish Tissue Quality Variables and Detection Limits for KSM Project, 2009

Parameter	Abbreviation	Detection Limit (mg/kg wwt)
Physical Tests		
Moisture		0.10%
Total Metals		
Aluminum	T-Al	2
Antimony	T-Sb	0.01
Arsenic	T-As	0.01
Barium	T-Ba	0.01
Beryllium	T-Be	0.1
Bismuth	T-Bi	0.03
Cadmium	T-Cd	0.005
Calcium	T-Ca	2
Chromium	T-Cr	0.1
Cobalt	T-Co	0.02
Copper	T-Cu	0.01
Iron	T-Fe	0.2
Lead	T-Pb	0.02
Lithium	T-Li	0.1
Magnesium	T-Mg	1
Manganese	T-Mn	0.01
Mercury	T-Hg	0.001
Molybdenum	T-Mo	0.01
Nickel	T-Ni	0.1
Phosphorus	T-P	5
Potassium	T-K	20
Selenium	T-Se	0.2
Sodium	T-Na	20
Strontium	T-Sr	0.01
Thallium	T-Tl	0.01
Tin	T-Sn	0.05
Titanium	T-Ti	0.1
Uranium	T-U	0.002
Vanadium	T-V	0.1
Zinc	T-Zn	0.1

5.4.1.5 Fish Diet and Fecundity

Diet and fecundity analyses were conducted from Dolly Varden collected for whole-body metals analysis. The stomach samples were sent to Applied Technical Services of Victoria, BC, for enumeration and identification. Each stomach was rinsed with water to remove the preservative. The stomach was carefully slit open and the contents were removed and blotted on filter paper to remove excess moisture. They were then weighed to the nearest milligram on a Denver TL-603D electronic balance.

Prey items were identified to the lowest possible taxonomic level and weighed. Where there were large numbers, a known number of each species was weighed; and the total number and weights were then extrapolated from those weights. Percent fullness (a measure of how full the stomach was) and percent digestion (the percentage of food, by weight, already digested and hence, unidentifiable) of the stomach contents were estimated.

Stomach contents were grouped by order and major life-history groups. This method was used because many taxonomic groups had so few representatives in the diet that obtaining the weight of the group was not possible. Therefore, stomach contents were organized by a few large taxonomic groups, (i.e., Diptera (minus Chironomidae), Chironomidae, Arachnida and Oligochaeta). The remaining individuals in the diet were organized into two major life history groups: the Hemimetabola (those insects with three life stages), and the Holometabola (those insects with four life stages). Data were presented by proportional number and weight of each taxonomic group.

The ovaries were removed from the fish and placed in a labelled bag with 10% formalin added as a preservative. The ovary samples were sent to Applied Technical Services of Victoria, BC, for fecundity counts. The ovaries were washed in water to remove the preservative, dried on filter paper to remove excess water, and weighed to the nearest 1 mg on a Denver TL-603D electronic balance. Depending on the apparent number of eggs, 10% by weight of the eggs were counted. Eggs usually fell into three size (diameter) categories: mature (large), immature (small) and future (extremely small). Only the first two categories were counted. Total numbers were then extrapolated from the sub-sample.

5.4.1.6 Spawning Habitat

Spawning surveys were conducted for a number of species (bull trout, steelhead, coho salmon, Chinook salmon, sockeye salmon) in the Teigen, South Teigen, Treaty, and North Treaty watersheds. The objectives, timing, and areas of the spawning surveys varied depending upon the target species (Table 5.4-2). In addition, Dolly Varden spawning surveys were conducted downstream of the TMF in South Teigen and North Treaty creeks as described in Section 5.3.3.3.

Generally, for each spawning survey field crews recorded water clarity and temperature (°C), number of fish observed spawning, number of redds observed, the UTM location of these observations and a habitat summary. Field crews used the methods and data cards from the *Redd Enumeration Field Guide* (RISC 2003), if redds were observed.

5.4.1.7 Instream Flow

The British Columbia Instream Flow Methodology (BCIFM) was conducted in North Treaty and South Teigen creeks downstream of the proposed TMF (Lewis et al. 2004) to determine flow data in-relationship to fish habitat data. Two instream flow sampling events were conducted from August 12 to 14 and from September 14 to 17. The purpose of the BCIFM is to provide a standardized approach to the collection of instream flow information in relation to fish and fish habitat. The BCIFM is complementary to other existing provincial methods and relies in part on data collection standards outlined in *Reconnaissance (1:20,000) Fish and Fish Habitat Inventory: Standards and Procedures* (RISC 2001) and *BC Watershed Restoration Protocol* (Johnston and Slaney 1996). Stratified-random transects were established based upon hydraulic habitat type (i.e., pool, riffle, glide or cascade) for fish habitat measurements with the objective of describing and quantifying habitat.

Table 5.4-2. KSM Spawning Habitat Surveys, 2009

Target Species	Objective	Surveyed Stream	Stream Section	Survey Date
Bull Trout	Determine Spawning use in South Teigen and North Treaty creeks	South Teigen Creek	Confluence with Teigen Creek upstream to falls	September 15-16,2009
		North Treaty Creek	Reaches below proposed TMF	
Steelhead	Determine spawning use and distribution in South Teigen and North Treaty creeks. Confirm spawning use downstream of South Teigen and North Treaty creek confluences in Teigen and Treaty creeks.	Teigen Creek	1 km downstream and 1 km upstream of South Teigen Creek confluence	June 5 to 7, 2009
		South Teigen Creek	Confluence with Teigen Creek upstream to falls	
		Treaty Creek	1 km downstream and 1 km upstream of North Treaty Creek confluence	
		North Treaty Creek	Confluence with Treaty Creek upstream to tributary confluence from eastern slopes	
Chinook and Sockeye	Determine spawning use in South Teigen and North Treaty creeks. Determine spawning distribution within Teigen and Treaty creeks.	Teigen Creek	Spot surveys from Snowbank Creek confluence to Teigen Lake Outlet	August 4 to 16, 2009
		South Teigen Creek	Confluence with Teigen Creek upstream to falls	
		Treaty Creek	Spot surveys from Bell-Irving River confluence to North Treaty confluence.	
		North Treaty Creek	Confluence with Treaty Creek upstream to tributary confluence from eastern slopes	
Coho	Determine spawning use in South Teigen Creek.	South Teigen Creek	Confluence with Teigen Creek upstream to falls	October 22 to 23, 2009

Depth (cm) and velocity (cm/s) data at transect verticals was collected with a Swoffer 2100 (2" propeller) according to the BCIFM methods. Each transect's cross sectional profile in South Teigen Creek was surveyed with a standard surveyor's level and rod according to the BCIFM methods. Habitat data collected at each vertical included; bed substrate composition and cover habitat type (e.g., boulder, pool, instream vegetation, etc). Stream temperature data loggers were installed in South Teigen and North Treaty Creeks downstream of the TMF. Dataloggers were wired to a steel bar staked into the stream bed. A piece of white PVC piping was used as a shield to protect the temperature loggers from direct exposure to the sun and from contact with bed load. Data loggers were deployed for a period of one year to record daily fluctuations in stream temperature.

5.4.2 Wetlands

5.4.2.1 Study Design

In September, wetland sites were selected within Teigen and Treaty Creek watersheds to determine fish species utilization, species distribution within watersheds, fish habitat quality and fish habitat connectivity to mainstem creeks.

5.4.2.2 Fish Habitat

Open water wetland habitat was qualitatively described and connectivity to mainstem creeks was documented. The width and length of open water wetland habitats were estimated, amount of cover and dominant cover type were recorded. Professional expertise was used to rank habitat suitability for each fish life history stage (i.e., spawning, rearing and overwintering) and overall habitat quality. Table 5.2-2 presents habitat suitability and overall habitat quality ranks and their corresponding criteria. For connecting stream habitats, fish habitat assessments were conducted based on the *Reconnaissance (1:20,000) Fish and Fish Habitat Inventory: Standards and Procedures* (RISC 2001) and *Reconnaissance 1:20,000 Fish and Fish Habitat Inventory: Site Card Field Guide* (RISC 1999b).

5.4.2.3 Fish Community

The fish community in each wetland was sampled using a combination of electrofishing and baited minnow traps. Electrofishing was conducted in narrow or shallow channels. Each wetland was electrofished for approximately 500 to 1,000 seconds, depending on catch rate. Minnow traps were set in deeper water habitats overnight. Fish caught were processed in a standardized manner as discussed in Section 5.3.3.

5.4.3 Lakes

5.4.3.1 Study Design

Receiving environment lake sites are those that may be directly or indirectly influenced by proposed mine development, and are located downstream or near proposed mine features. Reference lakes were selected and will be used in the future to determine if any changes observed at sites near or downstream of mine features are the result of potential mining activities, or due to natural changes in the environment. Lakes were assessed from July 8 to 11. Figure 4.1-1 shows the locations of the lakes. Table 5.4-3 provides a location, site description and rationale for each site.

Table 5.4-3. KSM Receiving Environment Lake Sites, 2009

Watershed	Gazetted Waterbody Name	Assigned Name	Site Code	Location		Site Description
				Easting	Northing	
Sulphurets Creek	-	Sulphurets Lake	SUL	420785	6261192	Sulphurets Lake is downstream of Sulphurets ore deposit. A glacial headwater lake
West Teigen Creek	-	West Teiegn Lake	LAL	431909	6279726	West Teigen Lake in upper West Teigen Creek Watershed
Todedada Creek	Todedada Lake	-	TDL	451692	6259677	Todedada Lake in upper watershed

Dashes indicates not applicable

5.4.3.2 Fish Habitat

In 2008, fish habitat assessments were conducted for West Teigen and Sulphurets lakes (Rescan 2009). Therefore, in 2009 fish habitat was only assessed for Todedada Lake. Shoreline and littoral zone substrates were mapped and categorized with a GPS and an inflatable boat. Shoreline and littoral zone substrate segments were categorized by dominant and subdominant substrates present. Shoreline type was described and categorized by one of the following types: beach, low-rocky, cliff/bluff, wetland and vegetated (mixed, shrub, coniferous or deciduous). Extensive submergent and emergent vegetation beds were described and mapped with a GPS. Cover and fish habitat was described for the lake. Inlets and outlets were located, photographed and described. Surface water temperature, pH and conductivity were measured.

5.4.3.3 Fish Community

Each lake was assessed using methodology based on the *Reconnaissance 1:20,000 Fish and Fish Habitat Inventory Protocol* (RISC 2001). Lakes were sampled with RISC standard sinking gillnets and baited minnow traps. A sinking gillnet net consisted of six panels, 15.2 m long and of different mesh sizes (25, 76, 51, 89, 38 and 64 mm), that were strung together in a “gang” to form a net 91.2 m long and 2.4 m deep. Gillnets were set randomly throughout the lake for a period of one hour to minimize fish mortality. If an unacceptable level of fish mortality occurred, then the durations of net sets were shortened. If fish were not caught with one hour net sets, then the durations of the net sets were lengthened. Overnight gillnet sets were set in lakes where previous netting efforts resulted in no fish caught or evidence suggested that no fish are present in the lake. Minnow traps were randomly set in the littoral zone (< 2 m water depth) along the lake shoreline overnight.

Fish caught were processed in a standardized manner as discussed in Section 5.3.3. Fish caught from West Teigen and Todedada lakes that were inadvertently killed during capture and handling were sampled for diet and fecundity analysis as discussed in Section 5.4.1.4.

5.5 DATA ANALYSIS

5.5.1 Fish Habitat and Community

Data collected during the fish habitat assessment and fish sampling associated with stream habitats were transcribed from field notes into the BC MOE Field Data Inventory System (FDIS) for data storage and interpretation. Fish habitat was characterized using mean lengths, widths and depths of the attributes collected in the field.

Fish communities were characterized using mean length (mm), mean weight (g), mean age (years) and catch-per-unit-effort (CPUE). CPUE is an index of relative abundance that can be used to compare fish populations among different areas. This was based on the assumption that catch is proportional to fishing effort (Hubert and Fabrizio 2007). It is defined as the number of fish captured per sampling device per unit time.

For electrofishing, the CPUE was calculated from the number of fish captured per 100 seconds:

1) CPUE = number of fish caught * (100/ electrofishing effort (s))

For minnow traps, CPUE was calculated from the number of fish captured per trap per day (24 h).

2) CPUE = number of fish caught per trap * (24 h/day/ set time (h))

For gillnets, CPUE was calculated from the number of fish captured per 100 m^2 of net per hour. Gillnet area (m^2) was standard for all net sets, with an area of 218.88 m^2.

3) CPUE = number of fish caught per gillnet * (100 /218.88)*(1 / set time (h))

Estimates of fish density were generated from data collected by the multiple-pass removal method using software called "PopEst7.xls" that was developed by the environmental division of BC Hydro (Bruce and Z'Graggen 1995). Density was estimated using the multiple-pass removal method. For sites with a clear trend of declining catch per pass, estimates of the number of fish were generated using a maximum likelihood method. For sites in which catch increased with successive passes or which did not decline with successive passes, Bayesian methods were used to estimate numbers. Bayesian population estimates are robust to violations of the assumption of constant probability of capture.

The program derived variances, standard errors, and confidence limits for each population size estimate. Estimates of population density were obtained by dividing the population size by the surface area of the site (i.e., fish/100 m^2). Surface area was calculated as the length of a stream site multiplied by its mean wetted width. Estimates of population density were averaged for similar types of sites (e.g., mainstem or tributary sites) in South Teigen, North Treaty and West Teigen watersheds.

Length-frequency distributions were constructed to visualize the distribution of fish among size classes. Length-frequency distributions were generated if there were adequate sample sizes. One of the interpretation assumptions of the distributions is that fish of all size classes have an equal probability of being captured. Also, a large sample size is required to ensure that all size classes are represented (Johnson et al. 2007).

Age-frequency distributions were constructed to present the distribution of fish in differing age classes.

Condition is an index of the relative health of fish. It was calculated for all fish for which length and weight data were obtained, and was based on the following formula from Ricker (1975):

4) Condition = weight (g) x 10^5 / length $(mm)^3$

Von Bertalanffy growth models (Ricker 1975) were fit to length-age data using SigmaPlot's (SYSTAT 2006) non-linear regression function. The equation for this model is:

5) $L_t = L_\infty(1 - e^{-K(t - t0)})$

where L_t is the length (mm) at age t (years), L_∞ is the length (mm) that the fish would attain if it were allowed to grow for an infinitely long time, K is a growth coefficient (year $^{-1}$), and t_0 is the age (years) at zero length.

Von Bertalanffy growth models (Ricker 1975) were fit to weight-age data using SigmaPlot's (SYSTAT 2006) non-linear regression function. The equation for this model is:

6) $W_t = W_\infty\ (1-e^{(-K(t-to))})^3$

where W_t is the weight (g) at age t (years), W_∞ is the weight (g) that the fish would attain if it were allowed to grow for an infinitely long time, K is a growth coefficient (year $^{-1}$), and t_0 is the age (years) at zero weight.

5.5.2 Statistical Analysis

SYSTAT statistics software (SYSTAT 2004) was used for all statistical analyses. Data outlier tests (i.e., box plots) were employed to look for outliers that may have been caused by recording errors or transcription errors.. Normal probability plots were employed to test for normality of variables. Data were transformed with natural logarithms to meet assumptions of normality. Where applicable, data were represented as means and the statistic of dispersion was the standard error (SE) of the mean. Analyses of variance (ANOVA) were used to test for differences among means. Analyses of covariance (ANCOVA) were used to test for differences in intercepts of linear regressions. Results of statistical tests and regressions were considered significant if the probability (P) of a false significant result was less than 5% (i.e., $P < 0.05$). Results of all regression analyses were reported with a coefficient of determination (r^2) that was adjusted for the number of degrees of freedom.

A general linear model (GLM) was used to test for equality in the slopes of the fish weight-length regressions among receiving environment streams. If the slopes were equal (i.e., there was no significant interaction between length and stream on the weight of fish tested), then ANCOVA, with length as the covariate, was used to test for differences in mean weight (i.e., the y-intercepts of the regressions) among sites. If the slopes of the regressions were not equal, this indicated that the relationship between length and weight differed among sites and the y-intercepts of the regressions could not be compared.

5.5.3 Metal Mining Effluent Regulation Analysis

For the purposes of the MMER, only specified biological response data (i.e., effect endpoints) generated from the fish data will be used to assess the presence of an effect. To determine whether or not there is an effect on the fish population, statistical analyses of the data are conducted. Three principal type responses to the fish population are shown in Table 5.5-1. Each of the responses, their respective effect endpoints and supporting response variables, are presented in the following sections as baselines conditions.

Table 5.5-1. Summary of Three Principal Endpoint Responses for Environmental Effects Monitoring

Type of Response	Effect Endpoint	Statistical Analysis	Supporting Response Variable	Statistical Analysis
Energy Use	Size at age (body weight against age)	ANCOVA	Body Weight	ANOVA
	Relative gonad size (gonad weight against body weight)	ANCOVA	Length	ANOVA
			Size at age (length against age)	ANCOVA
			Relative gonad size (gonad weight against length)	ANCOVA
			Relative fecundity	ANCOVA
Energy Storage	Condition	ANCOVA	Relative liver size (liver weight against length)	ANCOVA
	Relative liver size (liver weight against body weight)	ANCOVA	Relative egg size	ANCOVA
Survival	Age	ANOVA		

Dolly Varden was selected as the fish species because they are a resident species to the study area watersheds and are the most abundant species within the study area watersheds. Dolly Varden from three receiving environment sites (SC3, STE2 and NTR2) and one reference environment site (SCR) were sampled in August to establish baseline conditions relating to the MMER.

For analysis of tissue metals concentrations, metals in which 80% of the concentrations were below the method detection limit (MDL) were excluded from analyses. For the included metals, all values below the MDL were assigned values of one-half the MDL in order to use those values in statistical analyses.

Mean metal concentrations—with standard error (SE), minimum and maximum—were calculated from that dataset for each stream. To compare mean tissue metal concentrations among streams, concentrations were ln-transformed to normalize their frequency distributions—a pre-requisite of parametric statistics. Then, ln(concentrations) were compared among the streams with one-way ANOVA. For significant ANOVAs, multiple comparisons were conducted between the means of the streams using the Bonferonni correction for degrees of freedom.

Principle Component Analysis (PCA) was used to reduce redundancy in the tissue metals data set and to allow clearer interpretation of trends in the data. PCA is a statistical routine that reduces a dataset containing a large number of correlated observations into a smaller number of uncorrelated artificial variables called components. PCA is also called data reduction because there are always fewer components than original variables once the redundant information has been removed.

PCA was applied to a single matrix containing the ln-transformed tissue metal concentrations (in mg/kg WW) and ln-transformed fish length. To help interpret the components, the loadings on the components (i.e., the correlation coefficients between the components and the original metal concentrations) were rotated with the Varimax option and sorted by their relative magnitude. The amounts of variance explained by each component and a scree plot (not shown here) were used to determine how many of those components were important and which were trivial. A scree plot is a plot of the variance explained by a component against the order in which the components were extracted. Important components appear as a 'cliff face' and trivial components appear as the 'scree' at the bottom of the cliff.

5.6 QUALITY ASSURANCE / QUALITY CONTROL

In order to ensure consistently accurate data collection, a Quality Assurance (QA) and Quality Control (QC) program was established at the onset of the field program. The program involved a practice session held in the field prior to any crew conducting stream, lake and wetland assessments to review data collection procedures. Throughout the course of the field program, a qualified and experienced Quality Assurance Biologist reviewed each completed data card daily. A QA checklist was also completed for each site. Whenever clarification was required on specific points, the card was returned to the crew leader for editing and was accepted only after the necessary changes were made. Data entry, into FDIS and other databases, subsequent to the field program provided another opportunity to ensure data consistency through application of the built-in quality assurance routine which generated a QA report for review. Comments were provided to address deficiencies and conflicts identified in the quality assurance report generated by FDIS. Data transcription quality was also verified by comparing a sub-sample of randomly selected site cards with the corresponding data entered into FDIS and into project maps. The standard for QC under the *Reconnaissance (1:20,000) Fish and Fish Habitat Inventory Protocol* is to verify 5% of all site cards (RISC 2001).

For lake and wetland fish and fish habitat assessments, field notes were transcribed onto electronic spreadsheets in the office and all transcriptions were checked visually against the field forms and any errors corrected. The biological data were plotted to identify any outliers that may have resulted from transcription errors that occurred in the field.

6. Results

6.1 ACCESS ROADS

6.1.1 Stream Fish Habitat

6.1.1.1 Site Classification of Access Roads

There are three proposed access roads for the proposed KSM Project: Teigen Access and Plant Site Road, Tunnel Divide Portal Spur Road and Coulter Creek Access Road. Detailed site cards, fish cards and photos for all sites on the roads are located in Appendix 6.1-1. Fish-bearing stream crossing locations are shown in Figure 6.1-1 for the Teigen/plant site and tunnel access roads. Fish-bearing stream crossing sites are shown in Figure 6.1-2 for the Coulter Creek Access Road.

Of the 170 sites that were assessed, 106 (or 63%) conformed to the definition of "stream" according to the *Fish Forest Practices Code Fish-Stream Identification Guidebook* (MOF 1998) (Figure 6.1-3). The remaining sites were classified as either NCDs (57 sites or 34%) or fish-bearing fisheries sensitive zones (FSZ) (7 sites or 4%).

Stream classifications were determined using various habitat criteria including: channel width, gradient and fish presence. Of the 106 sites classified as streams, the majority of sites (92 sites or 54%) were considered non-fish bearing due to habitat limiting conditions such as high channel gradient (>30%), natural barriers and poor quality fish habitat. The Teigen Access and Plant Site Road and Tunnel Divide Portal Spur Road cross numerous ephemeral drainages that were not defined as streams. The majority of streams that are present along these access roads are subject to continuous avalanches and landslides, as a result channel formation and fish habitat is continuously disturbed. The Coulter Creek Access Road is located within the Coulter Creek and Sulphurets Creek watersheds. Fish migration barriers present in the lower reaches of these creeks resulted in non-fish bearing classification of stream crossings upstream of these fish migration barriers.

6.1.1.2 Individual Stream Crossing Characteristics

Table 6.1-1 presents a summary of each fish bearing stream crossing. Details regarding stream classification, location, channel measurements, bed substrate, channel morphology, cover type, riparian habitat and habitat quality are presented in this table. Channel characteristics and fish habitat cover are site specific, and habitat quality varies between sites.

6.1.2 Stream Fish Community

6.1.2.1 Species Presence and Community

Appendix 6.1-2 shows all species biological data for each site. Appendix 6.1-3 shows all electrofishing effort and catch data for each site. Table 6.1-2 summarizes fish species captured and historical fish presence information at stream sites along the proposed access roads. Dolly Varden was present along all access roads. Coho salmon were present along the Teigen and Plant Site Access Roads and Coulter Creek Access Road. Larger stream sites (e.g., Teigen Creek, South Teigen Creek, Unuk River) possessed the most diverse fish communities.

Presence of a species, either sampled in 2009, 2008 (Rescan 2009) or previously known, was used to determine the fish bearing status of a stream. If fish were observed or caught in 2008 or 2009, the stream classification was listed as confirmed fish bearing. If fish were not observed or caught at a site, and fish presence is known downstream (from historical data), and no barriers to fish passage were present, then the stream classification was listed as default fish bearing. In total, 24 sites were recorded as fish-bearing, 16 were confirmed, and 8 listed as default fish bearing. The Teigen Access and Plant Site Road had the most numerous fish bearing streams (9 sites), although two of them were default fish bearing. Along the Tunnel Divide portal Spur Road two of the four fish bearing streams were default, while along the Coulter Creek Access Road four of the eight streams were default.

Catch, effort and CPUE for all fish sampling locations along the access roads are presented in Table 6.1-3. A total of 14,147 seconds of electrofishing effort was expended over 19 sites. A total of 63 fish were caught along the proposed access roads, the majority of these fish were caught in South Teigen and Coulter creeks. Dolly Varden was the dominant catch, found along all access roads. Rainbow trout were caught along the Teigen Access and Plant Site Road, while coastal cutthroat trout were only caught at one stream along the Coulter Creek Access Road.

6.2 TAILINGS MANAGEMENT FACILITY AND PLANT SITE

6.2.1 Watershed Setting

The proposed TMF is situated within the headwaters of two watersheds: South Teigen and North Treaty creeks. The proposed plant site is situated within South Teigen Creek. South Teigen and North Treaty possess a watershed area of 61 and 33 km^2, respectively. Within South Teigen and North Treaty watersheds, the proposed TMF encompasses 12.6% (7.7 km^2) and 14.5% (4.8 km^2) of the total surface area, respectively.

South Teigen Creek originates from glaciers on the eastern hillslope and flows into a broad, flat valley surrounded by wetland fen habitat (Plates 6.2-1 and 6.2-2). The creek then increases in gradient flowing through a confined valley with a 2.5 m-high falls (Plates 6.2-3 and 6.2-4). Downstream of the falls, the creek flows through an unconfined valley and discharges into Teigen Creek (Plate 6.2-5).

North Treaty Creek originates from two sources: the eastern hillslope and wetland complexes on the valley floor. The eastern hillslope provides a significant water source during the freshet and early summer, after which the flow is reduced (Plate 6.2-6). The wetland complex provides continuous water sources throughout the duration of the year (Plate 6.2-7). Both water sources merge to form North Treaty Creek. The creek flows in a low gradient valley surrounded by shrub riparian habitat (Plate 6.2-8). The creek then increases in gradient flowing through a confined valley (Plate 6.2-9) and discharges into a larger tributary. The larger tributary originates from the eastern hillslope and eventually discharges into Treaty Creek (Plate 6.2-10).

6.2.2 Stream Habitat

6.2.2.1 Summary

SHIM was used to characterize fish habitat within the TMF and within South Teigen and North Treaty mainstems downstream of the TMF between July 6 and 18. Appendix 6.2-1 presents SHIM data for each ILP. Appendix 6.2-2 presents FHAP data for each ILP site. Within South Teigen Watershed, a total of 15.4 km of stream fish habitat was mapped and assessed within the TMF, of which 7.6 km was the mainstem and 7.8 km was tributaries. A total of 5.0 km of South Teigen Creek was mapped and assessed downstream of the TMF to the confluence with Teigen Creek.

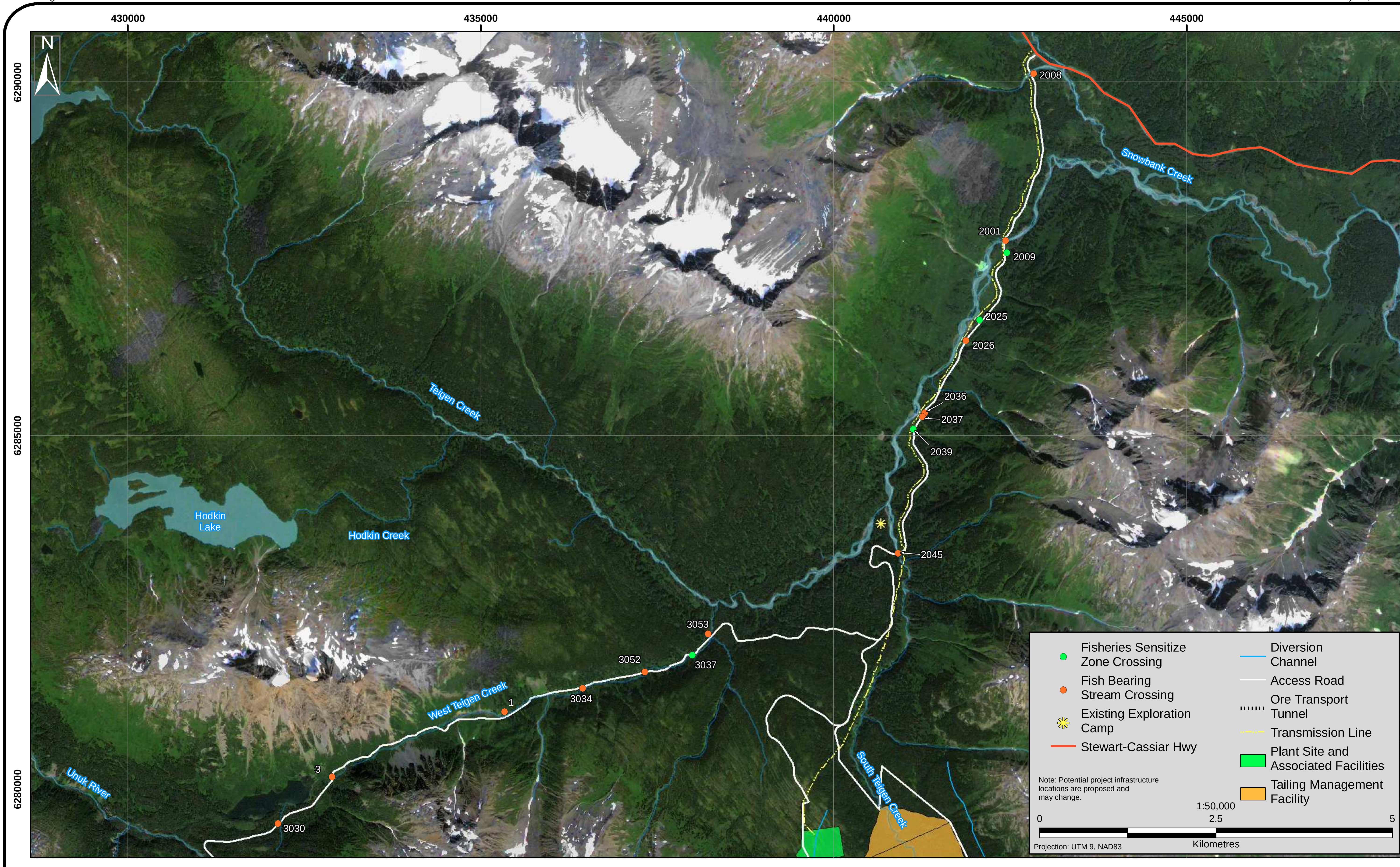


FIGURE 6.1-1

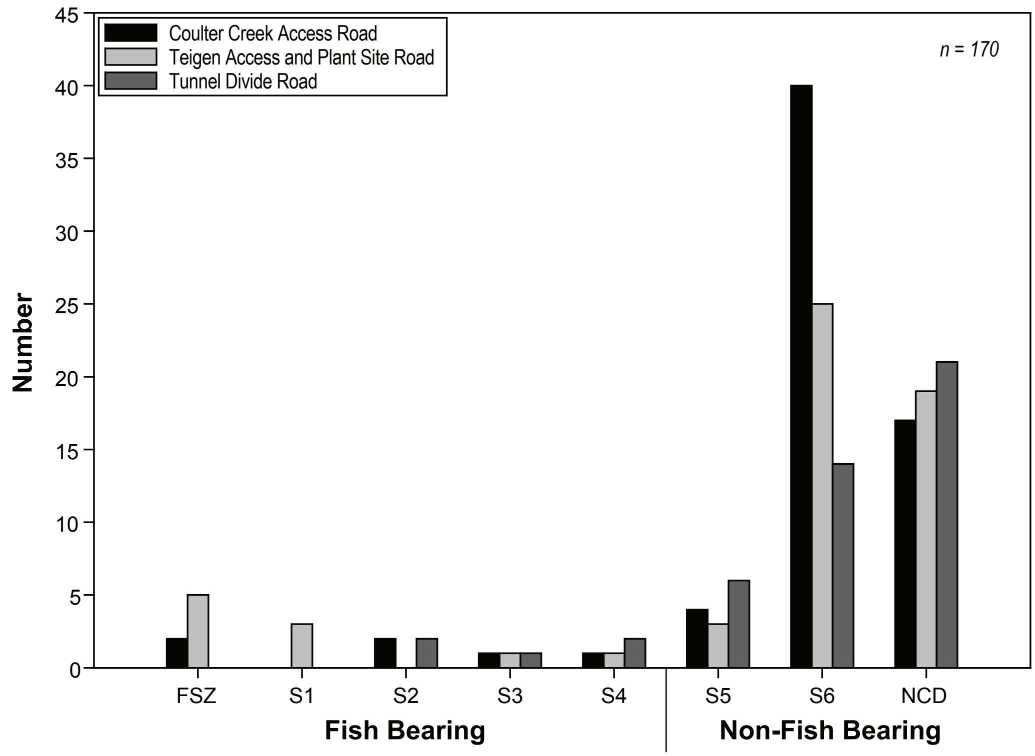
Location of Fish-Bearing Stream Crossings for the Teigen, Plant Site, Tunnel Access Roads

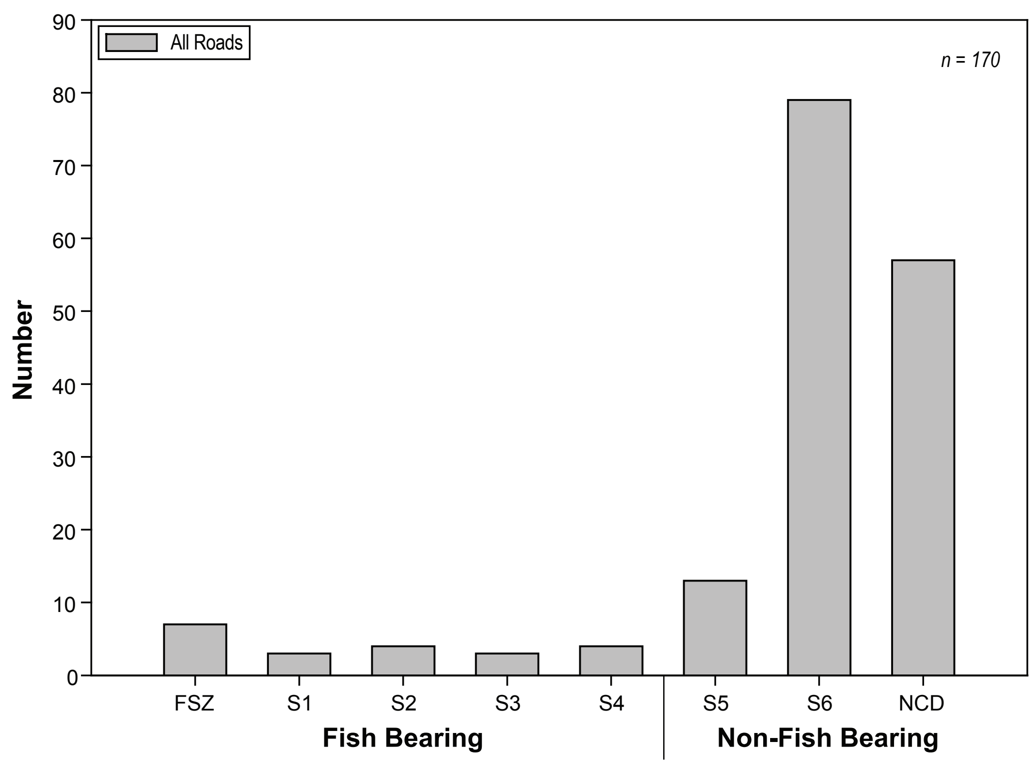
FIGURE 6.1-2

SEABRIDGE GOLD

Fish-Bearing Stream Crossings for the Coulter Creek Access Road

Rescan™ Engineers & Scientists





Site Classifications of
Access Road Streams, 2009

FIGURE 6.1-3

SEABRIDGE GOLD

Rescan™

Table 6.1-1. Individual Fish Bearing Stream Crossing Details, 2009

Road	ILP	Stream Class	Location		Channel Measurements			
			Easting	Northing	Mean Channel Width (m)	Mean Gradient (%)	Mean Residual Pool Depth (m)	Mean Bankfull Depth (m)
Teigen Access and Plant Site Roads	2001 (Teigen Creek)	S1	442433	6287758	83.0	1.0	-	0.9
	2008	S1	442832	6290119	25.6	5.0	-	0.9
	2009	FSZ*	442450	6287586	3.6	0.0	-	0.7
	2025	FSZ*	442064	6286636	-	-	-	-
	2026	S2	441871	6286342	6.3	21.0	-	0.5
	2036	S4	441285	6285316	1.4	1.0	-	0.3
	2037	S3	441259	6285265	2.6	1.0	-	0.3
	2039	FSZ**	441125	6285089	-	-	-	-
	2045 (South Teigen Creek)	S1	440912	6283335	23.8	2.5	-	0.9
Tunnel Divide Portal Spurs Road	3030	S3	432126	6279512	3.0	4.0	0.2	0.2
	3052 (West Teigen Creek)	S2	437324	6281660	11.5	4.3	-	0.4
	3053 (West Teigen Creek)	S2	438222	6282191	12.5	3.8	0.3	0.5
	1 (West Teigen Creek)	S2	435338	6281095	12.0	4.0	0.2	0.4
	3 (West Teigen Creek)	S2	432891	6280175	12.0	2.0	-	-
	3034	S4	436442	6281426	1.2	1.5	-	0.1
	3037	FSZ**	437997	6281895	1.4	1.5	0.1	0.1
Coulter Creek Access Road	2060	S3	407703	6266547	1.9	0.5	-	0.3
	2061 (Coulter Creek)	S2	407561	6266553	16.0	1.5	0.6	-
	2062	FSZ**	-	-	-	-	-	-
	2063	S2	407277	6265832	12.7	3.5	0.3	-
	2064	S4	407274	6265770	1.4	14.0	0.2	0.3
	2076	FSZ**	407807	6262859	-	-	-	-
	2077	FSZ**	408143	6262745	-	-	-	-
	2 Unuk River	S1	408020	6262770	145.0	1.0	-	-

Riparian Vegetation Type:
D = deciduous
C = coniferous
S = shrubs
G = grass
M = mixed

Dominant Substrate:
F = fines
C = cobble
B = boulder
G = gravel

Morphology:
CP = cascade pool
RP = riffle pool
SP = step pool
LC = large channel

Habitat
G = good
P = poor
F = fair
N = none

** FSZ = wetland*
*** FSZ = side channel*
Dashes indicate not applicable or no data available

(continued)

Table 6.1-1. Individual Fish Bearing Stream Crossing Details, 2009 (completed)

Road	ILP	Stream Class	Location		Channel Characteristics		Stream Habitat		Habitat Quality		
			Easting	Northing	Dominant Substrate	Morphology	Dominant Cover Type	Riparian Vegetation Type	Overwintering	Rearing	Spawning
Teigen Access and Plant Site Roads	2001 (Teigen Creek)	S1	442433	6287758	G	RP	OV	M	G	G	G
	2008	S1	442832	6290119	B	CP	B	M	P	P	P
	2009	FSZ*	442450	6287586	F	LC	IV	M	G	G	N
	2025	FSZ*	442064	6286636	-	-	OV	-	-	-	-
	2026	S2	441871	6286342	C	CP	OV	S	N	P	N
	2036	S4	441285	6285316	G	RP	SWD	S	N	F	N
	2037	S3	441259	6285265	F	RP	SWD	S	P	P	N
	2039	FSZ**	441125	6285089	-	-	LWD	S	-	-	-
	2045 (South Teigen Creek)	S1	440912	6283335	B	SP	B	D	P	P	P
Tunnel Divide Portal Spurs Road	3030	S3	432126	6279512	G	RP	OV	S	P	G	G
	3052 (West Teigen Creek)	S2	437324	6281660	C	CP	OV	S	P	G	G
	3053 (West Teigen Creek)	S2	438222	6282191	C	RP	OV	S	P	G	G
	1 (West Teigen Creek)	S2	435338	6281095	C	RP	OV	S	P	G	G
	3 (West Teigen Creek)	S2	432891	6280175	C	RP	OV	S	P	G	G
	3034	S4	436442	6281426	F	RP	OV	S	N	P	N
	3037	FSZ**	437997	6281895	F	-	OV	C	N	G	N
Coulter Creek Access Road	2060	S3	407703	6266547	F	RP	OV	C	F	G	N
	2061 (Coulter Creek)	S2	407561	6266553	G	RP	LWD	C	G	G	G
	2062	FSZ**	-	-	F	-	LWD	C	-	-	-
	2063	S2	407277	6265832	G	RP	LWD	C	P	F	N
	2064	S4	407274	6265770	C	SP	OV	C	P	F	N
	2076	FSZ**	407807	6262859	-	-	-	-	-	-	-
	2077	FSZ**	408143	6262745	-	-	-	-	-	-	-
	2 Unuk River	S1	408020	6262770	C	RP	DP	C	G	G	P

Riparian Vegetation Type:
D = deciduous
C = coniferous
S = shrubs
G = grass
M = mixed

Dominant Substrate:
F = fines
C = cobble
B = boulder
G = gravel

Morphology:
CP = cascade pool
RP = riffle pool
SP = step pool
LC = large channel

Habitat
G = good
P = poor
F = fair
N = none

Table 6.1-2. Summary of Known Fish Species by Access Road and Stream, 2009

Road	ILP	Stream Class	Fish Bearing Status	Sample Method	Species Present
Teigen Access and Plant Site Roads	2008	S1	Confirmed	EF	DV, RB
	2001 (Teigen Creek)	S1	Confirmed	EF	DV, RB, BT, CO, CH, SK, MW
	2009	FSZ*	Confirmed	VO	DV
	2025	FSZ*	Confirmed	VO	CO
	2026	S2	Confirmed	EF	DV
	2036	S4	Default	NS	-
	2037	S3	Confirmed	VO	CO
	2039	FSZ**	Default	NS	-
	2045 (South Teigen Creek)	S1	Confirmed	EF	DV, BT, RB, MW
Tunnel Divide Portal Spurs Road	3030	S3	Confirmed	EF	DV
	3052, 3053 (West Teigen Creek)	S2	Confirmed	EF	DV
	3034	S4	Default	NS	-
	3037	FSZ**	Default	NS	-
Coulter Creek Access Road	2060 (Coulter Creek - side channel)	S3	Default	NS	-
	2061 (Coulter Creek)	S2	Confirmed	EF	CO, DV
	2062	FSZ**	Default	NS	-
	2063	S2	Confirmed	EF	DV, CO, CCT
	2064	S4	Default	NS	-
	2076	FSZ**	Default	NS	-
	2077	FSZ**	Confirmed	VO	UNK
	Unuk River	S1	Confirmed	EF	CO, CH, SK, DV, CCT

DV = Dolly Varden, RB = rainbow trout, CO = coho salmon, CCT = coastal cutthroat trout, BT = bull trout, CH = chinook salmon, SK = sockeye, MW = mountain whitefish, UNK = unknown species

EF = electrofishing, VO = visual observation, NS = not sampled

** FSZ is wetland*

*** FSZ is side channel*

Dashes indicate no data available

Table 6.1-3. Electrofishing Effort, Catch and CPUE of Fish Bearing Streams along the Proposed Access Roads, 2009

				Dolly Varden		Rainbow Trout		Coho Salmon		Coastal Cutthroat Trout	
Road	**ILP**	**Site**	**Effort (s)**	**No. of Fish**	**CPUE**	**No. of Fish**	**CPUE**	**No. of Fish**	**Mean CPUE**	**No. of Fish**	**CPUE**
Teigen Access and Plant Site Roads	2006	1	157	0	-	0	-	0	-	0	-
	2008	1	495	1	0.20	1	0.20	0	-	0	-
	2008	2	503	0	-	0	-	0	-	0	-
	2026	1	295	2	0.68	0	-	0	-	0	-
	2045 (South Teigen Creek)	1	1,144	15	1.31	0	-	0	-	0	-
Tunnel Divide Portal Spurs Road	3000	1	1,006	NFC	-	NFC	-	NFC	-	NFC	-
	3001	1	1,036	NFC	-	NFC	-	NFC	-	NFC	-
	3002	1	1,004	NFC	-	NFC	-	NFC	-	NFC	-
	3003	1	1,004	NFC	-	NFC	-	NFC	-	NFC	-
	3004	1	1,014	NFC	-	NFC	-	NFC	-	NFC	-
	3005	1	1,038	NFC	-	NFC	-	NFC	-	NFC	-
	3009	1	502	NFC	-	NFC	-	NFC	-	NFC	-
	3031	1	122	NFC	-	NFC	-	NFC	-	NFC	-
	3048	1	583	NFC	-	NFC	-	NFC	-	NFC	-
	3051	1	1,023	NFC	-	NFC	-	NFC	-	NFC	-
	3052	1	1,056	1	0.09	0	-	0	-	0	-
	3053	1	503	NFC	-	NFC	-	NFC	-	NFC	-
Coulter Creek Access Road	2061 (Coulter Creek)	1	1,012	2	0.79	0	-	22	2.17	0	-
	2063	1	650	11	1.69	0	-	4	0.62	4	0.62

CPUE = catch-per-unit-effort, fish/100 s
NFC = no fish caught
Dashes indicate not applicable

Plate 6.2-1. South Teigen Creek along Eastern Hillslope.

Plate 6.2-2. South Teigen Creek within Flat Valley.

Plate 6.2-3. South Teigen Creek within Confined Valley.

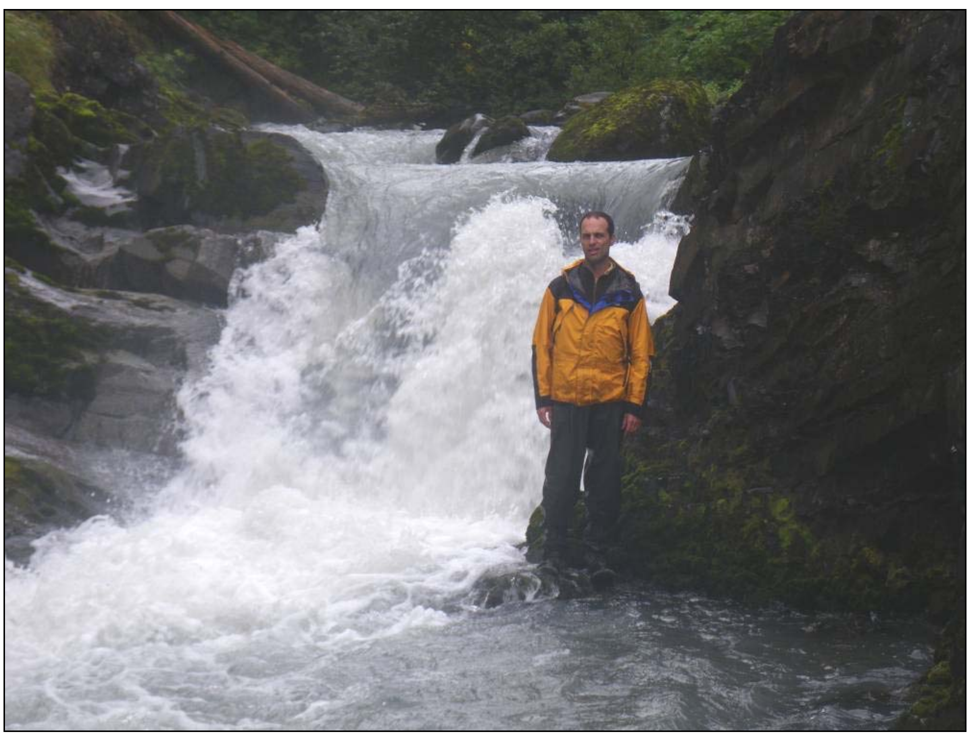


Plate 6.2-4. South Teigen Creek Falls.

Plate 6.2-5. South Teigen Creek Downstream of Falls.

Plate 6.2-6. North Treaty Creek along Eastern Hillslope.

Plate 6.2-7. North Treaty Creek Wetland Complex.

Plate 6.2-8. North Treaty Creek within Low Gradient Valley.

Plate 6.2-9. North Treaty Creek within Confined Valley.

Plate 6.2-10. Large Tributary Downstream of North Treaty Creek Confluence.

Within North Treaty Watershed, a total of 8.3 km of stream fish habitat was mapped and assessed within the TMF, of which 2.8 km was the mainstem and 5.5 km was tributaries. A total of 1.2 km of

North Treaty Creek was mapped and assessed downstream of the TMF to the confluence with a large tributary from the eastern hillslope.

For the purposes of this report, streams were grouped according watershed location and habitat type: South Teigen Creek (mainstem within TMF and downstream of TMF), South Teigen tributaries (within TMF), North Treaty Creek (mainstem within TMF and downstream of TMF) and North Treaty tributaries (within TMF). Results were then grouped into three categories:

- channel characteristics - length assessed, area assessed, bankfull width, wetted width, bankfull depth, wetted depth, residual pool depth and gradient;
- instream and riparian habitat characteristics - habitat unit ratio, habitat weighted substrate composition, habitat weighted cover composition, riparian vegetation type, riparian structural stage, riparian crown closure, channel morphology, bank stability and dominant bank substrate; and
- habitat quality characteristics - spawning habitat, rearing habitat, over-wintering habitat, overall habitat and potential spawning habitat.

6.2.2.2 Channel Characteristics

Tables 6.2-1 to 6.2-4 summarize channel characteristics for South Teigen and North Treaty watersheds. Within South Teigen Watershed, a total of 6.8 ha of stream fish habitat were present within the TMF, of which 4.9 ha were the mainstem and 1.9 ha was tributaries. A total of 6.0 ha of South Teigen Creek fish habitat was present downstream of the TMF to the confluence with Teigen Creek. Within North Treaty Watershed, a total of 2.4 ha of stream fish habitat were present within the TMF, of which 1.7 ha were the mainstem and 0.7 ha was tributaries. A total of 0.9 ha of North Treaty Creek fish habitat was present downstream of the TMF to the confluence with the large tributary.

Channel characteristics varied between mainstem reaches and tributaries. Generally, South Teigen Creek had a larger mean bankfull width and depth then North Treaty Creek. North Treaty Creek had a higher mean channel gradient then South Teigen Creek. South Teigen tributaries had a larger mean bankfull width (1.9 m) and depth (0.3 m) then North Treaty tributaries (1.2 and 0.3 m). South Teigen tributaries had a greater occurrence of residual pools compared to North Treaty tributaries. South Teigen tributaries had a higher average channel gradient then North Treaty tributaries.

6.2.2.3 Channel Morphology and Instream Habitat

<u>Channel Morphology</u>

Tables 6.2-5 to 6.2-8 summarize channel morphology for South Teigen and North Treaty watersheds. Figure 6.2-1 (located in the map pocket) presents the SHIM channel morphology mapping results for South Teigen and North Treaty watersheds within the TMF.

Cascade-pool streams often have larger substrate classes than riffle-pool streams due to steeper gradient. Of the three primary morphology types, riffle-pool channels have the highest likelihood for supporting stream resident salmonids. In gravel bed channels, riffle-pool morphology generally meets all the life history requirements for spawning, rearing, over-wintering and migration habitat. Cascade-pool reaches with cobble, gravel and boulder substrates provide rearing and over-wintering habitat for juvenile salmonids. Spawning habitat in cascade-pool reaches is generally not abundant due to the predominance of cobble substrates. In cascade-pool reaches, spawning habitat is primarily restricted to small patches of gravel and sand in pool tailout areas.

Table 6.2-1. South Teigen Mainstem: Channel Characteristics

	1	**2**	**3**	**4**	**All**	**4**	**5**	**6**	**7**	**8**	**All**
Stream Length (m)	1340.0	760.0	1407.0	1518.0	5025.0	2376.0	2964.0	1220.0	261.0	808.0	7629.0
Bankfull Width (m)											
Mean	15.33	10.30	10.30	11.33	11.82	6.70	6.44	5.06	6.00	8	6.44
SE	2.03	0.72	0.72	0.67	1.03	0.46	0.77	0.27	-	-	0.50
Stream Area (m^2)	20546.67	7828.00	14492.10	17204.00	60070.77	15922.17	19073.34	6167.10	1566.00	6464.00	49192.61
Wetted Width (m)											
Mean	12.33	10.07	10.07	10.67	10.78	6.28	6.14	4.61	6.00	7.8	6.16
SE	1.20	0.70	0.70	0.83	0.86	0.40	0.75	0.08	-	-	0.41
Bankfull Depth (m)											
Mean	1.11	1.00	1.00	0.99	1.03	0.97	0.84	0.55	0.30	0.7	0.67
SE	0.20	0.25	0.25	0.25	0.24	0.16	0.14	0.13	-	-	0.14
Wetted Depth (m)											
Mean	0.56	0.57	0.57	0.55	0.56	0.56	0.51	0.28	0.30	0.5	0.43
SE	0.07	0.17	0.17	0.21	0.15	0.11	0.09	0.02	-	-	0.07
Residual Pool Depth (m)											
Mean	-	-	-	-	-	0.97	0.93	-	-	-	0.95
SE	-	-	-	-	-	0.44	0.18	-	-	-	0.31
Gradient (%)											
Mean	1.50	2.85	3.00	3.50	2.71	2.75	1.00	5.00	-	6.00	3.00
SE	-	-	-	0.33	0.56	0.55	-	-	-	1.00	0.54

Dashes indicate not present or not applicable

Table 6.2-2. South Teigen Watershed Tributaries: Channel Characteristics

Attribute		1002	1003	1004	1005	1006	1007	1008	1009	1010	1011	1012	1013	1014	1015	1016	1017	1018
Stream Length (m)		42.00	87.00	455.00	105.00	161.00	169.00	176.00	39.00	371.00	182.00	279.00	14.00	55.00	75.00	520.00	70.00	24.00
Bankfull Width (m)																		
	Mean	1.10	0.91	2.17	1.67	1.17	2.26	1.32	0.50	6.20	1.93	3.60	2.00	0.65	0.90	3.45	3.50	1.50
	SE	0.11	0.08	0.57	0.09	0.08	0.31	0.08	-	0.25	0.30	0.06	-	-	-	0.54	-	0.50
Stream Area (m^2)		45.99	78.74	985.08	174.83	188.01	382.50	231.44	19.50	2300.20	350.35	1004.40	28.00	35.75	67.50	1794.00	245.00	36.00
Wetted Width (m)																		
	Mean	1.38	1.10	2.60	1.64	1.00	1.26	0.98	0.46	6.21	1.90	3.40	1.10	0.63	0.70	2.69	3.50	1.50
	SE	-	-	-	0.24	0.13	0.40	0.12	-	0.17	0.32	0.15	-	-	-	0.10	-	-
Bankfull Depth (m)																		
	Mean	0.30	0.30	0.30	0.24	0.20	0.18	0.29	0.24	0.52	0.48	0.35	-	0.17	0.70	0.41	-	-
	SE	-	-	-	0.05	0.02	0.03	0.01	-	0.06	0.14	0.08	-	-	-	0.10	-	-
Wetted Depth (m)																		
	Mean	0.18	0.16	0.10	0.16	0.15	0.11	0.11	0.05	0.37	0.40	0.26	0.25	0.13	0.08	0.26	-	-
	SE	-	-	0.00	0.02	0.04	0.01	0.02	0.00	0.06	0.04	0.05	0.05	0.02	0.01	0.02	-	-
Residual Pool Depth (m)																		
	Mean	0.10	0.17	-	0.12	0.12	0.16	0.05	-	-	0.37	0.28	0.33	-	0.10	-	-	-
	SE	-	0.02	-	0.01	0.01	0.07	0.01	-	-	0.07	0.07	0.09	-	0.00	-	-	-
Gradient (%)																		
	Mean	1.0	2.0	3.5	1.0	14.0	17.0	18.0	1.0	10.0	12.0	11.8	1.0	1.0	3.0	15.5	2.0	0.0
	SE	-	-	1.50	-	6.24	8.00	-	-	-	5.29	2.75	-	-	-	7.50	-	-

Dashes indicate not present or not applicable

(continued)

Table 6.2-2. South Teigen Watershed Tributaries: Channel Characteristics (completed)

Attribute		1019	1021	1022	1023	1025	1026	1027	1028	1029	1030	1110	1150	1151	1152	1205	1206	1207	All
Stream Length (m)		550.00	168.00	289.00	173.00	352.00	100.00	112.00	105.00	448.00	1743.00	125.00	575.00	51.00	24.00	62.00	39.00	24.00	7764.00
Bankfull Width (m)																			
	Mean	2.75	1.25	1.52	1.83	1.64	1.75	0.91	3.10	3.00	2.61	5.25	1.29	0.50	1.22	1.40	1.52	1.25	1.99
	SE	0.25	0.09	0.26	0.24	-	0.13	0.28	0.10	0.00	0.45	0.25	0.05	-	-	0.90	-	-	0.25
Stream Area (m^2)		1512.50	209.58	439.28	317.28	578.34	175.00	101.55	325.50	1344.00	4553.10	656.25	741.23	25.50	29.28	86.80	59.28	30.00	19151.75
Wetted Width (m)																			
	Mean	3.75	1.23	1.43	1.88	1.40	1.88	0.64	3.20	3.00	3.04	5.25	1.42	1.03	1.22	0.50	1.39	1.25	1.93
	SE	0.63	-	0.03	0.27	0.07	0.03	0.19	-	-	0.36	-	0.04	-	-	-	-	-	0.20
Bankfull Depth (m)																			
	Mean	0.45	-	0.13	0.22	0.47	0.21	0.19	0.20	0.40	0.52	-	0.31	0.17	0.15	0.10	0.30	-	0.30
	SE	0.16	-	0.03	0.06	0.17	0.04	0.01	-	-	0.14	-	0.05	-	-	-	-	-	0.07
Wetted Depth (m)																			
	Mean	0.30	0.13	0.09	0.17	0.34	0.16	0.14	0.14	0.29	0.35	-	0.21	0.13	0.05	0.05	0.06	0.08	0.18
	SE	0.06	0.03	0.00	0.01	0.17	0.01	0.00	0.00	0.02	0.04	-	0.01	0.02	0.00	0.00	0.01	-	0.03
Residual Pool Depth (m)																			
	Mean	0.19	0.18	0.12	0.18	0.14	-	0.07	0.33	0.16	-	-	-	-	-	-	-	-	0.18
	SE	0.05	0.04	0.02	0.05	0.02	-	0.01	0.07	0.07	-	-	-	-	-	-	-	-	0.04
Gradient (%)																			
	Mean	10.8	6.8	18.0	13.0	9.8	4.0	17.0	2.0	1.0	3.8	2.0	2.7	2.0	2.0	0.5	2.0	30.0	7.5
	SE	4.71	2.95	-	10.00	3.84	2.00	7.00	1.00	-	1.11	-	0.47	-	-	0.50	-	-	0.92

Dashes indicate not present or not applicable

Table 6.2-3. North Treaty Mainstem: Channel Characteristics

Attribute		Reach Downstream TMF	Reaches Within TMF		
		1	1	2	All
Stream Length (m)		1230	660.0	2150.0	2810.0
Bankfull Width (m)					
	Mean	6.12	5.50	6.07	5.78
	SE	0.40	0.50	0.53	0.51
Stream Area (m^2)		7527.60	3630.00	13043.33	16673.33
Wetted Width (m)					
	Mean	5.90	5.50	5.69	5.59
	SE	0.48	0.50	0.36	0.43
Bankfull Depth (m)					
	Mean	0.64	0.40	0.65	0.52
	SE	0.08	-	0.12	0.12
Wetted Depth (m)					
	Mean	0.39	-	0.42	0.42
	SE	0.03	-	0.08	0.08
Residual Pool Depth (m)					
	Mean	0.30	0.50	0.45	0.48
	SE	-	-	0.15	0.15
Gradient (%)					
	Mean	4.8	5.8	2.0	3.4
	SE	0.25	1.49	-	0.75

Dashes indicate not present or not applicable

Channel morphology varied between mainstem reaches and tributaries. There was a higher proportion of riffle-pool morphology in North Treaty Creek (83.7%) compared to South Teigen Creek (46.9%), which was dominated by cascade-pool morphology. There was a higher proportion of riffle-pool morphology in North Treaty tributaries (82.4%) compared to South Teigen tributaries (46.0%), which had high proportions of cascade-pool (24.3%) and step-pool (27.1%) morphology.

<u>Instream Habitat</u>

Tables 6.2-5 to 6.2-8 summarize instream habitat for South Teigen and North Treaty watersheds.

The habitat unit ratio was evenly distributed between three habitat types (riffle, pool and cascade) for North Treaty Creek. In comparison, habitat unit ratio favoured riffle and cascade habitat types in South Teigen Creek. There were a higher proportion of riffles in North Treaty tributaries (79.0%) compared to South Teigen tributaries (50.2%), which had a high proportion of cascades.

Substrate is a key component of fish habitat due to its physical properties and its biological functions (e.g., invertebrate habitat, cover for fish and incubator of fish embryos). The habitat-weighted substrate composition was evenly distributed between three substrate types for South Teigen Creek. In comparison, habitat weighted substrate composition favoured gravel substrates in North Treaty Creek (62.0%). South Teigen tributaries were dominated by gravel substrates and North Treaty tributaries were dominated by fine substrates.

Table 6.2-4. North Treaty Watershed Tributaries: Channel Characteristics

Attribute		1051	1052	1053	1054	1055	1056	1057	1059	1060	1061	1062	1063	1064	1065	1066	1067	1068	1069	1070
Stream Length (m)		71.0	23.0	90.0	136.0	135.0	45.0	29.0	957.0	707.0	31.0	245.0	15.0	29.0	39.0	15.0	81.0	70.0	12.0	61.0
Bankfull Width (m)																				
	Mean	1.8	1.42	1.80	1.54	1.65	1.46	1.40	1.88	3.59	0.73	1.20	0.70	0.69	1.15	0.99	1.75	1.00	0.40	0.81
	SE	0.3	0.02	-	0.17	-	-	-	0.13	0.55	-	0.22	-	-	-	-	-	-	-	-
Stream Area (m^2)		124.7	32.66	162.00	209.44	222.75	65.70	40.60	1797.79	2535.10	22.63	293.18	10.50	20.01	44.85	14.85	141.75	70.00	4.80	49.41
Wetted Width (m)																				
	Mean	1.76	1.42	1.80	1.37	1.65	1.46	0.40	1.85	3.30	0.73	1.42	0.70	0.69	1.15	0.99	1.70	1.00	0.40	0.81
	SE	0.27	0.02	-	-	-	-	-	0.45	-	-	0.02	-	-	-	-	-	-	-	-
Bankfull Depth (m)																				
	Mean	0.3	0.21	0.20	0.27	0.16	-	0.20	0.33	0.60	0.06	0.65	-	-	-	-	0.20	-	-	-
	SE	0.1	0.01	-	-	-	-	-	0.18	-	-	0.25	-	-	-	-	-	-	-	-
Wetted Depth (m)																				
	Mean	0.2	0.15	0.05	0.21	0.11	0.08	0.07	0.24	0.17	0.04	0.30	-	-	-	-	0.10	-	-	-
	SE	0.0	0.01	0.00	0.01	0.01	0.03	0.02	0.00	0.02	0.00	0.11	-	-	-	-	0.00	-	-	-
Residual Pool Depth (m)																				
	Mean	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.20	-	-
	SE	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.00	-	-
Gradient (%)																				
	Mean	4.0	2.0	3.3	2.0	4.0	2.0	2.0	9.2	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
	SE	2.00	-	1.33	-	-	-	-	2.88	-	-	-	-	-	-	-	-	-	-	-

Dashes indicate not present or not applicable

(continued)

Table 6.2-4. North Treaty Watershed Tributaries: Channel Characteristics (completed)

Attribute		1071	1072	1081	1082	1083	1084	1085	1086	1087	1088	1089	1090	1091	1101	All
Stream Length (m)		16.0	467.0	64.0	1212.0	66.0	128.0	89.0	53.0	232.0	40.0	72.0	28.0	40.0	14.0	5456.0
Bankfull Width (m)																
	Mean	0.81	0.94	1.67	1.75	0.83	1.30	0.65	1.84	1.06	1.00	0.50	0.50	0.82	0.50	1.21
	SE	-	0.24	-	0.15	-	-	-	0.03	0.06	-	-	-	-	-	0.19
Stream Area (m^2)		12.96	436.65	106.88	2119.65	54.78	166.40	57.85	97.34	246.69	40.00	36.00	14.00	32.80	7.00	9291.75
Wetted Width (m)																
	Mean	0.81	0.94	1.67	2.17	0.83	1.30	0.65	1.85	1.06	1.00	0.50	0.50	0.82	0.50	1.19
	SE	-	-	-	0.03	-	-	-	0.05	-	-	-	-	-	-	0.14
Bankfull Depth (m)																
	Mean	-	-	-	0.42	-	-	-	0.45	-	-	-	0.15	-	0.05	0.28
	SE	-	-	-	0.08	-	-	-	0.05	-	-	-	-	-	-	0.10
Wetted Depth (m)																
	Mean	-	-	-	0.22	-	-	-	0.27	-	-	-	0.12	-	0.03	0.15
	SE	-	-	-	0.03	-	-	-	0.05	-	-	-	0.00	-	0.01	0.02
Residual Pool Depth (m)																
	Mean	-	-	-	0.16	-	-	-	-	-	-	-	-	-	-	0.18
	SE	-	-	-	0.02	-	-	-	-	-	-	-	-	-	-	0.01
Gradient (%)																
	Mean	2.0	2.0	2.6	3.0	1.0	2.0	2.0	10.0	1.0	0.0	2.0	10.0	25.0	5.0	3.9
	SE	-	-	0.18	-	-	-	-	7.51	-	0.00	-	-	-	-	0.65

Dashes indicate not present or not applicable

Table 6.2-5. South Teigen Mainstem: Instream and Riparian Habitat Characteristics

		Reaches Downstream TMF					Reaches Within TMF					
Attribute	**Descriptor**	**1**	**2**	**3**	**4**	**All**	**4**	**5**	**6**	**7**	**8**	**All**
Stream Length Mapped	m	1340.0	760.0	1407.0	1518.0	5025.0	2376.0	2964.0	1220.0	261.0	808.0	7629.0
Mean Channel Width	m	15.33	10.30	10.30	11.33	11.82	6.70	6.44	5.06	6.00	8.00	6.44
Stream Area Mapped	m^2	20546.7	7828.0	14492.1	17204.0	60070.8	15922.2	19073.3	6167.1	1566.0	6464.0	49192.6
Habitat Unit Ratio (%)	Riffle	10.0	10.0	10.0	34.0	16.0	60.0	35.0	90.0	100.0	0.0	57.0
	Cascade	85.0	75.0	75.0	44.0	69.8	13.0	0.0	10.0	0.0	100.0	24.6
	Pool	5.0	15.0	15.0	22.0	14.3	21.0	25.0	0.0	0.0	0.0	9.2
	Glide	0.0	0.0	0.0	0.0	0.0	6.0	40.0	0.0	0.0	0.0	9.2
Habitat Weighted Substrate Composition - % by unit area	Fines	0.0	0.0	0.0	0.0	0.0	7.9	25.3	52.1	100.0	0.0	37.1
	Gravel	13.3	13.7	13.7	16.5	14.3	35.2	63.5	47.9	0.0	0.0	29.3
	Cobble	52.0	74.2	74.2	77.1	69.4	52.2	7.8	0.0	0.0	80.0	28.0
	Boulder	34.8	12.1	12.1	6.5	16.4	4.7	3.4	0.0	0.0	20.0	5.6
	Bedrock	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Habitat Weighted Cover Composition - % by unit area	Pool	36.7	29.3	29.3	28.2	30.9	10.3	19.4	0.0	0.0	10.0	7.9
	Boulder	31.5	6.3	6.3	6.5	12.7	2.5	1.3	0.0	0.0	20.0	4.8
	Instream Vegetation	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Overhanging Vegetation	5.0	3.2	3.2	3.2	3.6	6.4	5.0	12.1	100.0	0.0	24.7
	Undercut Bank	0.0	0.0	0.0	0.0	0.0	3.3	6.0	5.0	0.0	0.0	2.9
	Large Woody Debris	3.4	3.7	3.7	3.5	3.6		0.0	0.0	0.0	0.0	0.0
Riparian Vegetation Type - % by stream length	None	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Natural Wetland	0.0	0.0	0.0	0.0	0.0	0.0	100.0	100.0	100.0	0.0	58.3
	Shrubs	0.0	0.0	0.0	41.1	12.4	23.3	0.0	0.0	0.0	0.0	7.3
	Coniferous Forest	0.0	0.0	100.0	58.9	45.8	76.7	0.0	0.0	0.0	0.0	23.9
	Deciduous Forest	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Mixed Forest	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0	10.6
	Not Assessed	100.0	100.0	0.0	0.0	41.8	0.0	0.0	0.0	0.0	0.0	0.0

(continued)

Table 6.2-5. South Teigen Mainstem: Instream and Riparian Habitat Characteristics (completed)

		Reaches Downstream TMF					Reaches Within TMF					
Attribute	**Descriptor**	**1**	**2**	**3**	**4**	**All**	**4**	**5**	**6**	**7**	**8**	**All**
Riparian Structural Stage - % by stream length	Low Shrub (<2m)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Tall Shrub (2-10m)	0.0	0.0	0.0	41.1	12.4	23.3	100.0	100.0	100.0	0.0	65.5
	Sapling (>10m)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Young Forest	100.0	0.0	100.0	28.8	36.7	60.9	0.0	0.0	0.0	0.0	19.0
	Mature Forest	0.0	100.0	0.0	30.1	9.1	15.7	0.0	0.0	0.0	100.0	15.5
	Old Growth Forest	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Riparian Crown Closure - % by stream length	0	0.0	0.0	0.0	40.4	12.2	5.4	100.0	100.0	100.0	0.0	60.0
	1-20%	100.0	100.0	100.0	59.6	87.8	94.6	0.0	0.0	0.0	85.4	38.5
	21-40%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	14.6	1.5
	41-70%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	71-90%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	>90%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Channel Morphology - % by stream length	Cascade Pool	100.0	100.0	100.0	100.0	100.0	85.3	0.0	100.0	0.0	100.0	53.1
	Large Channel	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Riffle Pool	0.0	0.0	0.0	0.0	0.0	14.7	100.0	0.0	100.0	0.0	46.9
	Step Pool	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Bank Stability - % by stream length	Stable - Undercut	0.0	0.0	0.0	0.0	0.0	25.2	100.0	100.0	0.0	0.0	62.7
	Stable - No Undercut	100.0	100.0	100.0	100.0	100.0	74.8	0.0	0.0	0.0	0.0	23.3
	Aggrading	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	14.6	1.5
	Eroding	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0	85.4	12.5
Dominant Bank Substrate - % by stream length	Organics	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Fines	0.0	0.0	0.0	0.0	0.0	15.7	100.0	100.0	100.0	100.0	73.8
	Gravel	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Cobble	100.0	100.0	100.0	95.1	98.5	79.1	0.0	0.0	0.0	0.0	24.6
	Boulder	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Bedrock	0.0	0.0	0.0	4.9	1.5	5.1	0.0	0.0	0.0	0.0	1.6

Table 6.2-6. South Teigen Watershed Tributaries: Instream and Riparian Habitat Characteristics

Attribute	Descriptor	1002	1003	1004	1005	1006	1007	1008	1009	1010	1011	1012	1013	1014	1015	1016	1017	1018
Stream Length Mapped	m	42.0	87.0	455.0	105.0	161.0	169.0	176.0	39.0	371.0	182.0	279.0	14.0	55.0	75.0	520.0	70.0	24.0
Mean Channel Width	m	1.10	0.91	2.17	1.67	1.17	2.26	1.32	0.50	6.20	1.93	3.60	2.00	0.65	0.90	3.45	3.50	1.50
Stream Area Mapped	m^2	46.0	78.7	985.1	174.8	188.0	382.5	231.4	19.5	2300.2	350.4	1004.4	28.0	35.8	67.5	1794.0	245.0	36.0
Habitat Unit Ratio (%)	Riffle	0.0	0.0	100.0	40.0	37.5	30.0	25.0	100.0	10.0	50.0	10.0	0.0	0.0	100.0	40.0	-	-
	Cascade	100.0	100.0	0.0	50.0	55.0	70.0	70.0	0.0	53.3	30.0	60.0	0.0	0.0	0.0	50.0	-	-
	Pool	0.0	0.0	0.0	10.0	7.5	0.0	5.0	0.0	36.7	20.0	30.0	0.0	0.0	0.0	10.0	-	-
	Glide	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0	100.0	0.0	0.0	100.0	-
Habitat Weighted Substrate Composition - % by unit area	Fines	0.0	70.0	0.0	43.7	15.9	5.5	9.4	20.0	1.3	0.0	4.0	0.0	100.0	75.0	0.0	-	-
	Gravel	30.0	30.0	30.0	43.0	52.1	94.5	82.9	80.0	38.9	96.2	57.1	0.0	0.0	25.0	81.0	-	-
	Cobble	70.0	0.0	70.0	13.3	32.0	0.0	7.7	0.0	54.8	3.8	26.9	0.0	0.0	0.0	19.0	-	-
	Boulder	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.0	0.0	11.9	100.0	0.0	0.0	0.0	-	-
	Bedrock	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-
Habitat Weighted Cover Composition - % by unit area	Pool	0.0	0.0	0.0	8.4	13.2	2.8	11.3	0.0	34.6	19.8	27.6	0.0	0.0	0.0	7.2	-	-
	Boulder	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.2	0.0	11.9	50.0	0.0	0.0	0.0	-	-
	Instream Vegetation	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	25.0	0.0	0.0	-	-
	Overhanging Vegetation	70.0	70.0	80.0	4.6	0.0	37.6	4.7	80.0	2.7	4.5	0.5	0.0	90.0	25.0	4.5	-	-
	Undercut Bank	0.0	0.0	0.0	0.0	2.1	0.0	0.0	20.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-
	Large Woody Debris	5.0	5.0	0.0	10.6	2.8	0.0	5.9	0.0	9.1	15.0	14.0	0.0	0.0	0.0	7.4	-	-
Riparian Vegetation Type - % by stream length	None	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Natural Wetland	0.0	0.0	66.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0	0.0	0.0	0.0	100.0
	Shrubs	100.0	0.0	0.0	0.0	0.0	16.0	0.0	100.0	0.0	0.0	0.0	100.0	0.0	0.0	0.0	0.0	0.0
	Coniferous Forest	0.0	100.0	0.0	100.0	100.0	84.0	100.0	0.0	100.0	100.0	100.0	0.0	0.0	100.0	100.0	100.0	0.0
	Deciduous Forest	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Mixed Forest	0.0	0.0	33.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Riparian Structural Stage - % by stream length	Low Shrub (<2m)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0
	Tall Shrub (2-10m)	100.0	0.0	66.6	0.0	0.0	16.0	0.0	100.0	0.0	0.0	0.0	100.0	100.0	0.0	0.0	0.0	0.0
	Sapling (>10m)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Young Forest	0.0	100.0	0.0	100.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0	0.0	0.0	0.0
	Mature Forest	0.0	0.0	33.4	0.0	0.0	84.0	100.0	0.0	100.0	100.0	100.0	0.0	0.0	0.0	100.0	100.0	0.0
	Old Growth Forest	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Riparian Crown Closure - % by stream length	0	0.0	0.0	66.6	0.0	0.0	0.0	0.0	100.0	0.0	0.0	0.0	0.0	100.0	0.0	0.0	0.0	100.0
	1-20%	100.0	100.0	0.0	100.0	0.0	16.0	100.0	0.0	100.0	67.0	100.0	100.0	0.0	100.0	100.0	100.0	0.0
	21-40%	0.0	0.0	33.4	0.0	100.0	84.0	0.0	0.0	0.0	33.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	41-70%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	71-90%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	>90%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Not assessed	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

(continued)

Table 6.2-6. South Teigen Watershed Tributaries: Instream and Riparian Habitat Characteristics (continued)

Attribute	Descriptor	1002	1003	1004	1005	1006	1007	1008	1009	1010	1011	1012	1013	1014	1015	1016	1017	1018
Channel Morphology - % by stream length	Cascade Pool	0.0	0.0	33.4	0.0	60.2	16.0	0.0	0.0	62.0	74.2	39.8	0.0	0.0	0.0	57.7	0.0	0.0
	Large Channel	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0	100.0	0.0	0.0	100.0	100.0
	Riffle Pool	100.0	100.0	66.6	100.0	0.0	0.0	0.0	100.0	0.0	0.0	0.0	0.0	0.0	100.0	0.0	0.0	0.0
	Step Pool	0.0	0.0	0.0	0.0	39.8	84.0	100.0	0.0	38.0	25.8	60.2	0.0	0.0	0.0	42.3	0.0	0.0
	Not assessed	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Bank Stability - % by stream length	Stable - Undercut	0.0	100.0	0.0	0.0	60.2	0.0	0.0	0.0	0.0	0.0	100.0	100.0	100.0	0.0	0.0	0.0	0.0
	Stable - No Undercut	100.0	0.0	66.6	100.0	39.8	100.0	100.0	100.0	100.0	33.0	0.0	0.0	0.0	100.0	0.0	100.0	100.0
	Aggrading	0.0	0.0	33.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	57.7	0.0	0.0
	Eroding	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	67.0	0.0	0.0	0.0	0.0	42.3	0.0	0.0
Dominant Bank Substrate - % by stream length	Organics	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Fines	100.0	100.0	33.4	100.0	100.0	16.0	100.0	100.0	0.0	0.0	39.8	100.0	100.0	100.0	57.7	100.0	100.0
	Gravel	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	74.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Cobble	0.0	0.0	66.6	0.0	0.0	84.0	0.0	0.0	100.0	25.8	0.0	0.0	0.0	0.0	42.3	0.0	0.0
	Boulder	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	60.2	0.0	0.0	0.0	0.0	0.0	0.0
	Bedrock	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

(continued)

Table 6.2-6. South Teigen Watershed Tributaries: Instream and Riparian Habitat Characteristics (continued)

Attribute	Descriptor	1019	1021	1022	1023	1025	1026	1027	1028	1029	1030	1110	1150	1151	1152	1205	1206	1207	All
Stream Length Mapped	m	550.0	168.0	289.0	173.0	352.0	100.0	112.0	105.0	448.0	1743.0	125.0	575.0	51.0	24.0	62.0	39.0	24.0	7764.0
Mean Channel Width	m	2.75	1.25	1.52	1.83	1.64	1.75	0.91	3.10	3.00	2.61	5.25	1.29	0.50	1.22	1.40	1.52	1.25	2.0
Stream Area Mapped	m^2	1512.5	209.6	439.3	317.3	578.3	175.0	101.5	325.5	1344.0	4553.1	656.3	741.2	25.5	29.3	86.8	59.3	30.0	19151.7
Habitat Unit Ratio (%)	Riffle	75.0	100.0	0.0	40.0	45.0	60.0	70.0	100.0	100.0	81.7	-	41.7	0.0	100.0	100.0	100.0	0.0	50.2
	Cascade	15.0	0.0	90.0	52.5	50.0	40.0	30.0	0.0	0.0	0.0	-	30.0	0.0	0.0	0.0	0.0	100.0	33.7
	Pool	10.0	0.0	10.0	7.5	5.0	0.0	0.0	0.0	0.0	1.7	-	5.0	0.0	0.0	0.0	0.0	0.0	5.1
	Glide	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	16.7	-	23.3	100.0	0.0	0.0	0.0	0.0	13.8
Habitat Weighted Substrate Composition - % by unit area	Fines	12.8	0.0	2.0	5.7	1.4	0.0	0.0	50.0	60.0	12.9	-	37.7	100.0	10.0	30.0	40.0	0.0	22.8
	Gravel	87.2	100.0	32.0	58.4	98.6	68.9	100.0	50.0	40.0	72.9	-	37.2	0.0	90.0	70.0	60.0	20.0	55.7
	Cobble	0.0	0.0	65.9	35.9	0.0	31.1	0.0	0.0	0.0	14.2	-	22.0	0.0	0.0	0.0	0.0	80.0	17.6
	Boulder	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	3.1	0.0	0.0	0.0	0.0	0.0	3.9
	Bedrock	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Habitat Weighted Cover Composition - % by unit area	Pool	12.8	0.0	16.1	3.1	0.0	0.0	0.0	0.0	0.0	1.3	-	3.3	0.0	0.0	0.0	0.0	0.0	5.2
	Boulder	0.0	0.0	0.0	2.3	0.0	0.0	0.0	0.0	0.0	0.0	-	3.1	0.0	0.0	0.0	0.0	0.0	2.3
	Instream Vegetation	0.0	0.0	1.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	-	0.0	30.0	0.0	0.0	80.0	0.0	4.4
	Overhanging Vegetation	42.3	90.0	18.0	18.6	2.4	2.0	5.0	100.0	100.0	27.0	-	48.8	95.0	90.0	100.0	0.0	60.0	41.1
	Undercut Bank	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	1.8	0.0	0.0	0.0	0.0	0.0	0.8
	Large Woody Debris	10.1	0.0	20.5	14.0	10.0	14.1	0.0	0.0	0.0	0.0	-	6.8	0.0	0.0	0.0	0.0	0.0	4.8
Riparian Vegetation Type - % by stream length	None	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Natural Wetland	18.2	13.1	0.0	20.2	7.4	83.0	0.0	75.2	100.0	68.3	0.0	14.1	100.0	100.0	100.0	100.0	0.0	33.8
	Shrubs	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.6
	Coniferous Forest	81.8	86.9	100.0	79.8	92.6	17.0	100.0	24.8	0.0	0.0	100.0	85.9	0.0	0.0	0.0	0.0	100.0	55.6
	Deciduous Forest	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Mixed Forest	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	31.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	9.1
Riparian Structural Stage - % by stream length	Low Shrub (<2m)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3
	Tall Shrub (2-10m)	18.2	13.1	0.0	20.2	7.4	83.0	0.0	75.2	100.0	68.3	0.0	14.1	100.0	100.0	100.0	100.0	0.0	35.0
	Sapling (>10m)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Young Forest	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	14.0	0.0	72.7	0.0	0.0	0.0	0.0	0.0	14.0
	Mature Forest	81.8	86.9	100.0	79.8	92.6	17.0	100.0	24.8	0.0	17.7	100.0	13.2	0.0	0.0	0.0	0.0	100.0	50.6
	Old Growth Forest	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Riparian Crown Closure - % by stream length	0	18.2	39.3	0.0	100.0	7.4	83.0	0.0	75.2	100.0	82.3	0.0	14.1	100.0	100.0	100.0	0.0	0.0	39.3
	1-20%	81.8	60.7	0.0	0.0	92.6	17.0	100.0	24.8	0.0	17.7	100.0	85.9	0.0	0.0	0.0	100.0	0.0	50.1
	21-40%	0.0	0.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0	10.7
	41-70%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	71-90%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	>90%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Not assessed	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

(continued)

Table 6.2-6. South Teigen Watershed Tributaries: Instream and Riparian Habitat Characteristics (completed)

Attribute	Descriptor	1019	1021	1022	1023	1025	1026	1027	1028	1029	1030	1110	1150	1151	1152	1205	1206	1207	All
Channel Morphology - % by stream length	Cascade Pool	29.3	0.0	0.0	0.0	21.6	17.0	33.0	0.0	0.0	17.7	0.0	36.3	0.0	0.0	0.0	0.0	100.0	24.3
	Large Channel	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	66.1	0.0	0.0	2.6
	Riffle Pool	18.2	39.3	0.0	20.2	7.4	83.0	0.0	100.0	100.0	82.3	100.0	63.7	100.0	100.0	33.9	100.0	0.0	46.0
	Step Pool	52.5	60.7	100.0	79.8	71.0	0.0	67.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	27.1
	Not assessed	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Bank Stability - % by stream length	Stable - Undercut	13.6	0.0	0.0	0.0	52.8	0.0	67.0	0.0	0.0	53.4	0.0	14.1	0.0	0.0	66.1	100.0	0.0	25.2
	Stable - No Undercut	68.2	100.0	100.0	100.0	39.8	17.0	0.0	100.0	100.0	28.9	100.0	85.9	100.0	100.0	33.9	0.0	100.0	57.4
	Aggrading	18.2	0.0	0.0	0.0	7.4	83.0	33.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	9.0
	Eroding	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	17.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	8.4
Dominant Bank Substrate - % by stream length	Organics	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Fines	86.4	100.0	100.0	100.0	31.3	0.0	67.0	100.0	100.0	71.1	100.0	100.0	100.0	0.0	100.0	100.0	100.0	69.5
	Gravel	0.0	0.0	0.0	0.0	29.0	83.0	33.0	0.0	0.0	28.9	0.0	0.0	0.0	100.0	0.0	0.0	0.0	11.4
	Cobble	13.6	0.0	0.0	0.0	39.8	17.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	16.9
	Boulder	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.2
	Bedrock	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Table 6.2-7. North Treaty Mainstem: Instream and Riparian Habitat Characteristics

Attribute	Descriptor	Reach Downstream TMF	Reaches Within TMF		
		1	1	2	All
Stream Length Mapped	m	1230	660.0	2150.0	2810.0
Mean Channel Width	m	6.12	5.50	6.07	5.78
Stream Area Mapped	m^2	7527.6	3630.0	13043.3	16673.3
Habitat Unit Ratio (%)	Riffle	30.0	0.0	58.9	29.4
	Cascade	56.0	60.0	8.3	34.2
	Pool	14.0	40.0	32.8	36.4
	Glide	0.0	0.0	0.0	0.0
Habitat Weighted Substrate Composition - % by unit area	Fines	0.0	7.7	13.8	10.8
	Gravel	29.5	55.5	68.6	62.0
	Cobble	57.8	27.7	16.0	21.9
	Boulder	12.8	9.1	1.6	5.3
	Bedrock	0.0	0.0	0.0	0.0
Habitat Weighted Cover Composition - % by unit area	Pool	15.2	10.0	33.1	21.6
	Boulder	11.7	11.4	1.0	6.2
	Instream Vegetation	0.0	0.0	0.0	0.0
	Overhanging Vegetation	40.1	56.8	32.4	44.6
	Undercut Bank	0.8	0.0	0.0	0.0
	Large Woody Debris	9.0	10.0	8.9	9.5
Riparian Vegetation Type - % by stream length	None	0.0	0.0	0.0	0.0
	Natural Wetland	0.0	0.0	0.0	0.0
	Shrubs	14.6	30.8	44.5	41.2
	Coniferous Forest	0.0	69.2	55.5	58.8
	Deciduous Forest	0.0	0.0	0.0	0.0
	Mixed Forest	85.4	0.0	0.0	0.0
Riparian Structural Stage - % by stream length	Low Shrub (<2m)	0.0	0.0	0.0	0.0
	Tall Shrub (2-10m)	37.8	30.8	44.5	41.2
	Sapling (>10m)	0.0	0.0	0.0	0.0
	Young Forest	0.0	0.0	0.0	0.0
	Mature Forest	62.2	69.2	55.5	58.8
	Old Growth Forest	0.0	0.0	0.0	0.0
Riparian Crown Closure - % by stream length	0	100	30.8	24.9	26.3
	1-20%	0.0	69.2	75.1	73.7
	21-40%	0.0	0.0	0.0	0.0
	41-70%	0.0	0.0	0.0	0.0
	71-90%	0.0	0.0	0.0	0.0
	>90%	0.0	0.0	0.0	0.0
Channel Morphology - % by stream length	Cascade Pool	100.0	13.8	0.0	3.2
	Large Channel	0.0	0.0	0.0	0.0
	Riffle Pool	0.0	30.8	100.0	83.7
	Step Pool	0.0	55.5	0.0	13.0
Bank Stability - % by stream length	Stable - Undercut	54.9	0.0	24.9	19.1
	Stable - No Undercut	45.1	100.0	75.1	80.9
	Aggrading	0.0	0.0	0.0	0.0
	Eroding	0.0	0.0	0.0	0.0
Dominant Bank Substrate - % by stream length	Organics	0.0	0.0	0.0	0.0
	Fines	0.0	0.0	77.5	59.3
	Gravel	100.0	30.8	0.0	7.2
	Cobble	0.0	44.2	22.5	27.6
	Boulder	0.0	0.0	0.0	0.0
	Bedrock	0.0	25.0	0.0	5.9

Table 6.2-8. North Treaty Watershed Tributaries: Instream and Riparian Habitat Characteristics

Attribute	Descriptor	1051	1052	1053	1054	1055	1056	1057	1059	1060	1061	1062	1063	1064	1065	1066	1067	1068	1069	1070	1071
Stream Length Mapped	m	71.0	23.0	90.0	136.0	135.0	45.0	29.0	957.0	707.0	31.0	245.0	15.0	29.0	39.0	15.0	81.0	70.0	12.0	61.0	16.0
Mean Channel Width	m	1.8	1.42	1.80	1.54	1.65	1.46	1.40	1.88	3.59	0.73	1.20	0.70	0.69	1.15	0.99	1.75	1.00	0.40	0.81	0.81
Stream Area Mapped	m^2	124.7	32.7	162.0	209.4	222.8	65.7	40.6	1797.8	2535.1	22.6	293.2	10.5	20.0	44.9	14.9	141.8	70.0	4.8	49.4	13.0
Habitat Unit Ratio (%)	Riffle	86.7	75.0	100.0	100.0	100.0	0.0	100.0	100.0	0.0	100.0	60.0	100.0	100.0	0.0	0.0	100.0	100.0	100.0	100.0	100.0
	Cascade	13.3	25.0	0.0	0.0	0.0	100.0	0.0	0.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Pool	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	40.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Glide	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0	100.0	0.0	0.0	0.0	0.0	0.0
Habitat Weighted	Fines	40.5	82.7	20.0	90.0	20.0	75.0	80.0	74.2	0.0	80.0	20.0	100.0	60.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Substrate Composition - %	Gravel	59.5	17.3	80.0	10.0	80.0	25.0	20.0	25.8	10.0	20.0	80.0	0.0	40.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
by unit area	Cobble	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	90.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Boulder	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Bedrock	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Habitat Weighted Cover	Pool	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	23.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Composition - % by unit	Boulder	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
area	Instream Vegetation	0.0	0.0	0.0	60.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Overhanging Vegetation	95.8	70.0	100.0	0.0	10.0	40.0	5.0	52.4	0.0	5.0	80.0	100.0	100.0	50.0	100.0	40.0	100.0	100.0	10.0	10.0
	Undercut Bank	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.8	0.0	0.0	5.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Large Woody Debris	8.4	36.3	0.0	10.0	10.0	10.0	0.0	1.8	0.0	5.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	50.0	50.0
Riparian Vegetation Type -	None	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
% by stream length	Natural Wetland	0.0	0.0	0.0	21.3	0.0	0.0	0.0	5.3	27.7	0.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	0.0	0.0
	Shrubs	100.0	100.0	100.0	47.8	0.0	0.0	0.0	12.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Coniferous Forest	0.0	0.0	0.0	30.9	100.0	100.0	100.0	82.2	0.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0	100.0
	Deciduous Forest	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Mixed Forest	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	72.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Not assessed	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Riparian Structural Stage -	Low Shrub (<2m)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
% by stream length	Tall Shrub (2-10m)	100.0	100.0	100.0	69.1	0.0	0.0	0.0	17.8	27.7	0.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
	Sapling (>10m)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Young Forest	0.0	0.0	0.0	0.0	0.0	0.0	100.0	82.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Mature Forest	0.0	0.0	0.0	30.9	100.0	100.0	0.0	0.0	72.3	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Old Growth Forest	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Not assessed	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Riparian Crown Closure -	0	100.0	100.0	100.0	0.0	0.0	0.0	0.0	12.4	27.7	0.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	0.0	0.0
% by stream length	1-20%	0.0	0.0	0.0	100.0	0.0	100.0	100.0	87.6	41.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	21-40%	0.0	0.0	0.0	0.0	100.0	0.0	0.0	0.0	31.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0	100.0
	41-70%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	71-90%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	>90%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Not assessed	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Channel Morphology - %	Cascade Pool	43.7	100.0	0.0	30.9	0.0	100.0	0.0	0.0	65.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
by stream length	Large Channel	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Riffle Pool	56.3	0.0	100.0	69.1	100.0	0.0	100.0	100.0	34.7	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
	Step Pool	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Not assessed	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Bank Stability - % by	Stable - Undercut	0.0	100.0	100.0	0.0	0.0	0.0	0.0	94.7	27.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0	100.0
stream length	Stable - No Undercut	100.0	0.0	0.0	100.0	100.0	100.0	100.0	5.3	18.8	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	0.0	0.0
	Aggrading	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Eroding	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	53.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Not assessed	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Dominant Bank Substrate -	Organics	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
% by stream length	Fines	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	46.5	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
	Gravel	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Cobble	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	53.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Boulder	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Bedrock	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Not assessed	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

(continued)

Table 6.2-8. North Treaty Watershed Tributaries: Instream and Riparian Habitat Characteristics (completed)

Attribute	Descriptor	1072	1081	1082	1083	1084	1085	1086	1087	1088	1089	1090	1091	1101	All
Stream Length Mapped	m	467.0	64.0	1212.0	66.0	128.0	89.0	53.0	232.0	40.0	72.0	28.0	40.0	14.0	5456.0
Mean Channel Width	m	0.94	1.67	1.75	0.83	1.30	0.65	1.84	1.06	1.00	0.50	0.50	0.82	0.50	1.21
Stream Area Mapped	m^2	436.6	106.9	2119.7	54.8	166.4	57.9	97.3	246.7	40.0	36.0	14.0	32.8	7.0	9291.75
Habitat Unit Ratio (%)	Riffle	100.0	100.0	95.0	100.0	100.0	100.0	90.0	100.0	0.0	0.0	100.0	100.0	100.0	79.0
	Cascade	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.2
	Pool	0.0	0.0	5.0	0.0	0.0	0.0	10.0	0.0	0.0	0.0	0.0	0.0	0.0	1.7
	Glide	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.1
Habitat Weighted Substrate Composition - % by unit area	Fines	90.0	100.0	51.3	100.0	90.0	10.0	31.0	30.0	0.0	0.0	10.0	10.0	10.0	59.8
	Gravel	10.0	0.0	48.7	0.0	10.0	90.0	69.0	70.0	0.0	0.0	90.0	90.0	90.0	31.4
	Cobble	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.7
	Boulder	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Bedrock	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Habitat Weighted Cover Composition - % by unit area	Pool	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7
	Boulder	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2
	Instream Vegetation	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.8
	Overhanging Vegetation	10.0	100.0	71.7	100.0	100.0	50.0	10.0	100.0	0.0	0.0	80.0	80.0	10.0	53.9
	Undercut Bank	0.0	0.0	1.6	0.0	0.0	0.0	1.0	0.0	0.0	0.0	5.0	0.0	0.0	0.4
	Large Woody Debris	50.0	0.0	6.8	0.0	0.0	0.0	19.0	0.0	0.0	0.0	0.0	0.0	0.0	7.8
Riparian Vegetation Type - % by stream length	None	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Natural Wetland	0.0	0.0	51.7	100.0	100.0	100.0	0.0	62.1	100.0	0.0	100.0	0.0	0.0	34.9
	Shrubs	0.0	0.0	0.0	0.0	0.0	0.0	0.0	37.9	0.0	0.0	0.0	0.0	100.0	11.3
	Coniferous Forest	100.0	100.0	22.1	0.0	0.0	0.0	100.0	0.0	0.0	0.0	0.0	100.0	0.0	37.4
	Deciduous Forest	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Mixed Forest	0.0	0.0	26.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	15.2
	Not assessed	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0	0.0	0.0	0.0	1.3
Riparian Structural Stage - % by stream length	Low Shrub (<2m)	0.0	0.0	5.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.1
	Tall Shrub (2-10m)	0.0	0.0	46.5	100.0	100.0	100.0	0.0	100.0	100.0	0.0	100.0	0.0	100.0	46.4
	Sapling (>10m)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Young Forest	0.0	0.0	36.9	0.0	0.0	0.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0	24.1
	Mature Forest	100.0	100.0	11.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0	0.0	27.0
	Old Growth Forest	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Not assessed	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0	0.0	0.0	0.0	1.3
Riparian Crown Closure - % by stream length	0	0.0	0.0	7.3	100.0	0.0	0.0	0.0	100.0	100.0	0.0	0.0	0.0	100.0	29.1
	1-20%	0.0	100.0	46.5	0.0	100.0	100.0	100.0	0.0	0.0	0.0	100.0	100.0	0.0	42.8
	21-40%	100.0	0.0	46.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	26.7
	41-70%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	71-90%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	>90%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Not assessed	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0	0.0	0.0	0.0	1.3
Channel Morphology - % by stream length	Cascade Pool	0.0	0.0	0.0	0.0	0.0	0.0	0.0	37.9	0.0	0.0	0.0	0.0	100.0	12.9
	Large Channel	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0	0.0	0.0	0.0	0.0	0.7
	Riffle Pool	100.0	100.0	100.0	100.0	100.0	100.0	100.0	62.1	0.0	0.0	100.0	100.0	0.0	82.4
	Step Pool	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.6
	Not assessed	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0	0.0	0.0	0.0	1.3
Bank Stability - % by stream length	Stable - Undercut	0.0	0.0	11.5	0.0	100.0	0.0	100.0	62.1	0.0	0.0	100.0	0.0	0.0	32.7
	Stable - No Undercut	100.0	100.0	88.5	100.0	0.0	100.0	0.0	37.9	100.0	0.0	0.0	100.0	100.0	59.1
	Aggrading	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Eroding	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.9
	Not assessed	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0	0.0	0.0	0.0	1.3
Dominant Bank Substrate - % by stream length	Organics	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Fines	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	0.0	100.0	100.0	0.0	88.9
	Gravel	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0	0.3
	Cobble	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	9.6
	Boulder	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Bedrock	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Not assessed	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0	0.0	0.0	0.0	1.3

The habitat-weighted cover composition was dominated by overhanging vegetation and pool habitat in both South Teigen and North Treaty creeks. However, the proportions of these habitat types were greater in North Treaty Creek. South Teigen and North Treaty tributaries were dominated by overhanging vegetation, 41.4% and 53.9%, respectively.

In general, the more pools within a reach, the better the rearing and over-wintering habitat quality (Johnston and Slaney 1996). A very low pool cover proportion in South Teigen Creek indicates less complex habitat, reduced rearing and over-wintering habitat capability (depending upon winter flows). A low occurrence of pools can be explained by several factors. First, the bed substrate has a high composition of cobble which is resistant to scour and movement at all but peak flows, hence the bed is very stable. Second, the riparian zone lacks trees that strengthen banks and enable large undercuts to develop. In addition, the channel lacks any LWD because riparian zones are dominated by shrubs. LWD causes horizontal stream energy and laminar flow to be interrupted and deflected into the banks and bed causing pools to be scoured while also providing cover for fish.

Functional LWD abundance, type, and distribution influence fish habitat quality for all life stages. LWD cover was more abundant in tributaries then mainstem reaches. LWD cover was absent from South Teigen Creek and more prevalent in North Treaty Creek (9.5%).

Instream vegetation was not present in any mainstem streams of tributaries, which reflects the cold nature of these streams.

6.2.2.4 Riparian Vegetation and Stream Bank Characteristics

Riparian Vegetation

Tables 6.2-5 to 6.2-8 summarize riparian vegetation for South Teigen and North Treaty watersheds. Riparian vegetation provides diverse physical and biological functions along a stream channel, including bank stability, erosion prevention, shade, physical and energy inputs as well as habitat for invertebrates, fish and wildlife.

South Teigen Creek riparian vegetation type and structural stage was dominated by natural wetland (58.3%) composed of tall shrubs (65.5%). North Treaty Creek was evenly distributed by upland tall shrubs (41.2%) and mature coniferous forest (58.8%). In addition, crown closure varied between 0 to 20% for the majority of South Teigen and North Treaty creeks. South Teigen tributaries were distributed by natural wetland composed of tall shrubs (35.0%) and mature coniferous forest (50.6%). North Treaty tributaries were dominated by a variety of riparian vegetation types and structural stages. In addition, crown closure varied between 0 and 40% for the majority of South Teigen and North Treaty tributaries.

Bank Substrate and Stability

Tables 6.2-5 to 6.2-8 summarize stream bank characteristics for South Teigen and North Treaty watersheds. The composition and shape of the stream banks as well as erosion and deposition processes affect the overall channel stability and complexity of fish habitat.

North Treaty Creek had stable banks (no undercut) composed of fines and cobble substrates. South Teigen Creek had stable undercut banks, for the majority of the mainstem, which was composed of fines and cobble substrates. North Treaty and South Teigen tributaries possessed a mixture of stable banks (undercut and no undercut) composed of fines and cobble substrates depending upon site specific conditions.

6.2.2.5 Habitat Quality

Since Dolly Varden are the only fish species identified within the TMF, field crews focused on the habitat requirements of juvenile and adult Dolly Varden. Professional expertise was used to rank habitat as either poor, fair, good or not present (none) based upon Dolly Varden habitat requirements (McPhail 2007; Roberge et al. 2002). Good quality habitat has most or all of the key physical and biological attributes for the life stage and species of interest. Fair quality habitat has some physical/biological features for the life stage but is missing one or two key attributes. Poor quality habitat has very few physical/biological features for the life history stage and is missing most of the key attributes. No habitat has none of the physical/biological features for the life history stage.

<u>Rearing Habitat</u>

Tables 6.2-9 to 6.2-12 summarize rearing habitat quality for South Teigen and North Treaty watersheds. Figure 6.2-2 (located in the map pocket) presents the SHIM rearing habitat mapping results for South Teigen and North Treaty watersheds within the TMF.

The subjective evaluation of rearing habitat took into account several factors:

- rearing habitat preferences of Dolly Varden;
- distribution and abundance of habitat features (e.g. pools, riffles, cover types, water depth); and
- fish location, abundance and preferences determined during rearing habitat and density electrofishing assessments.

The relative quality of rearing habitat was rated as good, fair, poor, or none present for each stream segment. Ratings were summarized by percent of stream length for comparison of the relative amount of each habitat quality. Good rearing habitat contains most of the habitat features to sustain populations of Dolly Varden like sufficient depth, suitable velocity, several habitat cover types, a mix of substrates, mix of habitat unit types, low gradient, etc. Fair quality rearing habitat contains similar attributes but several components are at less than ideal states (e.g., lower abundance, monotypic substrate, lower complexity and patchy cover, higher gradient, etc.). Poor rearing habitat lacks most of the features necessary to support fish with obvious features lacking (e.g., sparse cover, lack of suitable flow or ephemeral flows, no fish found in that habitat, high gradient, etc.). No fish habitat occurs in NCDs and confirmed non-fish bearing streams.

Fair or better rearing habitat quality was observed at 96.6% or better of South Teigen and North Treaty creeks (Figure 6.2-2). Generally, North Treaty Creek possessed higher quality rearing habitat because of greater habitat diversity and fish habitat cover compared to South Teigen Creek. Furthermore, the overall rearing habitat for juveniles was of higher quality in North Treaty Creek compared to South Teigen Creek based upon electrofishing sampling data. The fish population density results supported the assessment of fair or better rearing throughout these creeks. Summer rearing habitat is not likely a population bottleneck or limiting factor in these creeks because it was abundant, widely dispersed and supported moderate to high fish densities through the mainstems.

Table 6.2-9. South Teigen Mainstem: Habitat Quality Characteristics

Attribute	Descriptor	Reaches Downstream TMF					Reaches Within TMF					
		1	2	3	4	All	4	5	6	7	8	All
Stream Length Mapped	m	1340.0	760.0	1407.0	1518.0	5025.0	2376.0	2964.0	1220.0	261.0	808.0	7629.0
Mean Channel Width	m	15.33	10.30	10.30	11.33	11.82	6.70	6.44	5.06	6.00	8.00	6.44
Stream Area Mapped	m^2	20546.7	7828.0	14492.1	17204.0	60070.8	15922.2	19073.3	6167.1	1566.0	6464.0	49192.6
Spawning Habitat Quality -	Fair	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
% of stream length	Good	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	None	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Poor	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Rearing Habitat Quality -	Fair	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
% of stream length	Good	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	0.0	100.0	96.6
	None	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Poor	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0	0.0	3.4
OverWintering Habitat	Fair	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Quality - % of stream	Good	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	0.0	100.0	96.6
length	None	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0	0.0	3.4
	Poor	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Potential Spawning	Abundant	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Habitat - % of stream	Micropatches	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
length	Moderate	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	None	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Overall Habitat Quality -	Critical	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
% of stream length	Important	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	0.0	100.0	96.6
	Marginal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0	0.0	3.4

Table 6.2-10. South Teigen Watershed Tributaries: Habitat Quality Characteristics

Attribute	Descriptor	1002	1003	1004	1005	1006	1007	1008	1009	1010	1011	1012	1013
Stream Length Mapped	m	42.0	87.0	455.0	105.0	161.0	169.0	176.0	39.0	371.0	182.0	279.0	14.0
Mean Channel Width	m	1.10	0.91	2.17	1.67	1.17	2.26	1.32	0.50	6.20	1.93	3.60	2.00
Stream Area Mapped	m^2	46.0	78.7	985.1	174.8	188.0	382.5	231.4	19.5	2300.2	350.4	1004.4	28.0
Spawning Habitat Quality - % of stream length	Fair	0.0	28.7	0.0	8.6	47.2	0.0	0.0	61.5	0.0	0.0	0.0	0.0
	Good	0.0	0.0	0.0	91.4	13.0	16.0	0.0	0.0	100.0	33.0	92.8	0.0
	None	0.0	0.0	0.0	0.0	0.0	0.0	0.0	38.5	0.0	0.0	7.2	100.0
	Poor	100.0	71.3	100.0	0.0	39.8	84.0	100.0	0.0	0.0	67.0	0.0	0.0
Rearing Habitat Quality - % of stream length	Fair	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.2	100.0
	Good	0.0	0.0	0.0	100.0	0.0	0.0	0.0	0.0	100.0	74.2	92.8	0.0
	None	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Poor	100.0	100.0	100.0	0.0	100.0	100.0	100.0	100.0	0.0	25.8	0.0	0.0
OverWintering Habitat Quality - % of stream length	Fair	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	47.0	0.0
	Good	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0	0.0	53.0	0.0
	None	0.0	0.0	0.0	0.0	0.0	0.0	0.0	38.5	0.0	0.0	0.0	0.0
	Poor	100.0	100.0	100.0	100.0	100.0	100.0	100.0	61.5	0.0	100.0	0.0	100.0
Potential Spawning Habitat - % of stream length	Abundant	0.0	0.0	0.0	0.0	13.0	0.0	0.0	0.0	100.0	0.0	92.8	0.0
	Micropatches	100.0	100.0	66.6	100.0	0.0	100.0	100.0	0.0	0.0	67.0	0.0	0.0
	Moderate	0.0	0.0	0.0	0.0	87.0	0.0	0.0	61.5	0.0	33.0	0.0	0.0
	None	0.0	0.0	33.4	0.0	0.0	0.0	0.0	38.5	0.0	0.0	7.2	100.0
	Not Assessed	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Overall Habitat Quality - % of stream length	Critical	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Important	0.0	0.0	0.0	100.0	13.0	16.0	0.0	0.0	100.0	74.2	100.0	0.0
	Marginal	100.0	100.0	100.0	0.0	87.0	84.0	100.0	100.0	0.0	25.8	0.0	100.0

(continued)

Table 6.2-10. South Teigen Watershed Tributaries: Habitat Quality Characteristics (continued)

Attribute	Descriptor	1014	1015	1016	1017	1018	1019	1021	1022	1023	1025	1026	1027
Stream Length Mapped	m	55.0	75.0	520.0	70.0	24.0	550.0	168.0	289.0	173.0	352.0	100.0	112.0
Mean Channel Width	m	0.65	0.90	3.45	3.50	1.50	2.75	1.25	1.52	1.83	1.64	1.75	0.91
Stream Area Mapped	m^2	35.8	67.5	1794.0	245.0	36.0	1512.5	209.6	439.3	317.3	578.3	175.0	101.5
Spawning Habitat Quality - % of stream length	Fair	0.0	0.0	42.3	0.0	0.0	18.2	63.1	49.5	20.2	0.0	0.0	33.0
	Good	0.0	0.0	57.7	0.0	0.0	68.2	13.1	0.0	0.0	60.2	0.0	0.0
	None	100.0	100.0	0.0	100.0	100.0	13.6	0.0	0.0	0.0	0.0	0.0	67.0
	Poor	0.0	0.0	0.0	0.0	0.0	0.0	23.8	50.5	79.8	39.8	100.0	0.0
Rearing Habitat Quality - % of stream length	Fair	0.0	0.0	0.0	0.0	0.0	13.6	0.0	0.0	100.0	39.8	0.0	0.0
	Good	0.0	0.0	100.0	0.0	0.0	68.2	0.0	49.5	0.0	60.2	0.0	0.0
	None	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Poor	100.0	100.0	0.0	100.0	100.0	18.2	100.0	50.5	0.0	0.0	100.0	100.0
OverWintering Habitat Quality - % of stream length	Fair	0.0	0.0	100.0	0.0	0.0	0.0	0.0	0.0	79.8	0.0	0.0	0.0
	Good	0.0	0.0	0.0	0.0	0.0	81.8	0.0	0.0	0.0	52.8	0.0	0.0
	None	100.0	100.0	0.0	100.0	0.0	18.2	0.0	0.0	0.0	0.0	0.0	0.0
	Poor	0.0	0.0	0.0	0.0	100.0	0.0	100.0	100.0	20.2	47.2	100.0	100.0
Potential Spawning Habitat - % of stream length	Abundant	0.0	0.0	57.7	0.0	0.0	68.2	13.1	0.0	0.0	0.0	0.0	0.0
	Micropatches	0.0	100.0	0.0	0.0	0.0	13.6	60.7	100.0	100.0	39.8	0.0	67.0
	Moderate	0.0	0.0	42.3	0.0	0.0	0.0	26.2	0.0	0.0	60.2	100.0	33.0
	None	100.0	0.0	0.0	100.0	100.0	18.2	0.0	0.0	0.0	0.0	0.0	0.0
	Not Assessed	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Overall Habitat Quality - % of stream length	Critical	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Important	0.0	0.0	100.0	0.0	0.0	81.8	39.3	49.5	20.2	60.2	0.0	0.0
	Marginal	100.0	100.0	0.0	100.0	100.0	18.2	60.7	50.5	79.8	39.8	100.0	100.0

(continued)

Table 6.2-10. South Teigen Watershed Tributaries: Habitat Quality Characteristics (completed)

Attribute	Descriptor	1028	1029	1030	1110	1150	1151	1152	1205	1206	1207	All
Stream Length Mapped	m	105.0	448.0	1743.0	125.0	575.0	51.0	24.0	62.0	39.0	24.0	7764.0
Mean Channel Width	m	3.10	3.00	2.61	5.25	1.29	0.50	1.22	1.40	1.52	1.25	2.0
Stream Area Mapped	m^2	325.5	1344.0	4553.1	656.3	741.2	25.5	29.3	86.8	59.3	30.0	19151.7
Spawning Habitat Quality - % of stream length	Fair	75.2	100.0	0.0	54.4	23.1	0.0	100.0	33.9	0.0	0.0	19.9
	Good	24.8	0.0	14.9	0.0	49.6	0.0	0.0	0.0	0.0	0.0	29.8
	None	0.0	0.0	0.0	0.0	0.0	100.0	0.0	66.1	0.0	0.0	6.6
	Poor	0.0	0.0	85.1	45.6	27.3	0.0	0.0	0.0	100.0	100.0	43.6
Rearing Habitat Quality - % of stream length	Fair	100.0	0.0	53.4	100.0	0.0	0.0	0.0	66.1	0.0	0.0	20.9
	Good	0.0	100.0	28.9	0.0	54.6	0.0	0.0	0.0	0.0	0.0	43.6
	None	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Poor	0.0	0.0	17.7	0.0	45.4	100.0	100.0	33.9	100.0	100.0	35.5
OverWintering Habitat Quality - % of stream length	Fair	75.2	100.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	39.4
	Good	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	14.9
	None	0.0	0.0	0.0	0.0	0.0	100.0	0.0	33.9	100.0	100.0	5.8
	Poor	24.8	0.0	0.0	100.0	100.0	0.0	100.0	66.1	0.0	0.0	39.9
Potential Spawning Habitat - % of stream length	Abundant	0.0	0.0	14.9	0	5.0	0.0	0.0	0.0	0.0	0.0	21.1
	Micropatches	0.0	0.0	0.0	0	72.7	0.0	0.0	0.0	0.0	100.0	30.6
	Moderate	24.8	0.0	67.4	54.4	22.3	0.0	100.0	33.9	100.0	0.0	29.9
	None	75.2	100.0	17.7	45.6	0.0	100.0	0.0	66.1	0.0	0.0	18.5
	Not Assessed	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Overall Habitat Quality - % of stream length	Critical	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Important	100.0	100.0	100.0	100.0	88.3	0.0	0.0	0.0	0.0	0.0	68.2
	Marginal	0.0	0.0	0.0	0.0	11.7	100.0	100.0	100.0	100.0	100.0	31.8

Table 6.2-11. North Treaty Mainstem: Habitat Quality

Attribute	Descriptor	Reach Downstream TMF	Reaches Within TMF		
		1	1	2	All
Stream Length Mapped	m	1230	660.0	2150.0	2810.0
Mean Channel Width	m	6.12	5.50	6.07	5.78
Stream Area Mapped	m^2	7527.6	3630.0	13043.3	16673.3
Spawning Habitat Quality - % of stream length	Fair	0.0	0.0	29.4	22.5
	Good	100.0	100.0	67.0	74.7
	None	0.0	0.0	0.0	0.0
	Poor	0.0	0.0	3.6	2.8
Rearing Habitat Quality - % of stream length	Fair	0.0	0.0	0.0	0.0
	Good	100.0	100.0	100.0	100.0
	None	0.0	0.0	0.0	0.0
	Poor	0.0	0.0	0.0	0.0
OverWintering Habitat Quality - % of stream length	Fair	0.0	0.0	0.0	0.0
	Good	100.0	100.0	96.4	97.2
	None	0.0	0.0	0.0	0.0
	Poor	0.0	0.0	3.6	2.8
Potential Spawning Habitat - % of stream length	Abundant	45.1	75.0	68.5	70.0
	Micropatches	0.0	0.0	3.6	2.8
	Moderate	54.9	25.0	27.9	27.2
	None	0.0	0.0	0.0	0.0
Overall Habitat Quality - % of stream length	Critical	0.0	0.0	0.0	0.0
	Important	100.0	100.0	100.0	100.0
	Marginal	0.0	0.0	0.0	0.0

Fair or better rearing habitat quality was similar between South Teigen and North Treaty tributaries, 64.5 and 63.8%, respectively. Generally, North Treaty tributaries possessed higher quality rearing habitat because of their lower gradient and abundant fish habitat cover compared to South Teigen tributaries. Furthermore, the overall rearing habitat for juveniles was of higher quality in North Treaty tributaries compared to South Teigen tributaries based upon electrofishing sampling data and fish population density results. Typically, as channel gradient increased the quality of rearing habitat decreased. In South Teigen tributaries along the western hillslopes, upstream reaches flowed subsurface during the summer months which isolated the upper reaches from the mainstem. Overall, summer rearing habitat is not likely a population bottleneck or limiting factor in these tributaries because it was abundant, widely dispersed and supported moderate to high fish densities.

Table 6.2-12. North Treaty Watershed Tributaries: Habitat Quality Characteristics

Attribute	Descriptor	1051	1052	1053	1054	1055	1056	1057	1059	1060	1061	1062	1063	1064	1065	1066	1067	1068
Stream Length Mapped	m	71.0	23.0	90.0	136.0	135.0	45.0	29.0	957.0	707.0	31.0	245.0	15.0	29.0	39.0	15.0	81.0	70.0
Mean Channel Width	m	1.8	1.4	1.8	1.5	1.7	1.5	1.4	1.9	3.6	0.7	1.2	0.7	0.7	1.2	1.0	1.8	1.0
Stream Area Mapped	m^2	124.7	32.7	162.0	209.4	222.8	65.7	40.6	1797.8	2535.1	22.6	293.2	10.5	20.0	44.9	14.9	141.8	70.0
Spawning Habitat Quality - % of stream length	Fair	100.0	0.0	100.0	30.9	100.0	0.0	0.0	32.7	6.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Good	0.0	0.0	0.0	21.3	0.0	0.0	0.0	12.4	0.0	0.0	100.0	100.0	100.0	0.0	0.0	0.0	0.0
	None	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.3	81.2	0.0	0.0	0.0	0.0	100.0	100.0	100.0	100.0
	Poor	0.0	100.0	0.0	47.8	0.0	100.0	100.0	49.5	11.9	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Rearing Habitat Quality - % of stream length	Fair	0.0	0.0	0.0	69.1	0.0	0.0	0.0	5.3	11.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Good	0.0	0.0	0.0	0.0	0.0	0.0	0.0	94.7	0.0	0.0	100.0	100.0	100.0	100.0	100.0	100.0	0.0
	None	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Poor	100.0	100.0	100.0	30.9	100.0	100.0	100.0	0.0	88.1	100.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0
OverWintering Habitat Quality - % of stream length	Fair	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Good	0.0	0.0	0.0	0.0	0.0	0.0	0.0	82.2	0.0	0.0	100.0	100.0	100.0	100.0	100.0	100.0	0.0
	None	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	27.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Poor	100.0	100.0	100.0	100.0	100.0	100.0	100.0	17.8	72.3	100.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0
Potential Spawning Habitat - % of stream length	Abundant	56.3	0.0	0.0	52.2	100.0	0.0	0.0	12.4	6.9	0.0	100.0	100.0	100.0	0.0	0.0	0.0	0.0
	Micropatches	0.0	100.0	0.0	47.8	0.0	100.0	0.0	49.5	0.0	100.0	0.0	0.0	0.0	0.0	100.0	0.0	0.0
	Moderate	43.7	0.0	100.0	0.0	0.0	0.0	0.0	32.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	None	0.0	0.0	0.0	0.0	0.0	0.0	100.0	5.3	93.1	0.0	0.0	0.0	0.0	100.0	0.0	100.0	100.0
	Not Assessed	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Overall Habitat Quality - % of stream length	Critical	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Important	100.0	0.0	0.0	21.3	0.0	0.0	0.0	94.7	0.0	0.0	100.0	100.0	100.0	100.0	100.0	100.0	0.0
	Marginal	0.0	100.0	100.0	78.7	100.0	100.0	100.0	5.3	100.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0

(continued)

Table 6.2-12. North Treaty Watershed Tributaries: Habitat Quality Characteristics (completed)

Attribute	Descriptor	1069	1070	1071	1072	1081	1082	1083	1084	1085	1086	1087	1088	1089	1090	1091	1101	All
Stream Length Mapped	m	12.0	61.0	16.0	467.0	64.0	1212.0	66.0	128.0	89.0	53.0	232.0	40.0	72.0	28.0	40.0	14.0	5456.0
Mean Channel Width	m	0.4	0.8	0.8	0.9	1.7	1.7	0.8	1.3	0.7	1.8	1.1	1.0	0.5	0.5	0.8	0.5	1.2
Stream Area Mapped	m^2	4.8	49.4	13.0	436.6	106.9	2119.7	54.8	166.4	57.9	97.3	246.7	40.0	36.0	14.0	32.8	7.0	9291.8
Spawning Habitat Quality - % of stream length	Fair	0.0	0.0	0.0	0.0	0.0	37.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	21.2
	Good	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0	100.0	23.3	0.0	0.0	100.0	100.0	0.0	12.8
	None	100.0	100.0	100.0	0.0	100.0	53.9	100.0	0.0	0.0	0.0	0.0	100.0	0.0	0.0	0.0	0.0	31.9
	Poor	0.0	0.0	0.0	100.0	0.0	8.4	0.0	100.0	0.0	0.0	76.7	0.0	100.0	0.0	0.0	100.0	34.0
Rearing Habitat Quality - % of stream length	Fair	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	23.3	0.0	100.0	0.0	0.0	0.0	6.5
	Good	0.0	0.0	0.0	100.0	100.0	100.0	0.0	0.0	0.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0	57.3
	None	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0	0.3
	Poor	100.0	100.0	100.0	0.0	0.0	0.0	100.0	100.0	100.0	0.0	76.7	100.0	0.0	100.0	100.0	0.0	35.9
OverWintering Habitat Quality - % of stream length	Fair	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0
	Good	0.0	0.0	0.0	0.0	0.0	11.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	24.7
	None	0.0	100.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0	0.0	0.0	0.0	100.0	6.0
	Poor	100.0	0.0	0.0	100.0	100.0	88.5	100.0	100.0	100.0	0.0	100.0	0.0	100.0	100.0	100.0	0.0	68.3
Potential Spawning Habitat - % of stream length	Abundant	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0	0.0	23.3	0.0	0.0	100.0	0.0	0.0	16.0
	Micropatches	0.0	0.0	0.0	100.0	0.0	15.8	0.0	100.0	0.0	0.0	76.7	0.0	0.0	0.0	0.0	100.0	32.5
	Moderate	0.0	0.0	0.0	0.0	0.0	37.7	0.0	0.0	0.0	100.0	0.0	0.0	0.0	0.0	100.0	0.0	18.0
	None	100.0	100.0	100.0	0.0	100.0	46.5	100.0	0.0	0.0	0.0	0.0	100.0	0.0	0.0	0.0	0.0	32.1
	Not Assessed	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0	0.0	0.0	0.0	1.3
Overall Habitat Quality - % of stream length	Critical	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Important	0.0	0.0	0.0	100.0	100.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0	100.0	0.0	59.4
	Marginal	100.0	100.0	100.0	0.0	0.0	0.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	0.0	0.0	100.0	40.6

Spawning Habitat Quality and Frequency

Tables 6.2-9 to 6.2-12 summarize spawning habitat quality and frequency for South Teigen and North Treaty watersheds. Figure 6.2-3 (located in the map pocket) presents the SHIM spawning habitat mapping results for South Teigen and North Treaty watersheds within the TMF.

The subjective evaluation of spawning habitat took into account several factors:

- spawning habitat preferences of Dolly Varden;
- distribution and abundance of habitat features (e.g., pools, riffles, cover types and water depth); and
- fish presence and preferences determined during surveys for spawning adults and presence of fry (i.e., those 0+ years in age) from electrofishing assessments. Since fry have limited swimming ability and generally cannot actively migrate upstream past small chutes, their presence indicates the successful spawning within a stream segment in the previous year.

Spawning habitat consists of several elements: suitable-sized gravel patches in the proper hydraulic location, adequate water depth and flow, and suitable cover for adults. During the assessment, field crews undertook a subjective assessment of each stream segment for spawning habitat quality (i.e., poor, fair, good and none) and rated the relative amount of potential spawning habitat within a segment (i.e., abundant, moderate, trace or micro-patch). The percentage of a stream segment that was suitable for spawning was classified as abundant (≥ 50%), moderate (30 to 50%) or micro-patch (i.e., gravel patch less than 1 m^2). Micro-patches were very small features within stream segments and were typically a sand or small gravel patch deposited behind a boulder along the bank.

Field crews considered good spawning habitat for Dolly Varden to contain mainly sand and gravel substrate with minor cobble. Good spawning habitat was generally found in low gradient and velocity stream segments with abundant overhanging vegetation and instream cover. Poor spawning habitat typically only had one of these elements resulting in a low likelihood of being used for spawning since key features (cover and depth) were not present. Stream segments that did not have gravel patches and some form of cover was not considered spawning habitat.

The results for spawning habitat quality and distribution were the opposite of the rearing habitat findings. In contrast to rearing habitat, which was observed throughout the mainstems and tributaries, South Teigen Creek provided none to poor suitable spawning habitat. The high composition of glacial fine substrate and high flows during the spawning season do not provide suitable spawning habitat for Dolly Varden. Furthermore, the lack of adults observed spawning in the mainstem (Table 6.2-13) and absence to low abundance of fry in the mainstem support this assessment. The entire length of North Treaty Creek provides good and abundant Dolly Varden spawning habitat due to habitat characteristics, suitable flow, and good water quality.

Fair or better spawning habitat quality was observed at 49.7% of South Teigen tributaries. Typically, as channel gradient increased the quality of spawning habitat decreased. South Teigen tributaries possessed higher quality spawning habitat in the lower gradient tributary reaches near the mainstem because suitable spawning habitat was present, and the abundance of fry rearing in these reaches based upon electrofishing sampling data. Spawning habitat is not likely a population bottleneck or limiting factor in the South Teigen tributaries. However, the maintenance of winter baseflows to provide sufficient egg incubation along the western and eastern hillslope tributaries is not known since certain tributaries flow subsurface during the summer months.

Table 6.2-13. Summary of Spawning Habitat Assessments within South Teigen and North Treaty Watersheds, 2009

Watershed	Streams Surveyed	Spawning Observed	Redd Observed
South Teigen	**1001 (South Teigen Creek)**	**-**	**-**
	1007	-	-
	1008	-	-
	1009	-	-
	1010	Y	-
	1011	-	-
	1012	Y	-
	1014	-	-
	1015	-	-
	1016	-	-
	1017	-	-
	1018	-	-
	1021	-	-
	1022	-	-
	1030	Y	-
	1150	-	-
	1206	-	-
	1207	-	-
North Treaty	**1050 (North Treaty Creek)**	**-**	**-**
	1059	Y	-
	1060	-	-
	1062	-	-
	1063	-	-
	1064	-	-
	1065	-	-
	1066	-	-
	1067	-	-
	1068	-	-
	1072	Y	Y
	1082	Y	-
	1083	-	-
	1088	-	-

Y = yes
Dashes indicate "no"

Fair or better spawning habitat quality was observed at 34.0% of North Treaty tributaries. North Treaty tributaries possessed higher quality spawning habitat near the wetland complex because of suitable flow, cover, substrate, depth, observation of adults spawning in these tributaries, and the abundance of fry rearing in these streams based upon electrofishing sampling data. The wetland complex provides maintenance of baseflows to provide sufficient egg incubation during the winter months. Spawning habitat is not a population bottleneck or limiting factor in the North Treaty tributaries.

Over-Wintering Habitat

Tables 6.2-9 to 6.2-12 summarize over-wintering habitat quality for South Teigen and North Treaty watersheds. Figure 6.2-4 (located in the map pocket) presents the SHIM over-wintering habitat mapping results for South Teigen and North Treaty watersheds within the TMF.

Over-wintering habitat consists of refuge areas, typically pools or deep runs, that remain wetted and do not freeze to the bottom at base winter flows (November to May). Water depth and velocity, cover, as well as ice thickness and distribution, generally determine the suitability of an area as over-wintering habitat. Fish reduce their activity during winter but still forage. Over-wintering habitat potential was based mainly upon the presence of pools or deep runs and knowing the maximum fish size (approximately 25 cm).

All reaches of South Teigen and North Treaty creeks provide good over-wintering habitat for Dolly Varden. This assessment was based upon the presence, frequency and distribution of pools, adequate residual pool depths, instream cover, and maintenance of base flows throughout the winter months.

Fair or better over-wintering habitat quality was observed at 54.3% for South Teigen tributaries. A high percentage of these tributaries possessed no over-wintering habitat. The majority of tributaries had very few deep pools and deeper runs of less than 20 cm residual depth, with the exception of Streams 1010, 1016 and 1019. As noted previously, the channel morphology was shallow with mean water depths during the high-flow summer period less than 20 cm and even lower winter base flows are predicted. The channels were mostly cobble riffles and runs which are anticipated to provide very little space for over-wintering fish.

Fair or better over-wintering habitat quality was observed at 25.7% of the North Treaty tributaries. A high percentage of these tributaries possessed no over-wintering habitat. The majority of tributaries had no residual pools. As noted previously, the channel morphology was shallow with mean water depths during the high-flow summer period less than 15 cm and even lower winter base flows are predicted. The channels were mostly fines and gravel riffles and runs which are anticipated to provide very little space for overwintering fish. However, tributaries located downstream of the wetland complex may provide sufficient over-wintering habitat despite the lack of pools.

Overall Habitat

Tables 6.2-9 to 6.2-12 summarize overall habitat quality for South Teigen and North Treaty watersheds. Figure 6.2-5 (located in the map pocket) presents the SHIM overall habitat mapping results for South Teigen and North Treaty watersheds within the TMF.

Overall habitat quality is based upon all the life history stage rankings (i.e., spawning, rearing and over-wintering) previously discussed for each stream segment. The criteria of overall habitat are defined in Table 5.2-2.

All reaches of South Teigen and North Treaty creeks provided important fish habitat for Dolly Varden. Important habitat quality was observed at 68.2% for South Teigen tributaries and 59.4% for North Treaty tributaries. Critical habitat was not identified in either watershed.

6.2.2.6 Spawning Habitat Assessment

The Dolly Varden spawning period was anticipated to be the last two weeks of September and first week of October, based upon field observations in 2008 (Rescan 2009), literature reviews (McPhail 2007; Roberge *et al.* 2002; Bustard 2006). Dolly Varden spawning surveys were conducted in mapped streams within the TMF from September 17 to 19. Appendix 6.2-3 presents spawning survey data for each stream ground-truthed within the TMF.

Table 6.2-13 summarizes the results of the spawning survey by spawning activity or redds observed. Spawning activity and redds were observed in six tributaries, but not mainstem reaches of South Teigen and North Treaty creeks. All sites were low-gradient reaches, with abundant cover and small- sized gravels. Photographs of typical Dolly Varden spawning substrate are shown in Plates 6.2-11 and 6.2-12. Spot surveys were conducted at various locations along South Teigen and North Treaty creeks. Water clarity was poor in South Teigen Creek during the time of the assessment.

6.2.3 Stream - Fish Community

The locations of density sampling sites within the TMF are shown in Figure 6.2-2. Appendix 6.1-2 shows all species biological data for each density sampling site and rearing sampling site. Appendix 6.1-3 shows all electrofishing effort and catch data for each site.

6.2.3.1 Length, Weight and Condition

Table 6.2-14 summarizes length, weight and condition data for fish species captured in South Teigen and North Treaty watersheds. Dolly Varden in South Teigen Creek were longer and heavier compared to conspecifics in its tributaries, North Treaty Creek and its tributaries. Length-frequency distributions were plotted for all Dolly Varden caught in South Teigen and North Treaty watersheds (Figures 6.2-6 and 6.2-7). Dolly Varden were smaller in South Teigen tributaries compared to South Teigen Creek. These results support previous assessments that the tributaries provide the majority of fry (0+) and parr (1+) rearing habitat within South Teigen watershed (Section 6.2.2.5). Dolly Varden were shorter in North Treaty tributaries compared to North Treaty Creek. Although this shift was of a smaller magnitude then in South Teigen watershed, it supports previous assessments that North Treaty Creek provides suitable rearing habitat for Dolly Varden fry and parr. Length class modes were similar between watersheds, with approximate length ranges of 25 to 45 mm for fry, 45 to 70 mm for parr, 70 to 85 mm for 2+ fish, and 85 to 105 mm for 3+ fish.

Dolly Varden weight-length regressions were calculated by watershed (Figure 6.2-8). Regressions of fish weight-length data for South Teigen and North Treaty watersheds were all highly significant ($P < 0.001$) and explained between 98 and 99% of the variation in weight. The slope of regressions for Dolly Varden sampled from these sites was close to the expected value of 3.0, typical for the length-weight geometry of fish. Generally, Dolly Varden in North Treaty Creek were in better condition than its tributaries, South Teigen Creek and its tributaries (Table 6.2-14).

6.2.3.2 Age and Growth

Age data for all fish captured in South Teigen and North Treaty watersheds are summarized in Table 6.2-15. Generally, Dolly Varden from the mainstems were older than from the tributaries. Age-frequency distributions were constructed for all Dolly Varden aged from South Teigen and North Treaty watersheds (Figure 6.2-9). South Teigen Creek had the greatest age range of 1 to 5 years. North Treaty tributaries had the narrowest age range of 2 to 3 years. However, interpretation of this dataset should be applied with caution because of low sample size – many fish were too small to effectively take age structures from.

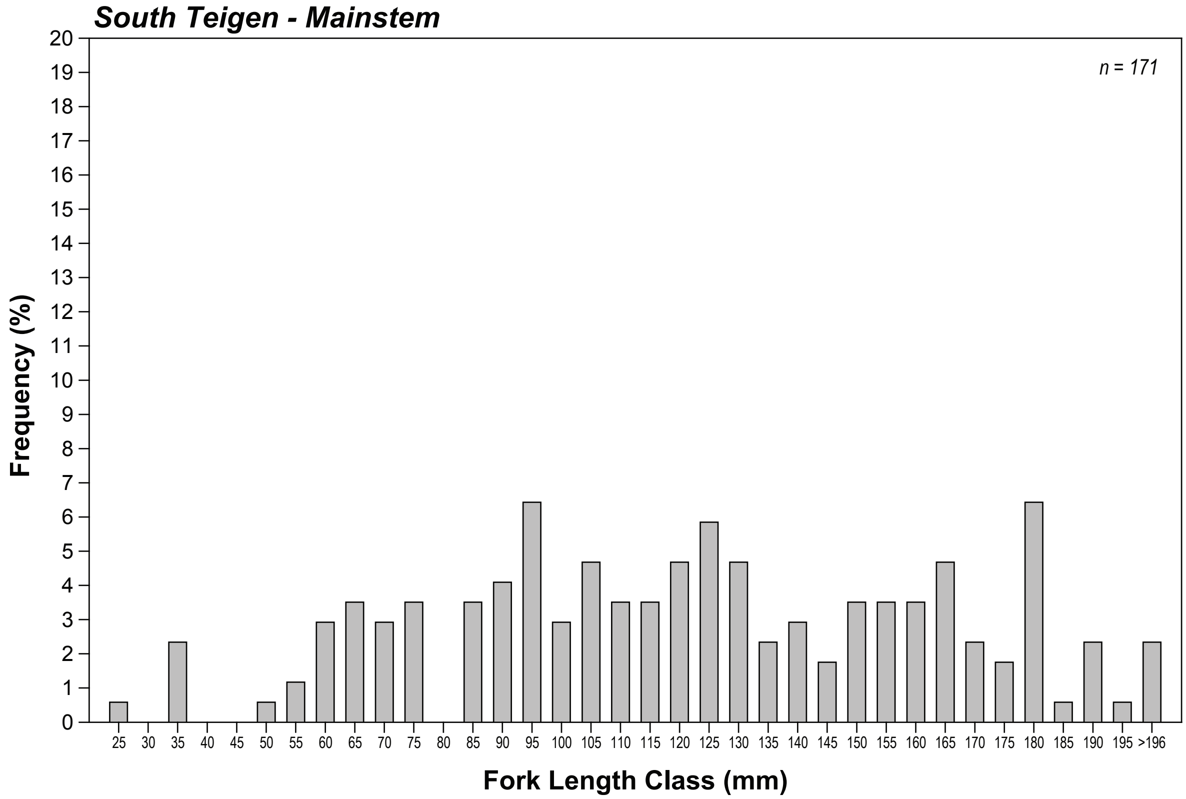
Plate 6.2-11. Typical Dolly Varden Spawning Habitat.

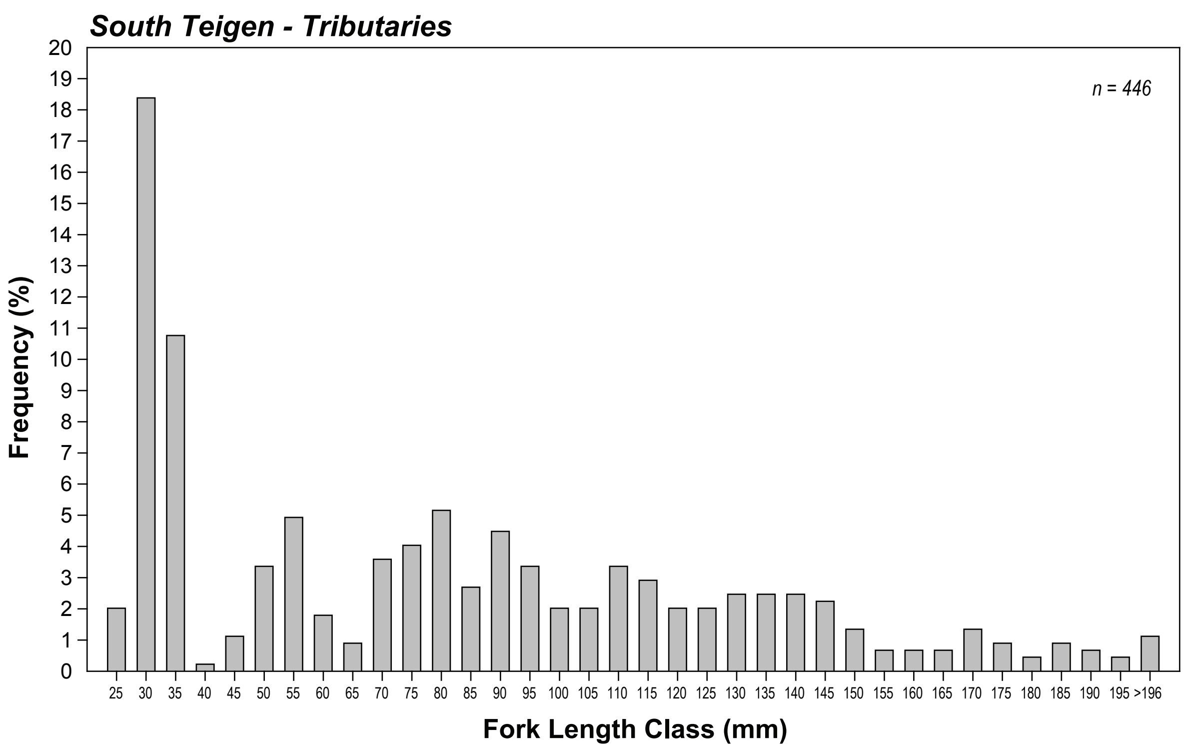
Plate 6.2-12. Dolly Varden within Cover near Spawning Habitat

Table 6.2-14. Mean Length, Weight and Condition of Dolly Varden Captured in South Teigen and North Treaty Watersheds, 2009

Watershed	Length (mm)						Weight (g)						Condition (g/mm^3)		
	N	Mean	SE	Min	Max		N	Mean	SE	Min	Max		N	Mean	SE
North Treaty (Mainstem)	261	97	2.1	28	185		261	13.1	0.8	0.2	66.5		261	1.05	0.01
North Treaty (Tributaries)	303	68	1.6	22	180		258	4.8	0.4	0.2	59.6		303	0.90	0.12
South Teigen (Mainstem)	171	120	3.2	25	210		170	25.1	1.7	0.2	101.9		171	1.04	0.01
South Teigen (Tributaries)	398	71	2.0	23	179		293	9.4	0.7	0.1	61.0		398	0.81	0.03

SE = standard error





Fork Length Class Distribution of Dolly Varden within South Teigen Watershed, 2009

FIGURE 6.2-6

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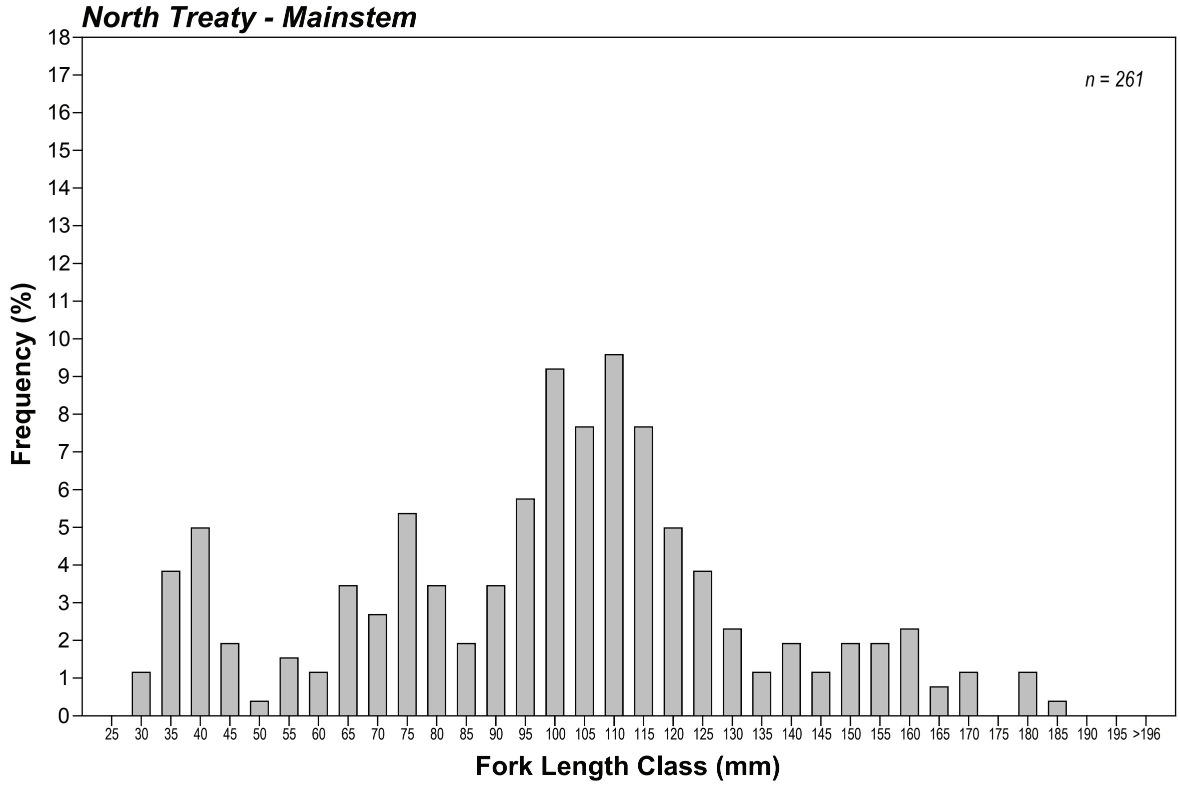
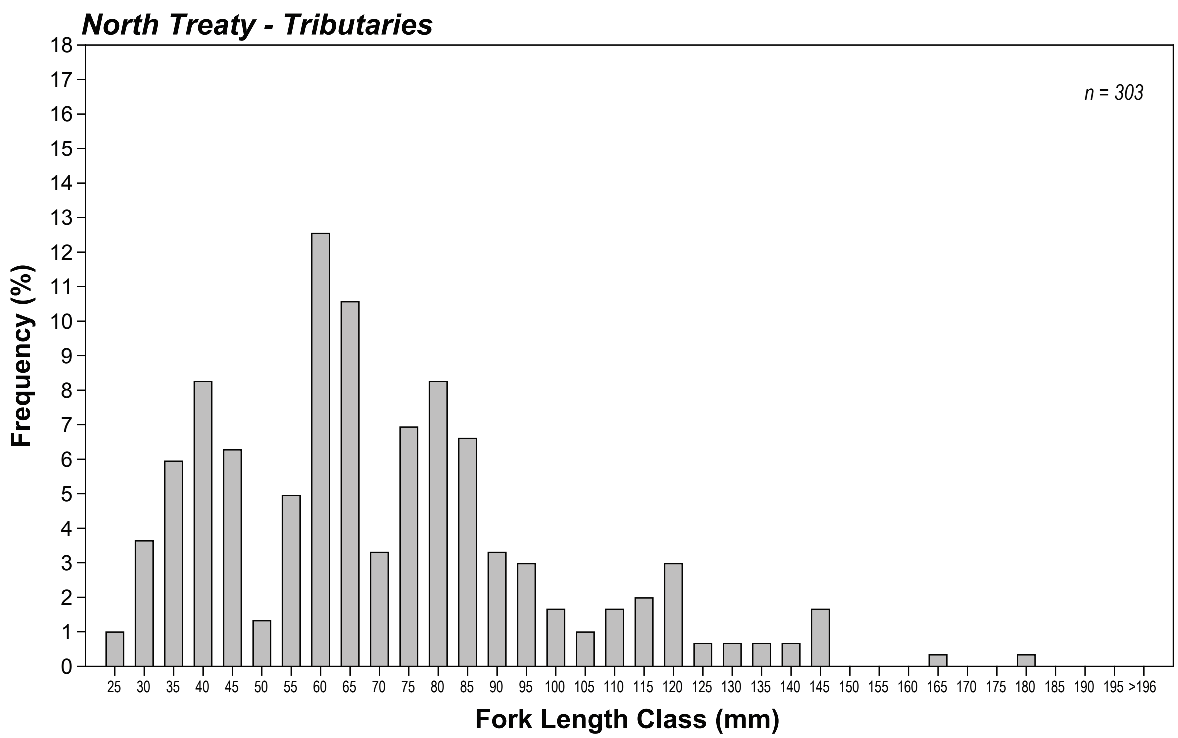
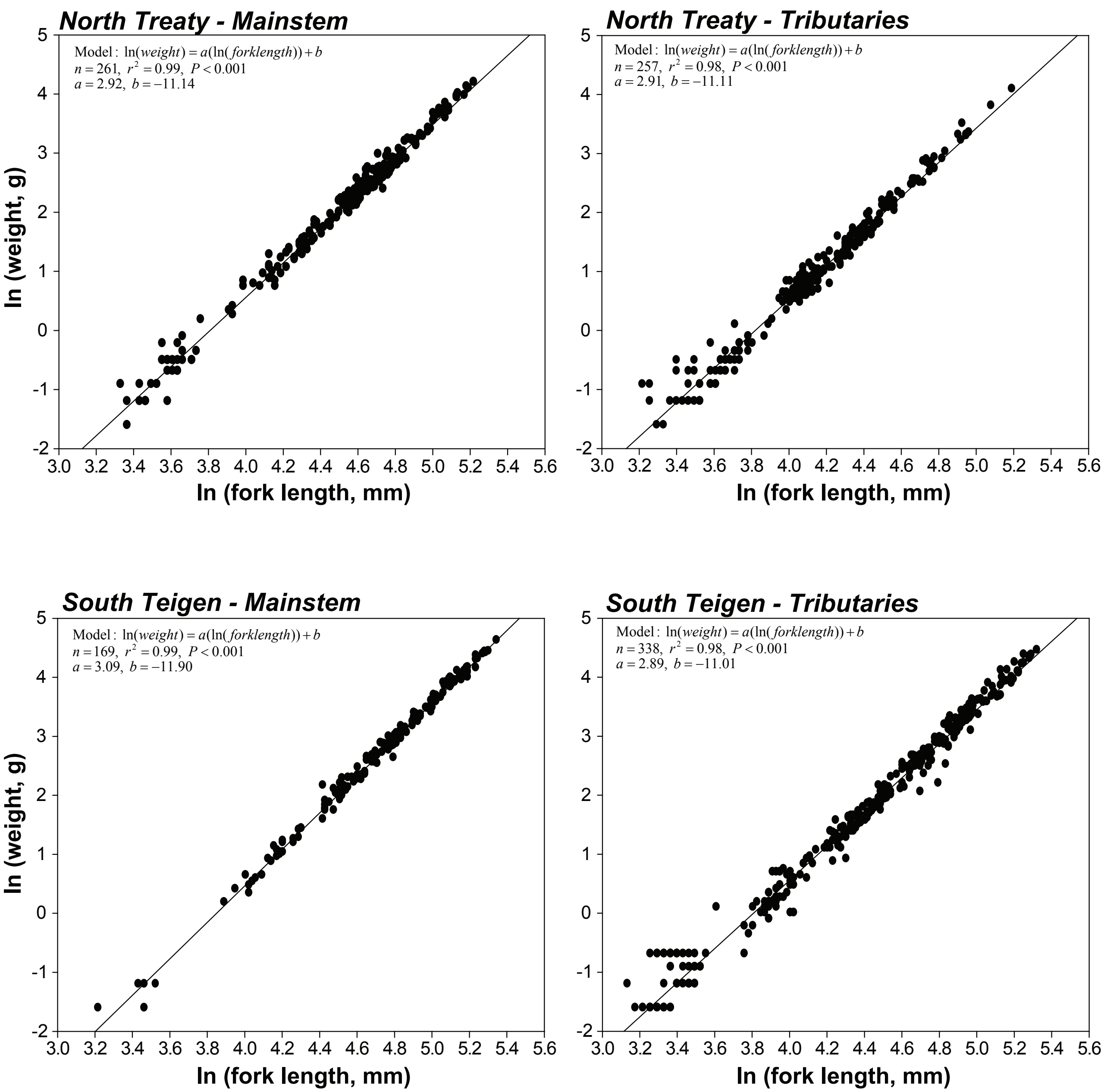




Fork Length Class Distribution of Dolly Varden within North Treaty Watershed, 2009

FIGURE 6.2-7



Weight-Length Regression of Dolly Varden within South Teigen and North Treaty Watersheds, 2009

FIGURE 6.2-8

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Table 6.2-15. Mean Age of Dolly Varden Captured in South Teigen and North Treaty Watersheds, 2009

		Age (years)			
Watershed	n	Mean	SE	Min	Max
North Treaty (Mainstem)	16	3	0.2	2	5
North Treaty (Tributaries)	11	2	1.0	2	3
South Teigen (Mainstem)	36	3	0.2	1	5
South Teigen (Tributaries)	30	3	0.1	2	4

SE = standard error

Von Bertalanffy growth models were fit to the age and length data of fish from South Teigen and North Treaty creeks (Figure 6.2-10). Age explained between 64 and 84% of the variation in fish length. The maximum attainable length was estimated at 202 mm for North Treaty Creek and 610 mm for South Teigen Creek. However, interpretation of these growth curves should be applied with caution because of low sample size.

6.2.3.3 Population Density

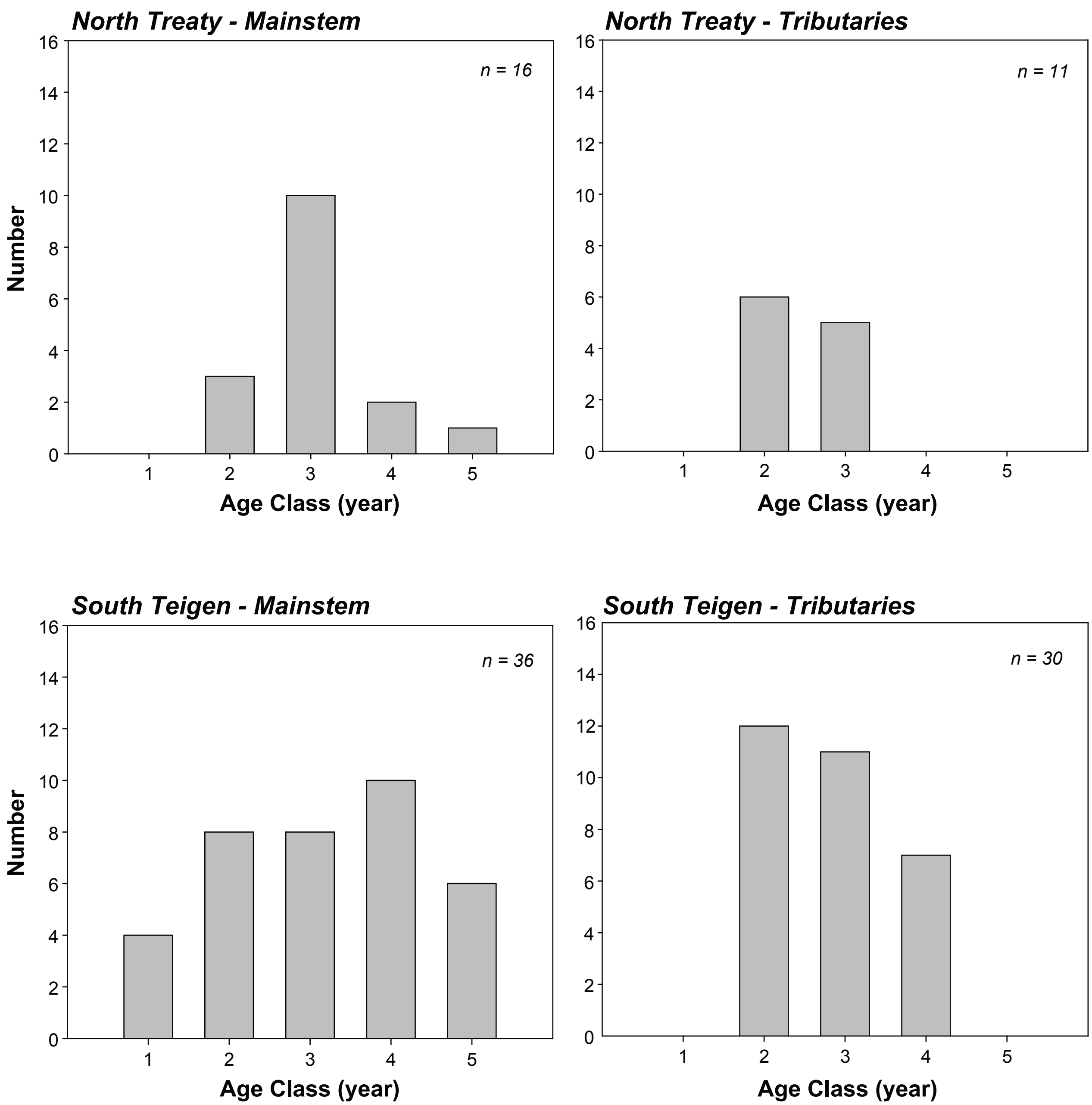
Appendix 6.1-3 shows all electrofishing effort and catch data for each density sampling site. Appendix 6.2-4 shows the results of density calculations with upper and lower confidence limits for each site.

Three-pass electrofishing surveys were completed in mid-August and early September (South Teigen Creek only) at 11 sites in South Teigen Creek, 16 sites in South Teigen tributaries, 7 sites in North Treaty Creek and 8 sites in North Treaty tributaries (Figure 6.2-2). Sites were randomly distributed among the mainstem reaches and tributaries throughout the TMF. Electrofishing sampling conditions were good across all sites with good water visibility, effective block nets preventing fish movement, low flows, and suitable water temperatures, except South Teigen Creek were water visibility and flow was moderate.

A total area of 5,856 m^2 was sampled for fish population density across the 42 sites (Appendix 6.2-4). The mean area sampled within South Teigen and North Treaty creeks was 159 m^2 with a range of 25 to 304 m^2. The mean area sampled within South Teigen and North Treaty tributaries was 82 m^2 with a range of 35 to 195 m^2.

Mean electrofishing effort was 2,057 s/site within South Teigen and North Treaty creeks. Mean electrofishing effort was 1,686 s/site within South Teigen and North Treaty tributaries. Crews were moderately successful in maintaining consistent effort between each pass. For South Teigen and North Treaty creeks, mean pass effort was 7.1, 6.9 and 6.7 s/m^2 for each pass. For South Teigen and North Treaty tributaries, mean pass effort was 8.5, 7.7 and 7.5 s/m^2 for each pass.

A total of 7 sites were excluded from the population density analysis because they failed to meet model assumptions (i.e., increasing catch probability with each successive pass) (Johnson et al. 2007). Dolly Varden population estimates were obtained with maximum likelihood methods for 30 sites with declining catch ratios. Population estimates were obtained with the Bayesian method for the other 5 sites that had catches that did not decline consistently with successive passes. Mean Dolly Varden population estimates for sites were 16 for South Teigen Creek, 63 for North Treaty Creek, 19 for South Teigen tributaries and 36 for North Treaty tributaries (Appendix 6.2-4).



Age Class Distribution of Dolly Varden within South Teigen andNorth Treaty Watersheds, 2009

FIGURE 6.2-9

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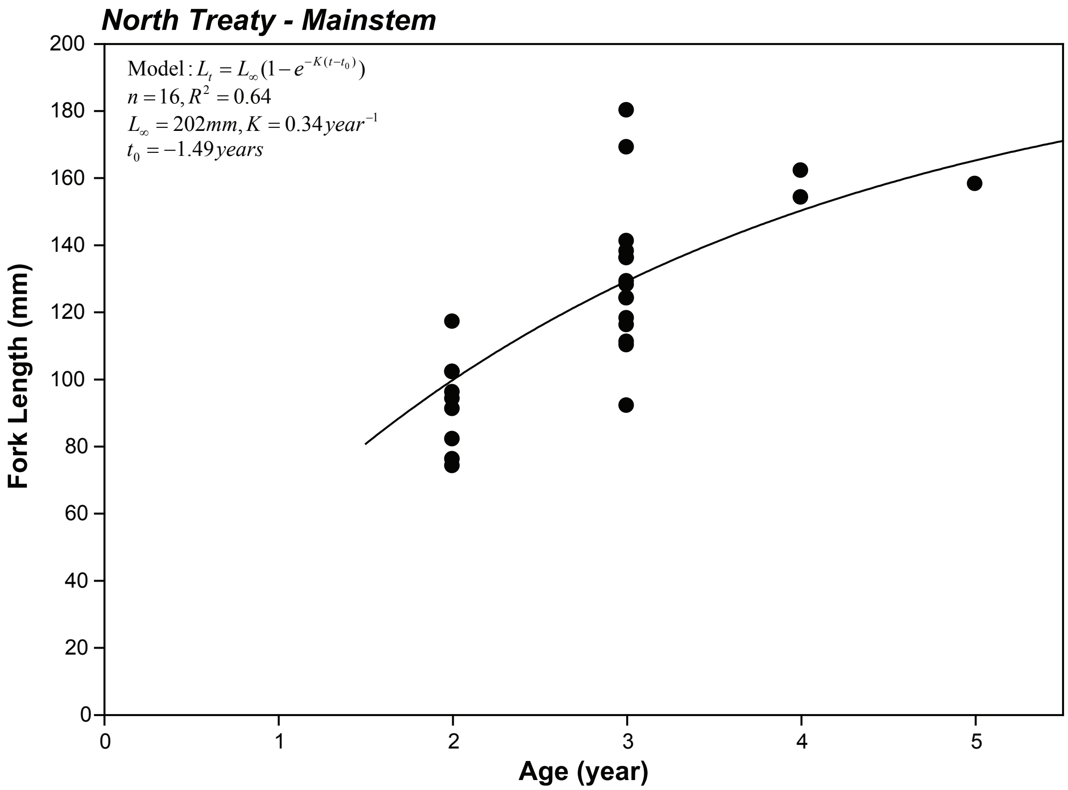
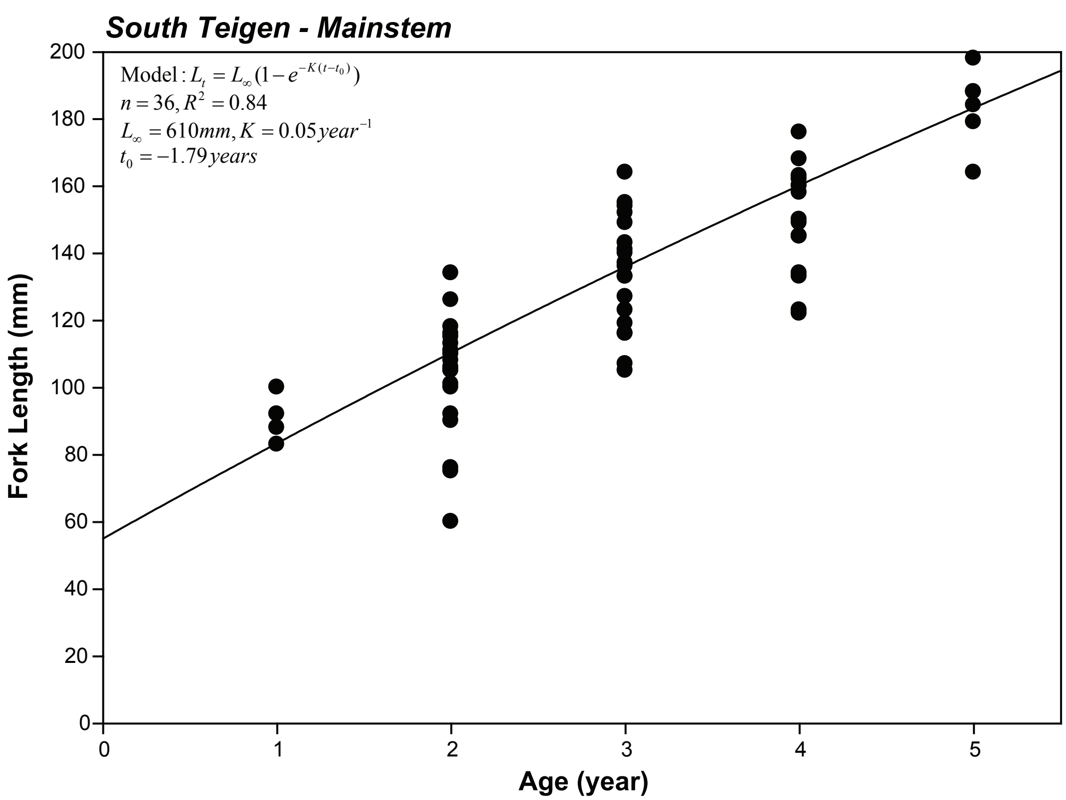




Von Bertalanffy Growth Models of Dolly Varden within South Teigen and North Treaty Watersheds, 2009

FIGURE 6.2-10

Mean Dolly Varden population densities were higher in North Treaty Creek (99 fish/100 m^2) compared to 9 fish/100 m^2 for South Teigen Creek (Table 6.2-16). The range of densities was 1.5 to 17.1 fish/100 m^2 in South Teigen Creek. The range of densities was 41.1 to 252 fish/100 m^2 in North Treaty Creek (Appendix 6.2-4). Mean Dolly Varden population densities were higher in North Treaty tributaries compared to South Teigen tributaries (Table 6.2-16). The range of densities was 0 to 54.5 fish/100 m^2 in South Teigen tributaries. The range of densities was 0 to 138 fish/100 m^2 in North Treaty tributaries (Appendix 6.2-4). Mean population densities and first-pass CPUE results were similar between watersheds.

Table 6.2-16. Mean CPUE and Density of Dolly Varden Captured in South Teigen and North Treaty Watersheds, 2009

Watershed	1st Pass CPUE (fish/100 s)			Population Density (fish/100m^2)		
	n	Mean	SE	n	Mean	SE
South Teigen (Mainstem)	11	1.2	0.6	11	8.8	1.2
South Teigen (Tributaries)	12	1.8	2.4	12	29.9	2.1
North Treaty (Mainstem)	4	3.8	1.9	4	99.3	17.2
North Treaty (Tributaries)	8	2.4	2.2	8	50.1	3.1

SE = standard error
n = sample size

Furthermore, electrofishing effort occurred on Stream 1010 upstream of a series of cascades (Plate 6.2-13) in the location of the proposed plant site (Figure 6.2-2). A total of 1,525 s electrofishing effort was exerted in Stream 1010 on two separate sampling events; however no fish were caught. Stream 1010, formally Stream 4009, was sampled in 2008 and no fish were caught despite 1,422 s of electrofishing effort (Rescan 2009). Therefore, streams above the series of cascades were classified as non-fish bearing.

6.2.3.4 Dolly Varden Genetics

A total of 164 Dolly Varden genetic tissue samples were collected from four areas within the Treaty and Teigen watersheds. The four areas were: upstream of South Teigen Creek falls (Teigen Watershed), downstream of South Teigen Creek falls (Teigen Watershed), North Treaty Creek within the TMF (Treaty Watershed) and Treaty Creek (Treaty Watershed). Appendix 6.2-5 presents a final report, conducted by UBC, of genetic variation within and between Dolly Varden from two localities within the Bell-Irving Watershed assessed using microsatellite DNA. A summary of the report results are provided below.

The genetic variation from Teigen Creek was slightly more variable (mean number of alleles per locus = 13.6, mean expected heterozygosity of 0.70) than that from Treaty Creek (11.7 and 0.65, respectively). These markers clearly provide considerable power to investigate genetic differentiation in these Dolly Varden populations.

The proportion of the total variation in allele frequencies that is attributable to differences among samples is known as F_{ST} and is estimated from sample data using Weir and Cockerham's (1984) θ statistic, which varies from 0 (no difference) to 1.0 (maximum difference among samples). There was clear separation between Dolly Varden collected from the two watersheds. This was evident in the ordination of each fish along the first three FCA axes (Figure 6.2-11). In Figure 6.2-11, the blue symbols represent individuals from Teigen Creek watershed and the yellow symbols represent individuals from Treaty Creek watershed.

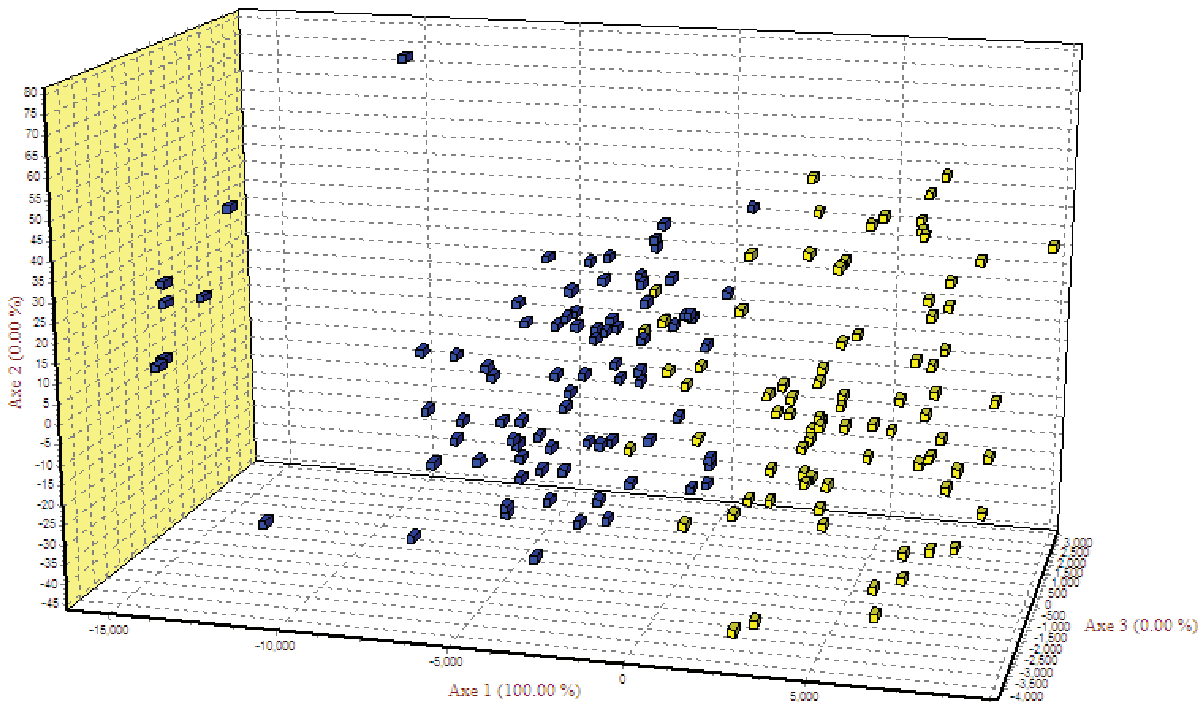
Plate 6.2-13. Stream 1010 Cascades.

Within Treaty Creek, there was a clear distinction between samples collected from the lower watershed and those from the upper watershed (Appendix 6.2-5, Figure 2). Within Teigen Creek, there was a clear separation between fish collected above and below the putative migration barrier (Appendix 6.2-5, Figure 3). There were also a number of individuals sampled below the putative migration barrier, in South Teigen Creek, that were homozygous for an allele at Sfo18 that is normally diagnostic for bull trout.

The F_{ST} resolved was consistent with values (0.02 to 0.09) across a similar spatial scale and reported in allozyme surveys of Dolly Varden populations within tributaries flowing to the Beaufort Sea on the North Slope of Alaska (Everett et al. 1997). For interconnected systems, such as examined in this study, the reported F_{ST} values are consistent with values reported for other salmonid populations (Taylor et al. 2003; Hendry et al. 2004). The analyses also indicate that there is significant population subdivision within each creek; F_{ST} values between above and below barrier localities both within Treaty and Teigen creeks were significant and slightly exceeded those between creeks. Such within-stream variation above and below migration barriers is a common phenomenon in fluvial-dwelling salmonid populations, including char. Although the presence of such within-stream variation in Treaty and Teigen creeks is not a unique situation, it is likely an important one to acknowledge for local management.

6.2.4 Wetland - Habitat

The locations of six assessed wetlands within South Teigen and North Treaty watersheds are shown in Figure 6.2-2. Each fish-bearing wetland was mapped according to the SHIM methodology and habitat was assessed in each wetland (Tables 6.2-17 and 6.2-18). All wetland substrates were dominated by sand and fines with gravels as sub-dominant. All wetlands were dominated by pool cover type with instream vegetation (*Carex spp.*) and overhanging vegetation as sub-dominant cover types. All wetlands had tall shrub riparian vegetation, except wetland ST-W1.



Note: Blue symbols represent individuals from Teigen Creek Watershed and the yellow symbols represent individuals from Treaty Creek Watershed.

Microsatellite DNA Allele Frequency Differences of Dolly Varden from Teigen and Treaty Watersheds

FIGURE 6.2-11

Table 6.2-17. Summary of Wetland Characteristics within South Teigen and North Treaty Watersheds, 2009

Watershed	Wetland Name	Pond No.	Survey Date (dd/mm/yy)	Open Water (%)	Max Water Depth (m)	Area (m^2)
	NT-W3	3	13-Jul-09	-	0.7	624
	NT-W2	4	13-Jul-09	-	0.7	4,344
North Treaty	NT-W1	2	13-Jul-09	-	1.5	4,421
	ST-W1	5	13-Jul-09	-	0.8	1,544
	ST-W2	7	-	40	0.5	314
South Teigen	ST-W3	1	8-Jul-09	80	-	309

Dashes indicate no data avaiable

Table 6.2-18. Summary of Wetland Habitat within South Teigen and North Treaty Watersheds, 2009

Watershed	Wetland Name	Pond No.	Bed Composition (%)					Instream Cover Presence						Riparian Vegetation	Fish Habitat (Y/N)	Fish Present	Comments
			Sand	Gravel	Cobble	Boulder	Bedrock	Pool	Boulder	IV	OV	UB	LWD				
North Treaty	NT-W3	3	95	5	0	0	0	D	-	SD	SD	-	-	Tall Shrub	Y	N	Old beaver dam at outlet to larger beaver pond, no fish caught in pond
	NT-W2	4	100	0	0	0	0	D	-	SD	SD	-	-	Tall Shrub	Y	N	Old beaver dam at outlet, fish present on other side of dam, no fish caught in pond
	NT-W1	2	100	0	0	0	0	D	-	SD	T	-	-	Tall Shrub	Y	N	Old beaver dam at outlet to larger beaver pond, no fish caught in pond
South Teigen	ST-W1	5	100	0	0	0	0	D	-	SD	T	-	-	Grass	Y	Y	Direct connection to mainstem South Teigen, DV caught in pond
	ST-W2	7	70	30	0	0	0	D	-	SD	SD	-	-	Tall Shrub	Y	Y	Direct connection to stream 1152
	ST-W3	1	100	0	0	0	0	D	-	SD	SD	-	T	Tall Shrub	Y	Y	Old beaver pond and dam, connected by channels to mainstem

IV = instream vegetation
OV = overhanging vegetation
UB = undercut bank
LWD = large woody debris
D = dominant
SD = sub-dominant
T = trace
Dashes indicate not applicable

All wetlands possessed good rearing habitat. Wetland NT-W1 possessed abundant over-wintering habitat with water depths greater than 1.5 m present in some areas; however a beaver dam was present which restricts fish passage and use. All wetlands possessed no spawning habitat, due to the fine substrates.

6.2.5 Wetland - Fish Community

Appendix 6.2-6 shows the biological data on all species of fish sampled from each wetland. Appendix 6.2-7 shows all electrofishing and minnow trap effort and catch data for each wetland.

Two wetlands were sampled in 2009 (Table 6.2-19). Dolly Varden were captured in Wetland ST-W1. No fish were caught in Wetland NT-W2 despite 125 h of minnow trap effort. Wetland NT-W2 was sampled in 2008, formerly named Wetland 1, and no fish were caught despite 52 h of minnow trap effort and 850 s of electrofishing effort (Rescan 2009). The presence of a beaver dam likely restricts upstream fish movement into this wetland.

Mean length, weight, and condition of Dolly Varden sampled in Wetland ST-W1 are presented in Table 6.2-20.

6.3 RECEIVING ENVIRONMENT – STREAM AND WETLAND HABITAT

6.3.1 Watershed Setting

The fish and fish habitat study area encompasses a number of watersheds (Figure 4.1-1). For the purposes of data analysis and comparison, three watersheds were selected for detailed fish and fish habitat analysis: Teigen Creek, Treaty Creek and the Unuk River. A number of other watersheds within the study area were assessed for fish and fish habitat values, including: Bowser, South Unuk and Bell-Irving rivers, Oweegee, Snowbank, West Teigen, Sulphurets and Coulter creeks.

Stream reaches were identified and mapped for watersheds, within the study area, through air-photo interpretation, flight surveys, and ground-truthing according to RISC (2001). Characterization of each stream and reach within the study area is presented in Table 6.3-1 (Rescan 2009; SKR 1998). The location and reach boundaries for each watershed are presented in Figure 6.3-1.

6.3.2 Teigen, Treaty and Unuk Watersheds - Fish Habitat

Teigen Creek is a sixth order tributary of the Bell-Irving River and possesses a watershed area of 98.4 km^2 (Figure 6.3-2). Teigen Creek originates from a large headwater lake, Teigen Lake, and glaciers on the eastern hillslope. The creek is frequently confined, with a gradient of 4% and cobble channel substrates in the upper watershed (Plate 6.3-1). The creek then decreases in gradient, is unconfined with side channels and substrate size decreases in the middle watershed (Hodkin Creek to Snowbank Creek confluences) (Plate 6.3-2). In the lower watershed, downstream of Snowbank Creek confluence, the creek is braided with frequent side channels and wetlands, and discharges into the Bell-Irving River (Plate 6.3-3).

Treaty Creek is a fourth order tributary of the Bell-Irving River and possesses a watershed area of 180.6 km^2 (Figure 6.3-3). Treaty Creek is turbid and originates from glaciers. The creek is unconfined with braided channels near the glacial headwaters then the channel becomes confined with increased channel substrate size (Plate 6.3-4). The middle watershed is unconfined and heavily braided with numerous side channels (Plate 6.3-5). In the lower watershed, the creek is partially entrenched with few side channels, and discharges into the Bell-Irving River (Plate 6.3-6).

Table 6.2-19. Wetland Sampling Effort, CPUE and Catch Statistics in South Teigen and North Treaty Watersheds, 2009

Watershed	Site	MT Effort (hrs)	Species	No. Caught	CPUE (fish/trap/24h)
South Teigen	ST-W1	125.2	Dolly Varden	14	2.7
North Treaty	NT-W2	125.0	NFC	0	-

CPUE = catch-per-unit-effort

NFC = no fish caught

MT = minnow trap

Dashes indicate not applicable

Table 6.2-20. Mean Length, Weight and Condition of Dolly Varden Captured in South Teigen and North Treaty Wetlands, 2009

		Length (mm)					Weight (g)					Condition (g/mm^3)	
Watershed	Site	N	Mean	SE	Min	Max	N	Mean	SE	Min	Max	Mean	SE
South Teigen	ST-W1	14	118	5.3	80	142	14	17.0	2.1	4.7	26.8	0.96	0.01
North Treaty	NT-W2	-	-	-	-	-	-	-	-	-	-	-	-

Dashes indicate no data available

SE = standard error

N = sample size

Table 6.3-1. Summary of Stream Reaches within the Receiving Environment Watersheds, 2009

Watershed	Sub-Watershed	Watershed Description	Reach	Stream Length (km)	Reach Description
Bell-Irving					
Treaty Creek	-	4th order tributary of Bell-Irving River	1	7.9	Channel partially entrenched with few side channels, gradient 1%
			2	18.4	Channel heavily braided and unconfined, numerous side channels, gradient 1%
			3	9.2	Channel confined, increased channel substrate size, gradient 1%
			4	2.8	Channel unconfined, channels briaded
Teigen Creek	-	6th order tributary of Bell-Irving River	1	7.9	Channel unconfined, frequent side channels, low gradient 1%
			2	11.4	Channel unconfined and braided, low gradient 1%
			3	11.0	Channel frequently confined, increased gradient to 4%, decreased channel width, increased channel substrate size
			4	-	Teigen Lake
Teigen Creek	West Teigen Creek	Tributary of Bell-Irving River that discharges into Teigen Creek	1	0.5	Channel unconfined, braided, occasional gravel bars, gradient 1%
			2	3.3	Channel occasionally confined, seldom braided, no side channels
			3	3.0	Channel confined, channel not well defined in sections due to avalanche activity
			4	-	West Teigen Lake
Teigen Creek	Hodkin Creek	Tributary of Bell-Irving River that discharges into Teigen Creek	1	0.6	Low gradient, riffle-pool morphology channel
			2	2.9	Channel entrenched with high banks
			3	0.4	Steep gradient channel with cascades and falls
			4	-	Hodkin Lake
Snowbank Creek	-	Tributary of Bell-Irving River that discharges into Teigen Creek	1	6.1	Channel infrequently confined and braided, gradient 3%
			2	1.8	Flooded wetland with no well defined channel, beaver dams present throughout reach, substrates consisted of fines
			3	1.8	Defined channel, low gradient, gravel substrates, wetlands present
Bowser					
Scott Creek	-	4th order tributary of Bowser River	1	3.8	Channel partially confined, gradient 2-2.5%
			2	2.0	Channel confined with occasional side channels, infrequent gravel-cobble bars
			3	1.5	Channel partially confined, gradient1.5%
			4	6.4	Heavily braided with extensive beaver dam activity, sections lack well defined channel

(continued)

Table 6.3-1. Summary of Stream Reaches within the Receiving Environment Watersheds, 2009

Watershed	Sub-Watershed	Watershed Description	Reach	Stream Length (km)	Reach Description
Unuk					
Unuk River	Kaypros Creek	Headwater Tributary of Unuk River	1	2.8	Channel confined, low gradient, riffle-pool morphology, gravel channel substrates
Unuk River	-	-	1-3	2.5	The first three reaches are located in Alaska. Reach 3 channel unconfined and braided
			4	1.7	Entrenched channel, second canyon
			5	2.4	Unconfined channel, multiple channel braids
			6	3.2	Entrenched channel, thrid canyon
			7	29.4	Unconfined channel, multiple channel braids and side channels, gradient 1%
			8	4.9	Confined and entrenched channel, bedrock banks and substrates
			9	9.5	Unconfined channel, braided with gravel/cobble bars
			10	12.6	Ocassionally confined channel smaller channel width
South Unuk River	-	Tributary of Unuk River	1	9.5	Unconfined channel, braided with gravel/cobble bars
Coulter Creek	-	Tributary of Unuk River	1	1.8	Unconfined channel, channel banks not defined due to high velocity flood event, low gradient
			2	3.4	Entrenched channel, multiple falls and cascades, high gradient
			3	4.7	Confined channel, low gradient
Sulphurets Creek	-	Tributary of Unuk River	1	1.3	Unconfined channel, gradient 1%, briaded channel
			2	5.7	Entrenched channel, long cascades and falls, bedrock banks
			3	5.3	Unconfined channel, gradient 3%, briaded channel
			4	2.0	Confined channel, cobble and boulder channel substrates, gradient 4%
			5	-	Sulphurets Lake
Sulphurets Creek	Ted Morris Creek	Tributary of Unuk River that discharges into Sulphurets Creek	1	9.5	Confined channel, cobble and boulder channel substrates, gradient 5%
Mitchell Creek	-	Tributary of Unuk River that discharges into Sulphurets Creek	1	0.6	Unconfined channel, braided channel, low gradient
			2	5.1	Confined channel and entrenched in sections, cobble and boulder channel substrates, high gradient,
			3	2.4	Broad glacial fan, multiple braided channels, gradient 1%
McTagg Creek	-	Tributary of Unuk River that discharges into Mitchell Creek	1	2.5	Confined channel and entrenched in sections, cobble and boulder channel substrates, high gradient,
			2	0.8	Unconfined channel, braided channel, low gradient
			3	1.9	Confined channel, cobble and boulder channel substrates, gradient 5%

Dashes indicates not applicable

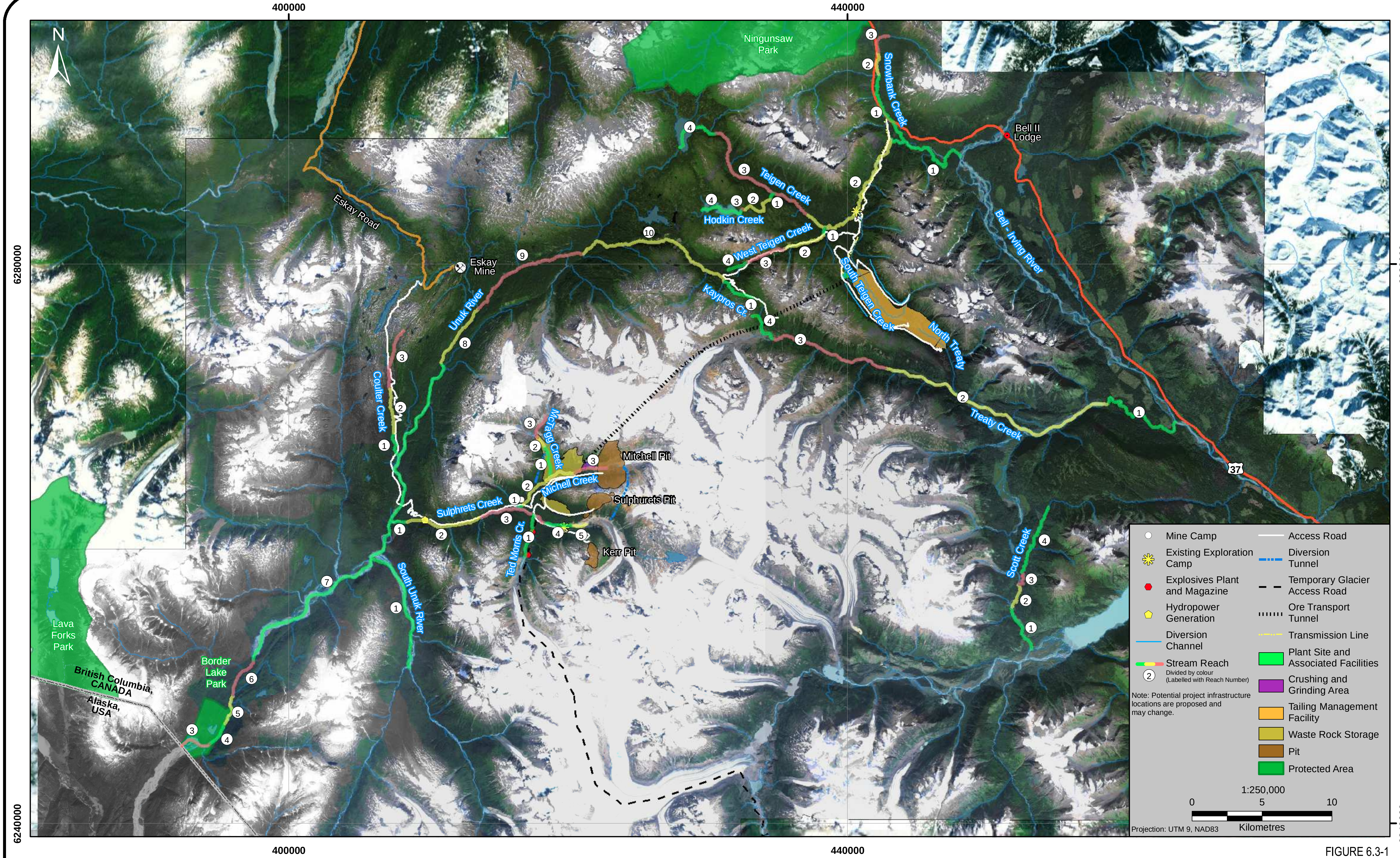


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FIGURE 6.3-1

Stream Reaches within the Receiving Environment Watersheds

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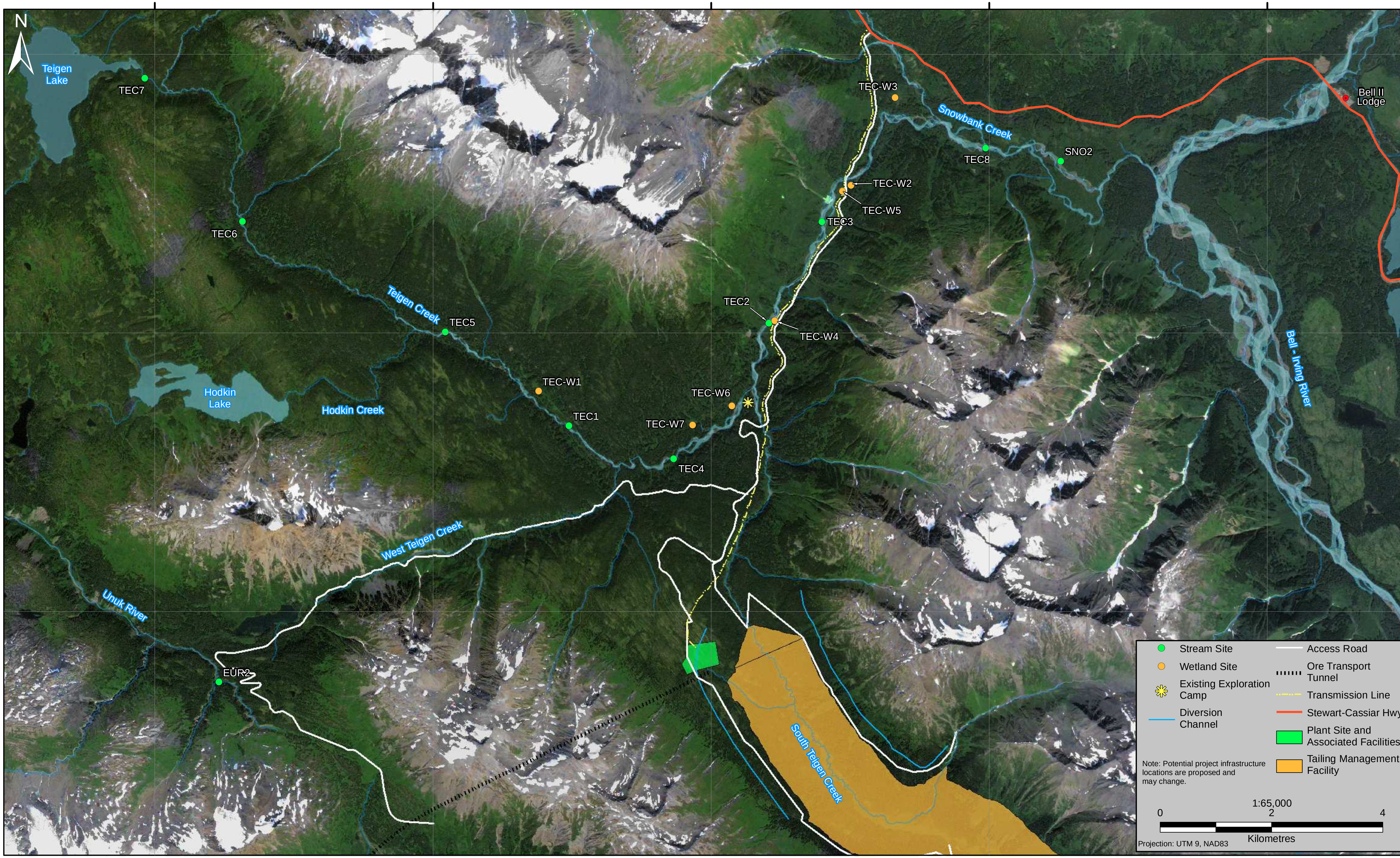


FIGURE 6.3-2

SEABRIDGE GOLD

Teigen Creek Watershed Fish and Fish Habitat Assessment Sites, 2009

Rescan™

Plate 6.3-1. Teigen Creek Upper Reaches.

Plate 6.3-2. Teigen Creek Middle Reaches.

Plate 6.3-3. Teigen Creek Lower Reaches.

The Unuk River is a large river that originates from glaciers in British Columbia, flows through Alaska and discharges into the Pacific Ocean (Figure 6.3-4). There are ten reaches within the Unuk River. The majority of these reaches are low gradient, unconfined and braided (Plates 6.3-7 and 6.3-8). However, sections of the river are entrenched (Plate 6.3-9).

Channel Characteristics

Appendix 6.1-1 shows site and stream habitat details presented in the form of completed site cards. Detailed fish habitat data for receiving environment streams are presented in Appendix 6.3-1. Tables 6.3-2 and 6.3-3 present a summary of channel statistics and characteristics for Teigen Creek, Treaty Creek and the Unuk River, from the headwaters to lower reaches. Figures 6.3-5, 6.3-6 and 6.3-7 show a summary of weighted mean bed substrate composition for Teigen Creek, Treaty Creek and the Unuk River, from the headwaters to lower reaches.

The majority of Treaty Creek possessed riffle-pool morphology with meandering and sinuous, unconfined, braided channels of 1 to 2% gradient. Bankfull widths ranged from 21.2 to 218.2 m from the headwaters to lower reaches. Wetted depths were deep and defined pools were not present throughout the creek. Bed substrate composition varied throughout the creek, however the dominant bed substrates were cobble and gravel.

The Unuk River possessed cascade-pool morphology in the upper reaches then changes to riffle-pool morphology downstream of Storie Creek confluence. The reaches downstream of Storie Creek confluence are sinuous, unconfined with braided channels of 1 to 2% gradient. Bankfull widths range from 14.3 to 106.9 m from the headwaters to lower reaches. Wetted depths are deep and un-wadeable due to stream velocity. Bed substrate composition varies throughout the creek, however the dominant bed substrates are cobble and boulders in the headwater reaches and cobble in the lower reaches.

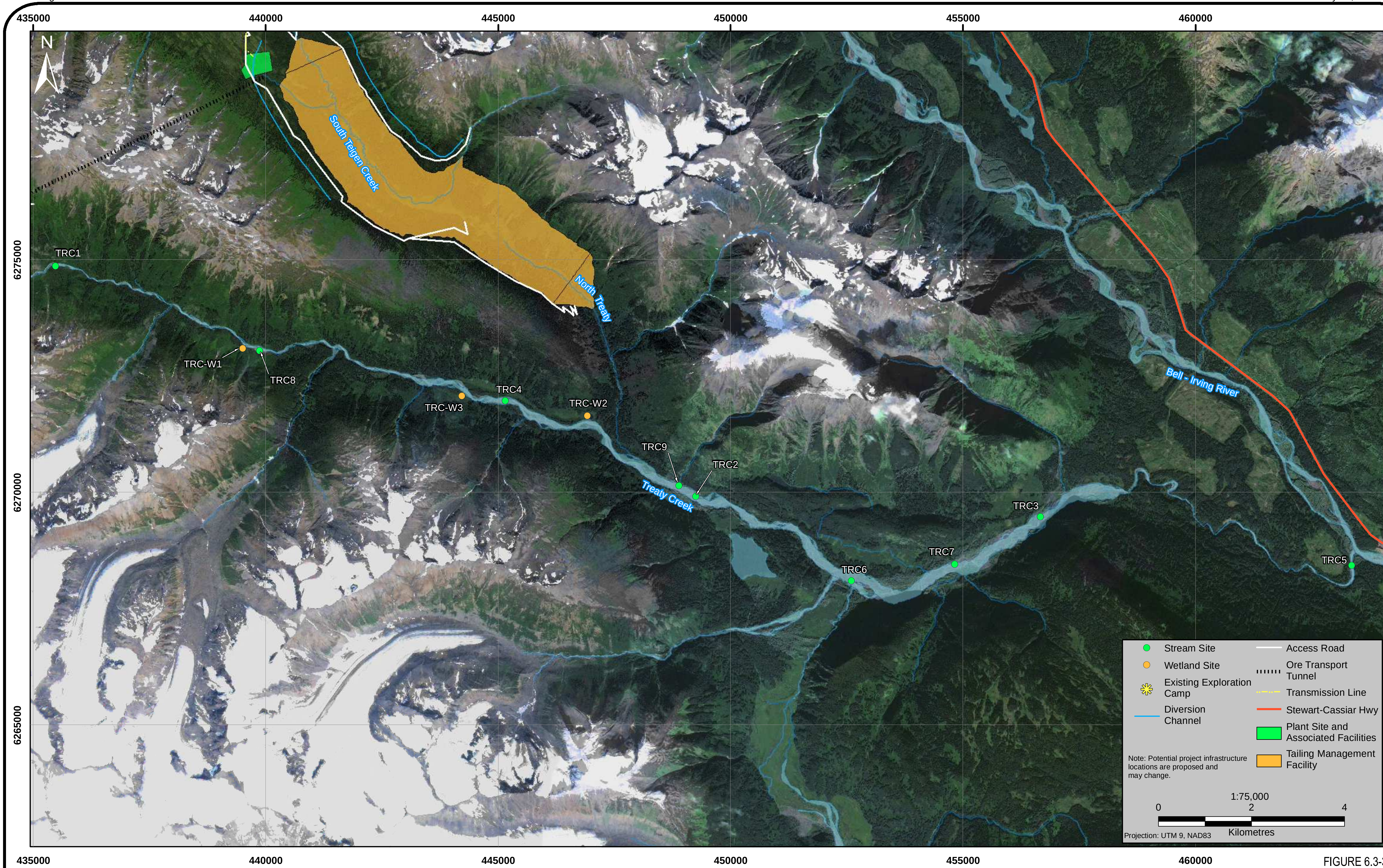


FIGURE 6.3-3

SEABRIDGE GOLD

Treaty Creek Watershed Fish and Fish Habitat Assessment Sites, 2009

Rescan™

Plate 6.3-4. Treaty Creek Upper Reaches.

Plate 6.3-5. Treaty Creek Middle Reaches.

Plate 6.3-6. Treaty Creek Lower Reaches.

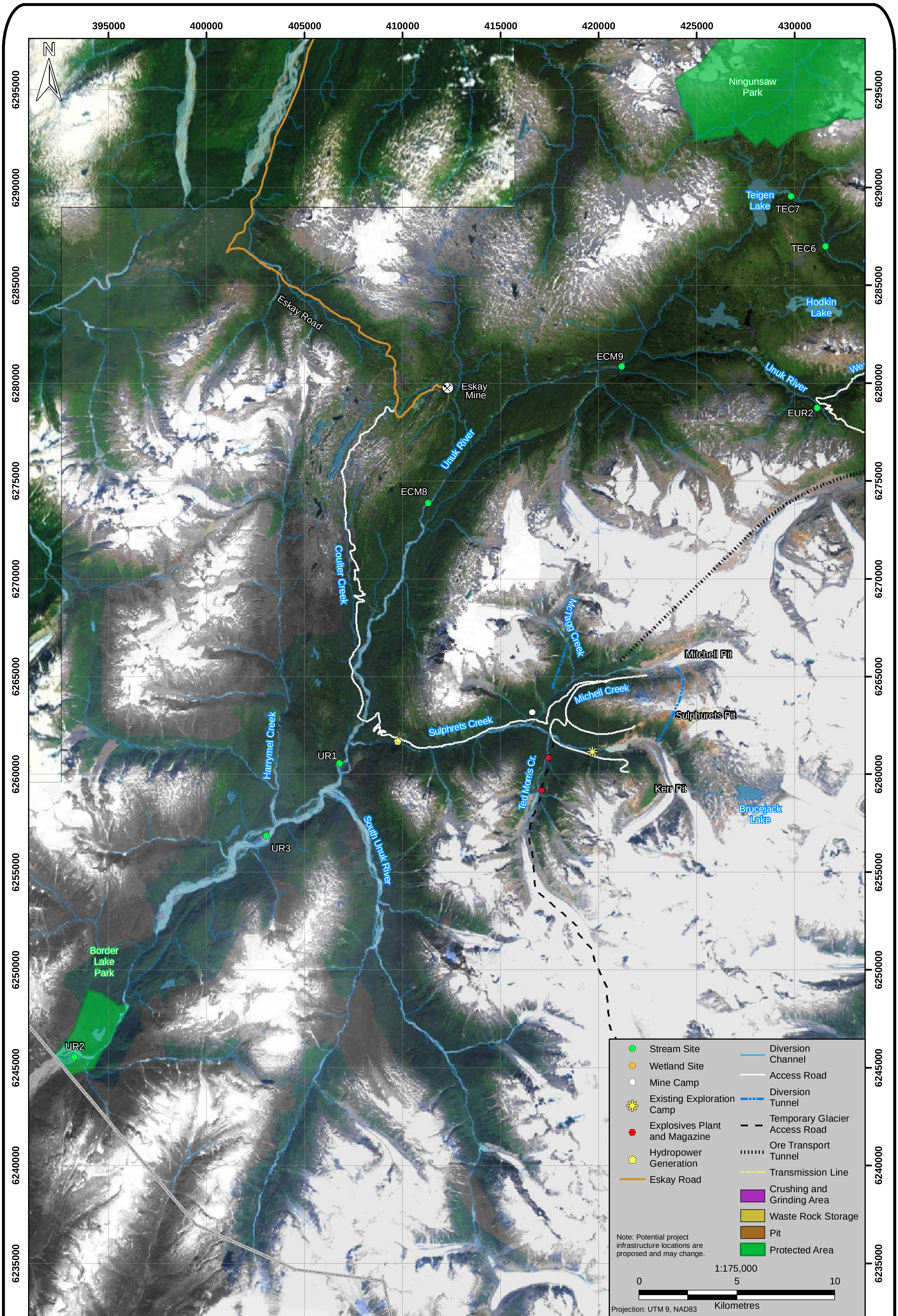
Habitat

Figures 6.3-8, 6.3-9 and 6.3-10 show a summary of weighted mean habitat unit composition for Teigen Creek, Treaty Creek and the Unuk River, from the headwaters to lower reaches. Figures 6.3-11, 6.3-12 and 6.3-13 show a summary of weighted mean habitat cover composition for Teigen Creek, Treaty Creek and the Unuk River, from the headwaters to lower reaches. Table 6.3-4 present a summary of LWD abundance, distribution and riparian habitat.

For Teigen Creek, dominant habitat unit composition was riffles and cascades in the upper reaches, with a higher proportion of riffles and glides in the middle and lower reaches. Pool and boulder habitat cover were present and dominant throughout the creek. LWD was abundant throughout the creek, and was distributed both evenly and in clumps. Riparian habitat types were mixed along the creek channel.

For Treaty Creek, dominant habitat unit composition was riffles in all reaches, except the reach near the confluence with the Bell-Irving River. Pool, overhanging vegetation, and LWD habitat cover were present and dominant throughout the creek. LWD was scattered throughout the creek, which was clumped in distribution. Riparian habitat types were dominated by shrubs along the creek channel.

For the Unuk River, dominant habitat unit composition was riffles in all reaches, except the confined upper reach (ECM9). All habitat cover types were present throughout the creek, except instream vegetation. LWD was scattered throughout the river, which was clumped in distribution.



SEABRIDGE GOLD

Unuk River Watershed Fish and Fish Habitat Assessment Sites, 2009

FIGURE 6.3-4

Rescan

Plate 6.3-7. Unuk River Lower Reaches.

Plate 6.3-8. Unuk River Middle Reaches.

Plate 6.3-9. Unuk River Upper Reaches.

6.3.3 Teigen, Treaty and Unuk Watersheds - Fish Community

6.3.3.1 Fish Presence

Table 6.3-5 presents the known fish species presence/distribution for all streams by watershed. Dolly Varden was the most widely distributed species within Teigen, Treaty and Unuk watershed reaches. The wide distribution is a reflection of the species ability to tolerate cold, turbid glacial water conditions (McPhail 2007), which is generally a limiting factor of other fish species, reside in steep gradient streams (<30%) and sustain populations above barriers (Ihlenfeldt 2005; McPhail 2007).

Dolly Varden and bull trout coexist in Teigen, Snowbank and Scott creeks. Hybrids were captured and identified, through genetic analysis, in Teigen Creek. Teigen and Treaty creeks support summer run populations of steelhead (LGL 1995; Bocking et al. 2005). Steelhead habitat capability models for smolt production and escapement goals have been developed for these creeks (Bocking et al. 2005). Pacific salmon species, such as coho, sockeye and chinook are present in these creeks. Sockeye salmon are only present in Teigen Creek. Coho habitat capability models for smolt production and escapement goals have been developed for Teigen and Treaty creeks (Bocking and Peacock 2004).

Salmon species are present in the Unuk River, with the majority of salmon spawning and rearing occurring in the lower 39 km of the Alaska section (Mecum and Kissner 1989) and in Border Lake, approximately 2 km upstream of the Alaska/British Columbia border. The lake is known to possess significant recruitment of sockeye, pink, coho and chum salmon (Tripp 1987; DFO 1987). The canyons located upstream of Border Lake restrict the upstream migration of pink and chum salmon. However, spawning and rearing of sockeye, chinook, and coho salmon are known to extend as far upstream as Storie Creek, which is approximately 15 km upstream of Sulphurets Creek confluence on the Unuk River (Reach 7; Knight Piesold and Homestake 1993). Only Dolly Varden was captured, in this study and others, in the Unuk River upstream of Storie Creek.

Table 6.3-2. Summary of Channel Statistics in Teigen, Treaty and Unuk Watersheds, 2009

			Bankful Width (m)			Wetted Width (m)			Bankful Depth (m)			Wetted Depth (m)			Gradient (%)			Residual Pool (m)		
Watershed	Site Name	Site Code	n	Mean	SE	n	Mean	SE	n	Mean	SE	n	Mean	SE	n	Mean	SE	n	Mean	SE
Unuk	EUR2	EUR2	6	14.3	1.5	6	9.5	1.3	4	0.6	0.2	3	0.4	0.1	4	4.8	0.9	-	-	-
	ECM9	ECM9	6	26.0	2.6	6	15.0	1.2	3	1.5	0.1	6	0.6	0.1	3	2.0	0.6	1	0.5	-
	ECM8	ECM8	4	42.0	-	4	30.0	-	4	1.4	0.4	15	0.5	0.1	4	1.8	0.9	1	0.8	-
	UR1	UR1	7	27.4	9.5	7	18.0	7.2	6	0.7	0.2	12	0.5	0.1	7	2.6	0.4	2	0.7	0.4
	UR3	UR3	-	-	-	-	-	-	-	-	-	-	-	-	3	1.0	-	-	-	-
	UR2	UR2	8	106.9	7.4	8	48.5	2.1	-	-	-	-	-	-	4	1.0	-	-	-	-
Treaty	TRC1	TRC1	6	21.2	2.2	6	14.8	2.0	3	0.3	0.1	-	-	-	3	3.0	0.6	2	0.2	0.1
	TRC8	9060	2	36.5	12.5	2	26.0	4.0	5	1.3	0.3	6	0.8	0.1	2	3.0	-	-	-	-
	TRC4	5544	-	-	-	-	-	-	7	0.7	0.1	12	0.3	0.0	7	2.9	0.5	3	0.4	0.1
	TRC2	TRC2	1	160.0	-	1	35.0	-	1	1.5	-	3	0.4	0.1	1	2.0	-	-	-	-
	TRC6	TR3.5	6	218.2	12.4	6	69.7	7.9	3	1.5	0.3	3	0.5	0.1	2	1.5	0.5	-	-	-
	TRC7	5543	-	-	-	-	-	-	6	0.6	0.1	15	0.3	0.0	6	2.3	0.5	3	0.4	0.1
	TRC3	TRC3	1	150.0	-	5	25.0	11.5	5	1.1	0.1	14	0.4	0.0	5	2.0	0.5	1	0.4	-
	TRC5	TR2.5	6	74.0	2.8	6	52.7	4.2	4	1.2	0.1	3	0.7	0.0	2	1.5	0.5	-	-	-
Teigen	TEC7	TR4	12	9.1	0.9	12	8.3	1.0	8	0.7	0.1	15	0.4	0.0	7	1.4	0.2	2	0.2	0.0
	TEC6	9058	5	19.0	4.4	5	15.0	3.1	8	1.0	0.3	15	0.4	0.1	5	2.2	0.4	1	0.7	-
	TEC5	M1	5	33.3	5.6	5	11.7	1.6	5	1.3	0.2	15	0.5	0.0	5	2.2	0.5	2	0.2	0.0
	TEC1	TEC1	6	22.3	1.9	6	12.9	1.7	6	1.3	0.1	18	0.5	0.0	6	2.0	-	2	0.5	0.2
	TEC4	M2	5	35.0	5.3	5	10.8	0.9	5	1.3	0.1	15	0.6	0.0	5	1.0	-	2	0.2	0.0
	TEC2	TEC2	3	59.0	8.6	3	22.0	4.0	3	1.4	0.4	9	0.6	0.1	3	1.0	-	1	0.1	-
	TEC3	M3	4	33.8	2.9	4	20.8	2.3	4	1.6	0.1	12	0.6	0.1	4	1.5	0.3	3	0.5	0.2
	TEC8	M4	11	102.9	12.6	11	43.7	4.6	8	1.4	0.2	15	0.7	0.1	7	0.8	0.1	7	1.1	0.1
	SNO2	SNO2	4	78.0	13.1	4	25.8	3.5	3	1.4	0.1	12	1.1	0.1	4	1.0	-	2	1.0	-

Dashes indicate no data available or not applicable

SE = standard error

Table 6.3-3. Summary of Channel Characteristics in Teigen, Treaty and Unuk Watersheds, 2009

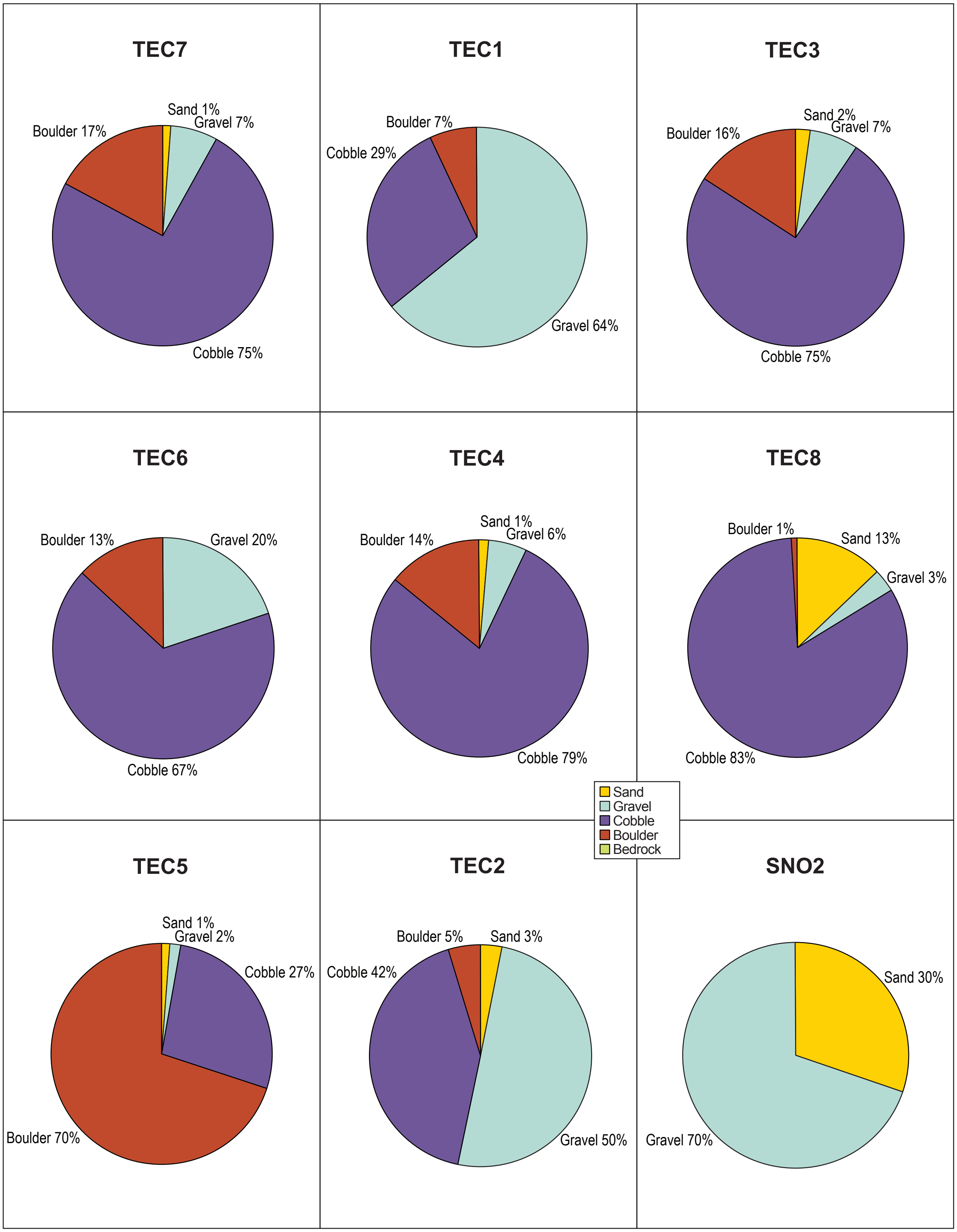
				Bed Substrates			
Watershed	Site Name	Site Code	Channel Morphology	Dominant	Sub-Dominant	Channel Pattern	Channel Confinement
Unuk	EUR2	EUR2	CP	C	F	ME	FC
	ECM9	ECM9	CP	B	C	SI	FC
	UR1	UR1	RP	C	F	ME	UN
	UR3	UR3	RP	C	G	SI	OC
	UR2	UR2	RP	C	G	IR	OC
Treaty	TRC1	TRC1	RP	F	C	ME	OC
	TRC8	9060	RP	C	G	SI	UN
	TRC4	5544	RP	C	G	ME	OC
	TRC6	TR3.5	RP	C	G	IR	UN
	TRC7	5543	RP	C	G	ME	UN
	TRC5	TR2.5	RP	C	G	SI	OC
Teigen	TEC7	TR4	RP	C	B	SI	OC
	TEC6	9058	CP	C	G	SI	UN
	TEC8	M4	RP	G	C	SI	OC

Channel Morphology: RP = riffle-pool, CP = cascade-pool

Bed Substrates: F = fines, G = gravel, C = cobble, B = boulder

Channel Pattern: IM = irregular meandering, IR = irregular wandering, SI = sinuous, ME = meandering

Channel Confinement: OC = occasionally confined, UN = unconfined, FC = frequently confined, CO = confined



Weighted Mean Bed Substrate Composition of Teigen Creek, 2009

FIGURE 6.3-5

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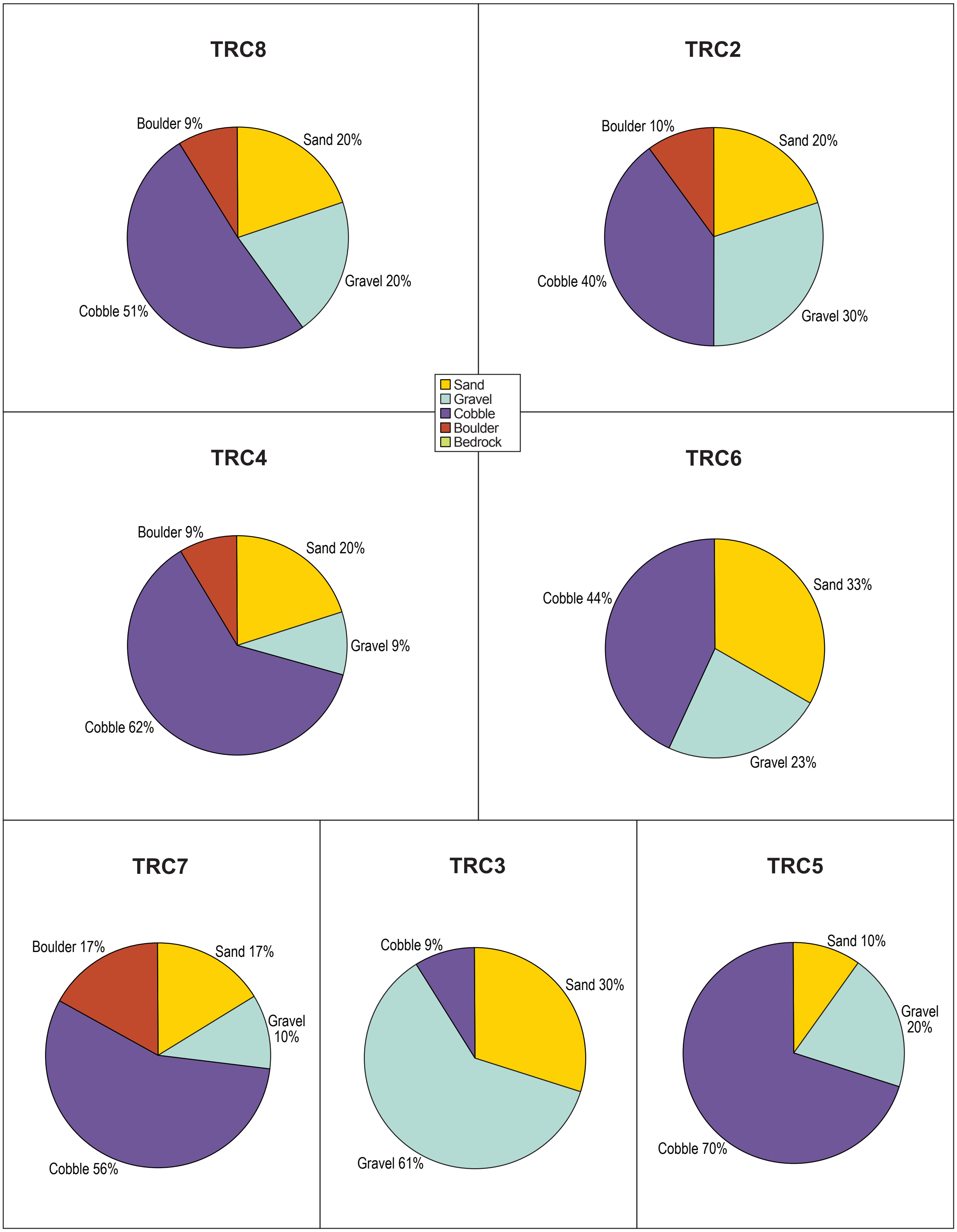

Weighted Mean Bed Substrate Composition of Treaty Creek, 2009

FIGURE 6.3-6

SEABRIDGE GOLD

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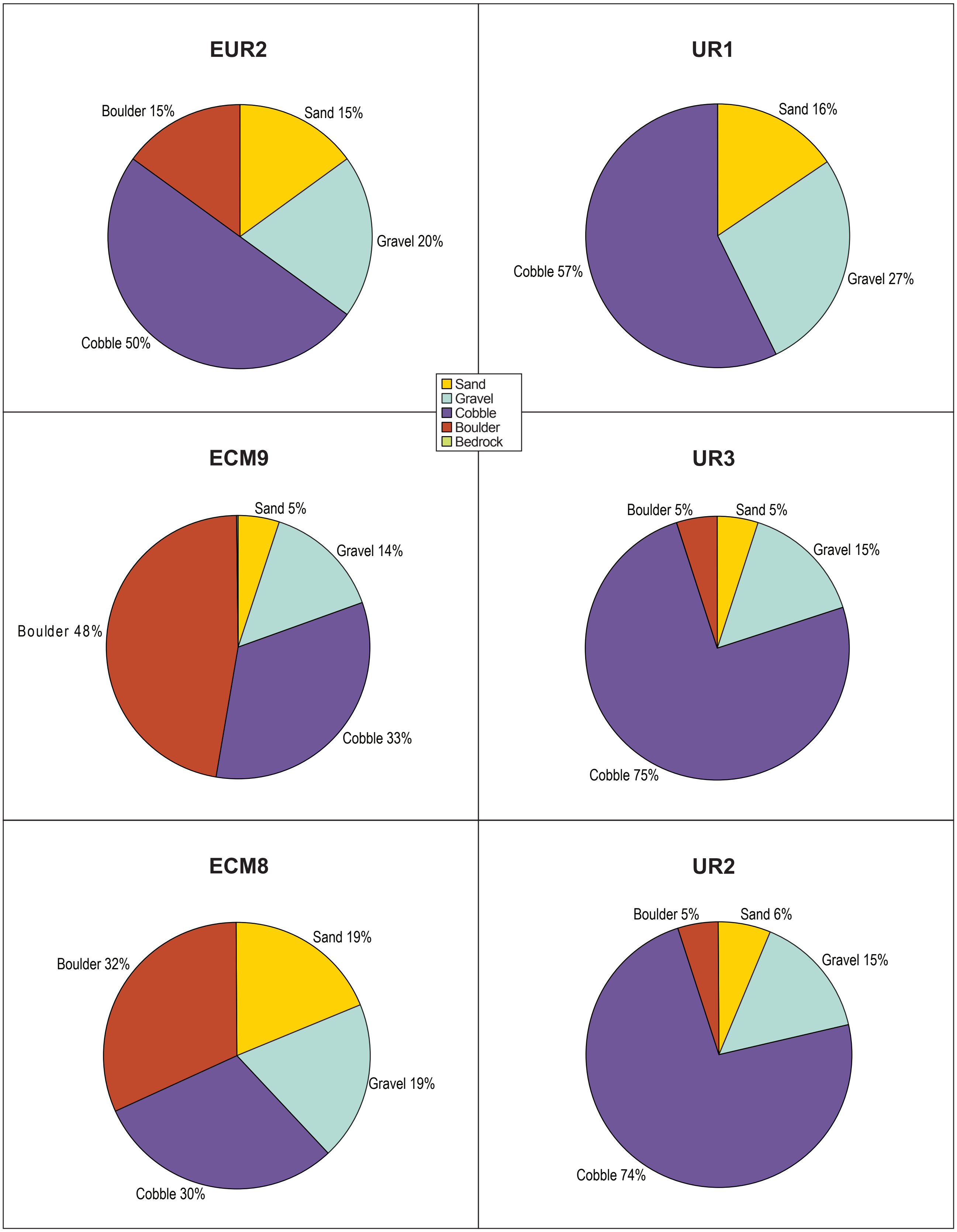


Weighted Mean Bed Substrate Composition of the Unuk River, 2009

FIGURE 6.3-7

Table 6.3-4. Summary of LWD Abundance and Distribution, and Riparian Characteristics in Teigen, Treaty and Unuk Watersheds, 2009

Watershed	Site Name	Site Code	LWD Abundance	LWD Distribution	Riparian Cover	Riparian Stage
Unuk	EUR2	EUR2	NS	NS	SHR	SHR
	ECM9	ECM9	NS	NS	M	PS
	UR1	UR1	F	C	SHR	NS
	UR3	UR3	NS	NS	M	NS
	UR2	UR2	NS	NS	M	YF
Treaty	TRC1	TRC1	F	C	SHR	SHR
	TRC8	9060	F	C	SHR	SHR
	TRC4	5544	F	E	SHR	SHR
	TRC6	TR3.5	NS	NS	M	YF
	TRC7	5543	F	C	N	NA
	TRC5	TR2.5	NS	NS	M	MF
Teigen	TEC7	TR4	N	NA	C	PS
	TEC6	9058	F	E	SHR	SHR
	TEC8	M4	A	E	D	MF

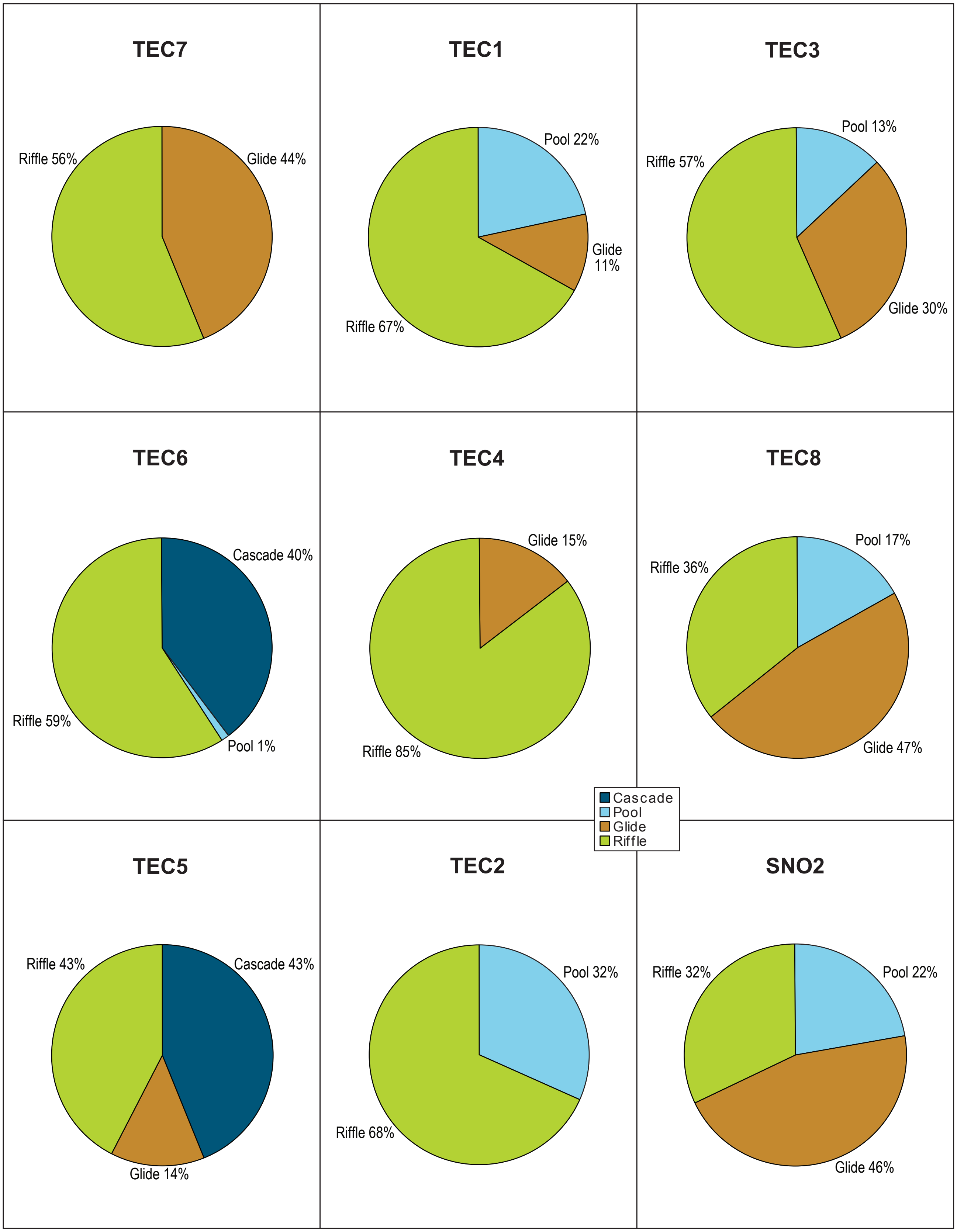
LWD Abundance: N = none, F = few, A = abundant, NS = Not Specified, NA = Not Applicable
LWD Distribution: E = even, C = clumped, NS = Not Specified
Riparian Cover: S = shrub, M = mixed, D = deciduous, C = coniferous, G = Grass, N = None, NS = Not Specified
Riparian Stage: SHR = shrub/herb, YF = young forest, MF = mature forest, PS = Pole Sapling, NS = Not Specified, NA = Not Applicable

6.3.3.2 Relative Abundance

Appendices 6.1-3 and 6.2-7 show all electrofishing effort and catch data for each stream and wetland site. Tables 6.3-6, 6.3-7, and 6.3-8 summarize sampling effort, catch and individual species CPUE for all stream and wetland sites by watershed.

In Teigen Creek, Chinook salmon fry were the most abundant and rainbow trout/steelhead fry were the second most abundant species present. Chinook parr were not sampled in Teigen Creek watershed. Rainbow trout/steelhead fry had a high abundance in the upper watershed on Teigen Creek, upstream of Hodkin Creek confluence. Rainbow trout/steelhead parr were distributed throughout the mainstem. Dolly Varden parr and adults were present throughout the mainstem, although the species abundance was less compared to Treaty Creek and the Unuk River. Bull Trout parr and adults were more abundant in the mainstem compared to Dolly Varden. Coho salmon fry and parr were the most abundant species present within side channels and off channel wetlands of Teigen Watershed. Dolly Varden fry, parr and adults also occupied the side channels and off channel wetlands.

In Treaty Creek, Dolly Varden parr and adults were the most abundant and present throughout the mainstem. Rainbow trout/steelhead parr were the second most abundant species present; however their distribution is restricted to downstream of the Todedada Creek confluence. Mountain whitefish were present downstream of the Todedada Creek confluence. Dolly Varden fry, parr and adults were the most abundant species present within side channels and off channel wetlands throughout Treaty Watershed. Based upon previous fisheries assessments, coho salmon fry and parr also occupied the side channels and off channel wetlands, downstream of Todedada Creek confluence (Tripp 1987).

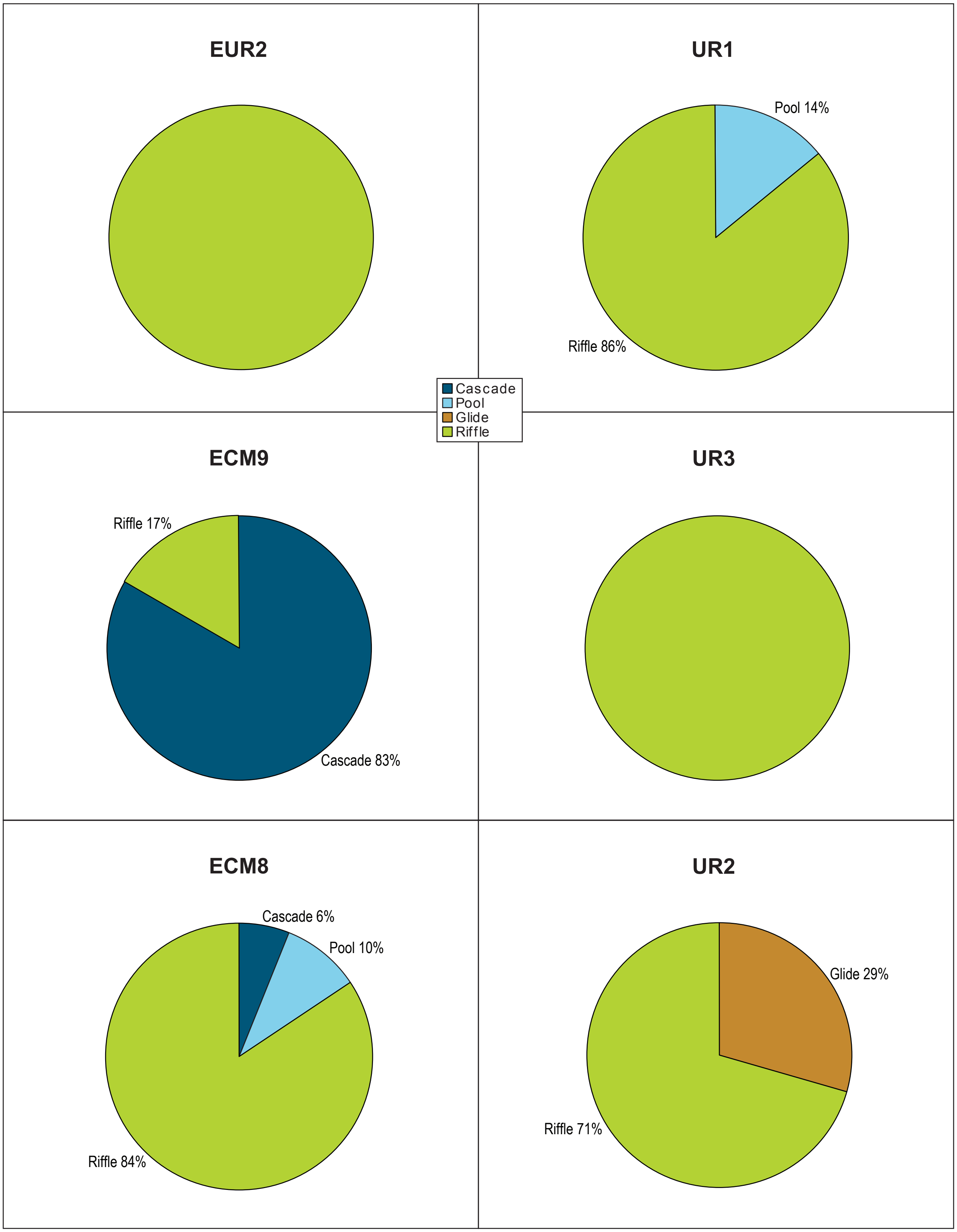


Weighted Mean Habitat Unit Composition Within Teigen Creek, 2009

FIGURE 6.3-8

Weighted Mean Habitat Unit Composition Within Treaty Creek, 2009

FIGURE 6.3-9



Weighted Mean Habitat Unit Composition Within the Unuk River, 2009

FIGURE 6.3-10

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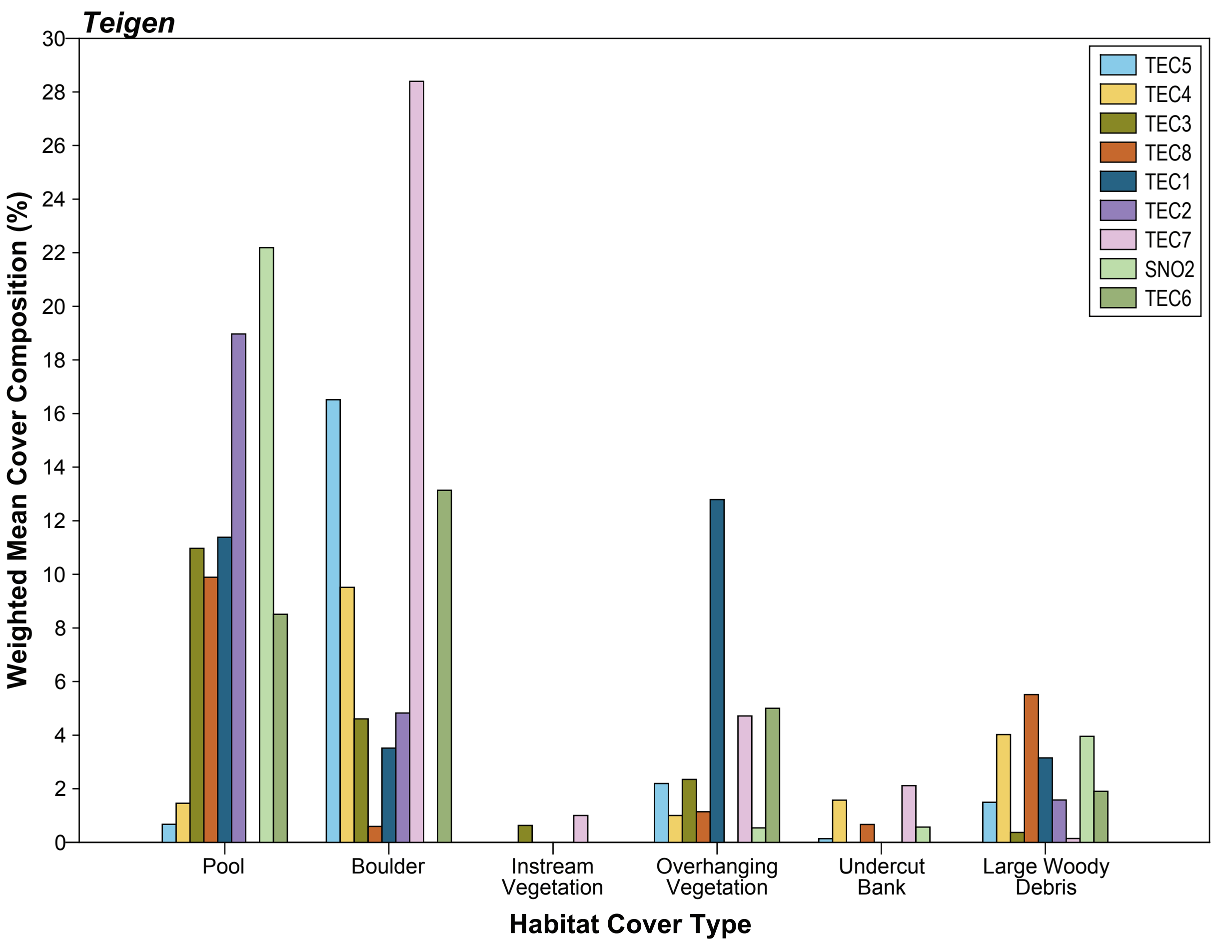
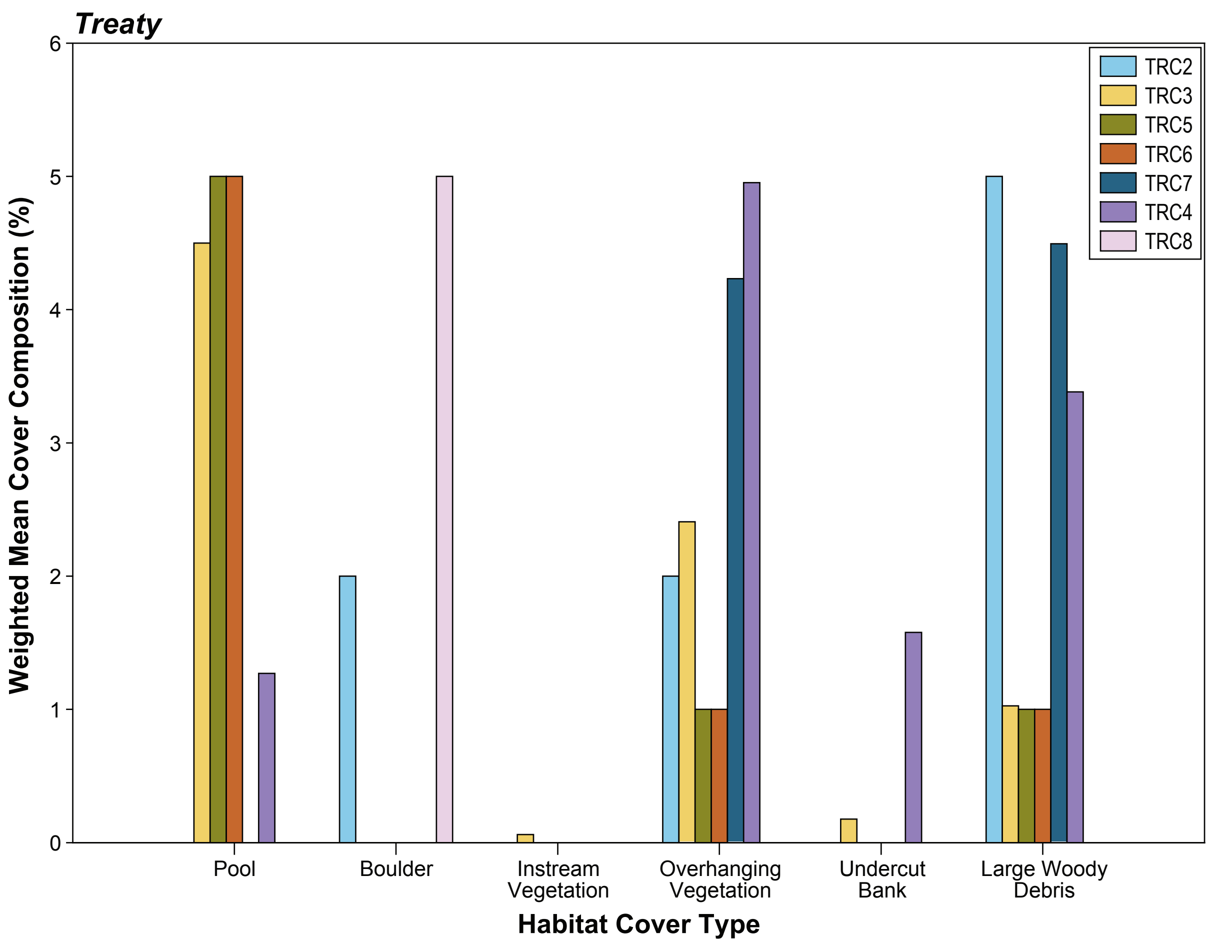
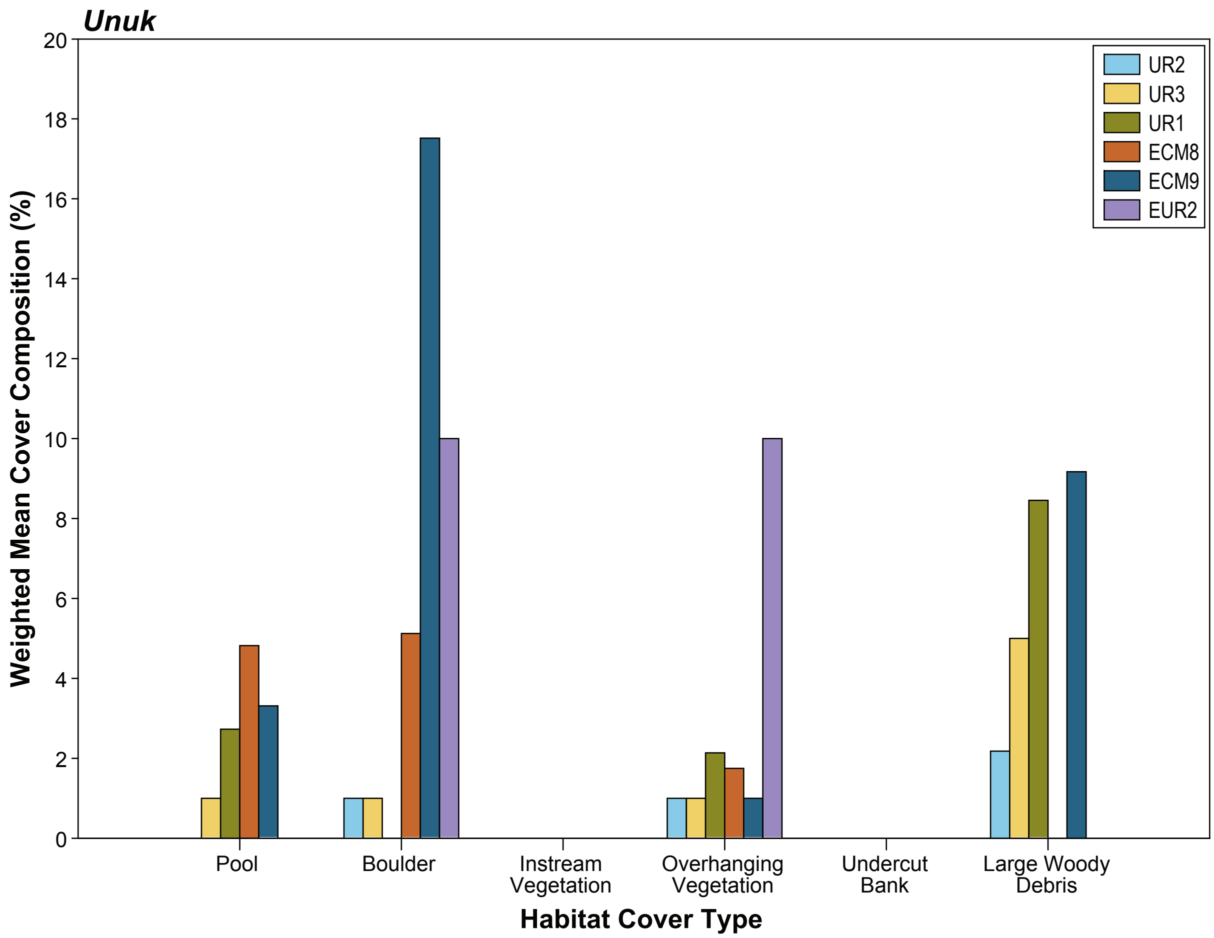


Weighted Mean Cover Composition Within Teigen Creek, 2009

FIGURE 6.3-11



Weighted Mean Cover Composition Within Treaty Creek, 2009



Weighted Mean Cover Composition Within the Unuk River, 2009

FIGURE 6.3-13

Table 6.3-5. Summary of Known Fish Species by Watershed

	Bell-Irving and Bowser Watersheds										
Species	**Bell-Irving**	**Bowser**	**Hodkin**	**North Treaty**	**Oweegee**	**Scott**	**Snowbank**	**South Teigen**	**Teigen**	**Treaty**	**West Teigen**
Bull Trout*	O	O^	X	-	-	X	X	X°	X	X	-
Chinook Salmon	X	O^	-	-	X	-	X	-	X	O	-
Coastal Cutthroat Trout*	-	-	X	-	-	-	-	-	-	-	-
Coho Salmon	X	O^	-	-	O	-	X	-	X	O	-
Dolly Varden*	O	X	X	X	O	X	X	X	X	X	X
Dolly Varden/Bull Trout*	O	-	-	-	-	X	-	X°	X	-	-
Mountain Whitefish	X	O^	-	X	X	O	O	X°	X	X	-
Sockeye Salmon	O	O^	-	-	O	-	-	-	X	-	-
Rainbow Trout/Steelhead	X	O^	X	-	X	-	X	X°	X	X	-

	Unuk Watershed						
Species	**Coulter**	**Kaypros**	**McTagg**	**Mitchell**	**South Unuk**	**Sulphurets**	**Unuk**
Chinook Salmon	-	-	-	-	-	-	X
Coastal Cutthroat Trout*	-	-	-	-	-	-	X
Coastrange Sculpin	-	-	-	-	-	-	X
Coho Salmon	X°	-	-	-	O	-	X
Dolly Varden*	X°	-	-	-	X	X°	X
Sockeye Salmon	O°	-	-	-	-	-	X
Rainbow Trout/Steelhead	-	-	-	-	-	-	X

**Blue-listed species*

Dolly Varden/Bull Trout indicates hybrid

X = indicates that project specific sampling data was utilized to confirm fish species presence

O = indicates that other sources of exisiting inventory data was utilized to confirm fish species presence

Dashes indicate not present

^ = not likely present at stream site

° = present below falls/cascade only

Table 6.3-6. Summary Statistics of Electrofishing Effort, Catch and CPUE in Teigen, Treaty and Unuk Watershed Mainstems, 2009

Watershed		Treaty	Teigen	Unuk
No. of Sites		9	8	8
Total Effort (s)		9,121	7,984	7,548
Species				
Dolly Varden	No. of Fish	88	7	139
	Mean CPUE	1.0	0.10	1.9
	SE	0.2	0.3	0.5
Bull Trout	No. of Fish	3	10	-
	Mean CPUE	0.0	0.2	-
	SE	0.0	0.1	-
Rainbow Trout	No. of Fish	23	97	7
	Mean CPUE	0.3	1.1	0.1
	SE	0.2	0.3	0.1
Cutthroat Trout	No. of Fish	-	-	1
	Mean CPUE	-	-	0.0
	SE	-	-	0.0
Coho Salmon	No. of Fish	-	18	41
	Mean CPUE	-	0.3	0.5
	SE	-	0.2	0.3
Chinook Salmon	No. of Fish	-	183	14
	Mean CPUE	-	2.3	0.2
	SE	-	0.8	0.2
Sockeye Salmon	No. of Fish	-	-	1
	Mean CPUE	-	-	0.0
	SE	-	-	0.0
Mountain Whitefish	No. of Fish	15	19	-
	Mean CPUE	0.2	0.3	-
	SE	0.1	0.2	-
Coastrange Sculpin	No. of Fish	-	-	5
	Mean CPUE	-	-	0.1
	SE	-	-	0.1

Dashes indicate no data available
CPUE = catch-per-unit-effort, fish/100 s
SE = standard error of the mean

In the Unuk River, Dolly Varden parr and adults were the most abundant and present throughout the mainstem. Coho fry were the second most abundant species present in the mainstem, downstream of the Storie Creek confluence. Sockeye fry were present in the mainstem downstream of the Harymel Creek confluence.

6.3.3.3 Population Demography

Appendices 6.1-2 and 6.2-6 show all species biological data for each stream and wetland sampling site and rearing sampling site. Table 6.3-9 summarizes length, weight and condition data for fish species captured in the Teigen, Treaty and Unuk watersheds. Dolly Varden was selected as the keystone species for data analysis because they are present within all fish bearing streams. Statistical comparisons between watersheds were not conducted because 2008 data determined no significant differences of population demographics between these watersheds (Rescan 2009)

Table 6.3-7. Summary Statistics of Electrofishing Effort, Catch and CPUE in Teigen, Treaty and Unuk Watershed Mainstems by Site, 2009

				Dolly Varden		Bull Trout		Rainbow Trout		Cutthroat Trout		Coho Salmon		Chinook Salmon		Sockeye Salmon		Mountain Whitefish		Coastrange Sculpin	
Watershed	**Site Name**	**Site Code**	**Total Effort (s)**	**n**	**CPUE**	**n**	**CPUE**	**n**	**CPUE**	**n**	**CPUE**	**n**	**CPUE**	**n**	**CPUE**	**n**	**CPUE**	**n**	**CPUE**	**n**	**CPUE**
Teigen	TEC7	6800 TR4	1016	2	0.2	-	-	26	2.6	-	-	-	-	5	0.5	-	-	-	-	-	-
	TEC6	9058	1013	-	-	-	-	17	1.7	-	-	-	-	24	2.4	-	-	-	-	-	-
	TEC5	8001 M1	1043	1	0.1	-	-	22	2.1	-	-	-	-	19	1.8	-	-	-	-	-	-
	TEC1	4025 TEC1	1016	1	0.1	-	-	-	-	-	-	7	0.7	1	0.1	-	-	3	0.3	-	-
	TEC4	8002 M2	1012	1	0.1	-	-	14	1.4	-	-	-	-	31	3.1	-	-	-	-	-	-
	TEC2	4025 TEC2	866	-	-	1	0.1	1	0.1	-	-	11	1.3	-	-	-	-	-	-	-	-
	TEC3	8003 M3	1043	2	0.2	-	-	13	1.2	-	-	-	-	40	3.8	-	-	-	-	-	-
	TEC8	9082 M4	975	-	-	9	0.9	4	0.4	-	-	-	-	63	6.5	-	-	16	1.6	-	-
Treaty	TRC1	3050 TRC1	1063	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	TRC8	9060	966	16	1.7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	TRC4	5544	1002	17	1.7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	TRC9	5001	931	12	1.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	TRC2	TRC2	1093	11	1.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	TRC6	6009 TR3.5	1016	9	0.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	TRC7	5543	1006	3	0.3	-	-	2	0.2	-	-	-	-	-	-	-	-	5	0.5	-	-
	TRC3	TRC3	1031	19	1.8	-	-	11	1.1	-	-	-	-	-	-	-	-	8	0.8	-	-
	TRC5	6008 TR2.5	1013	1	0.1	3	0.3	10	1.0	-	-	-	-	-	-	-	-	2	0.2	-	-
Unuk	EUR2	3049 EUR2	850	1	0.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	ECM9	6004 ECM9	1015	22	2.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	ECM8	ECM8	1015	13	1.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	UR1	3008 UR1	1008	4	0.4	-	-	7	0.7	-	-	-	-	-	-	-	-	-	-	-	-
	UR1	6005 UR1	1076	21	2.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	UR1	6005 UR1	507	15	3.0	-	-	-	-	-	-	1	0.2	-	-	-	-	-	-	-	-
	UR3	6007 UR3	1032	45	4.4	-	-	-	-	1	0.1	11	1.1	1	0.1	1	0.1	-	-	-	-
	UR2	6006 UR2	1045	32	3.1	-	-	-	-	-	-	7	0.7	13	1.2	-	-	-	-	5	0.5

Dashes indicate no data available
CPUE = catch-per-unit-effort, fish/100 s

Table 6.3-8. Summary Statistics of Minnow Trap and Electrofishing Effort, Catch and CPUE in Teigen and Treaty Watershed Wetlands, 2009

Electrofishing				Minnow Traps			
Watershed		**Treaty**	**Teigen**	***Watershed***		**Treaty**	**Teigen**
No. of Sites		2	6	***No. of Sites***		3	7
Total Effort (s)		830	4,574	***Total Effort (h)***		249.0	727.5
Species				***Species***			
Dolly Varden	No. of Fish	8	47	Dolly Varden	No. of Fish	19	4
	Mean CPUE	1.1	1.0		Mean CPUE	2.0	0.2
	SE	0.7	0.3		SE	1.1	0.1
Coho Salmon				Coho Salmon			
	No. of Fish	-	56		No. of Fish	0	47
	Mean CPUE	-	1.6		Mean CPUE	-	2.0
	SE	-	0.8		SE	-	0.7
Chinook Salmon				Chinook Salmon			
	No. of Fish	-	11		No. of Fish	0	3
	Mean CPUE	-	0.3		Mean CPUE	-	0.2
	SE	-	0.2		SE	-	0.1
Rainbow Trout				Rainbow Trout			
	No. of Fish	-	1		No. of Fish	0	0
	Mean CPUE	-	0.0		Mean CPUE	-	-
	SE	-	0.0		SE	-	-

Dashes indicate no data available

CPUE = catch-per-unit-effort, Electrofishing - fish/100 s, Minnow Trap - fish/trap day

SE = standard error of the mean

Table 6.3-9. Mean Length, Weight and Condition of Fish Captured in Teigen, Treaty

		Length (mm)					Weight (g)					Condition (g/mm^3)				
Species	**Watershed**	**N**	**Mean**	**SE**	**Min**	**Max**	**N**	**Mean**	**SE**	**Min**	**Max**	**N**	**Mean**	**SE**	**Min**	**Max**
Dolly Varden	Teigen	38	71	6.1	36	179	38	7.7	2.2	0.6	59.1	38	1.44	0.15	0.44	4.50
	Treaty	88	125	3.5	21	200	87	22.8	1.6	0.5	79.6	85	0.97	0.02	0.29	1.38
	Unuk	131	90	3.1	30	215	126	11.4	1.5	0.2	101.4	126	1.02	0.01	0.34	1.52
Bull Trout	Teigen	14	113	16.7	52	272	13	15.5	6.7	1.0	88.3	13	0.91	0.04	0.64	1.14
	Treaty	3	217	67.0	139	350	2	29.7	5.7	24.0	35.4	2	0.87	0.02	0.85	0.89
Rainbow Trout	Teigen	105	55	3.1	28	182	102	4.3	1.0	0.1	71.7	102	1.04	0.03	0.27	2.10
	Treaty	23	120	4.6	82	154	23	19.8	2.0	5.6	34.6	23	1.07	0.02	0.86	1.25
	Unuk	7	89	8.0	62	123	-	-	-	-	-	-	-	-	-	-
Cutthroat Trout	Unuk	1	206	-	206	206	1	83.9	-	83.9	83.9	1	0.96	-	0.96	0.96
Coho Salmon	Teigen	29	52	2.2	39	102	12	2.8	1.1	1.0	14.0	12	1.03	0.05	0.80	1.32
	Unuk	19	88	17.5	52	400	18	4.0	0.4	1.4	7.6	18	1.06	0.02	0.88	1.29
Chinook Salmon	Teigen	186	57	0.5	42	81	185	2.2	0.1	0.5	8.1	185	1.11	0.01	0.66	1.68
	Unuk	14	65	2.9	52	90	14	3.9	0.7	1.6	8.7	14	1.26	0.10	0.70	2.06
Sockeye Salmon	Unuk	1	75	-	75	75	1	3.7	-	3.7	3.7	1	0.88	-	0.88	0.88
Mountain Whitefish	Teigen	21	145	19.1	40	342	10	44.1	20.8	1.0	192.0	10	1.16	0.07	0.90	1.56
	Treaty	15	119	6.8	70	150	15	20.8	3.0	3.1	37.9	15	1.08	0.05	0.89	1.67
Coastrange Sculpin	Unuk	5	93	7.4	65	105	5	10.3	2.1	2.5	14.1	5	1.15	0.07	0.91	1.32

Dashes indicates not applicable

SE = standard error

Length-frequency distributions were plotted for all Dolly Varden caught in the watersheds (Figure 6.3-14). Length classes present in Teigen Watershed was shifted towards smaller length classes compared to other watersheds with fewer larger length classes. Length class modes varied between watersheds. Teigen Watershed had a mode of 50 mm. Unuk Watershed had a mode of 70 mm. Treaty Watershed had two modes of 125 and 145 mm.

Dolly Varden weight-length regressions were calculated by watershed (Figure 6.3-15). All regressions were highly significant ($P<0.001$) and explained between 87 to 98% of the variation in ln(weight). The regression slopes were close to the expected value of 3.0, typical for the length-weight geometry of fish. Generally, Dolly Varden in Teigen Watershed were in better condition than other watersheds (Table 6.3-9).

Age data for all fish captured in are summarized in Table 6.3-10. Age-frequency distributions were constructed for all Dolly Varden aged from Treaty and Unuk watersheds (Figure 6.3-16). Treaty Watershed had the greatest age range of 1 to 5 years. However, interpretation of this dataset should be applied with caution because of low sample sizes and because of the lack of measured ages for fry and those who were too small to take age structures.

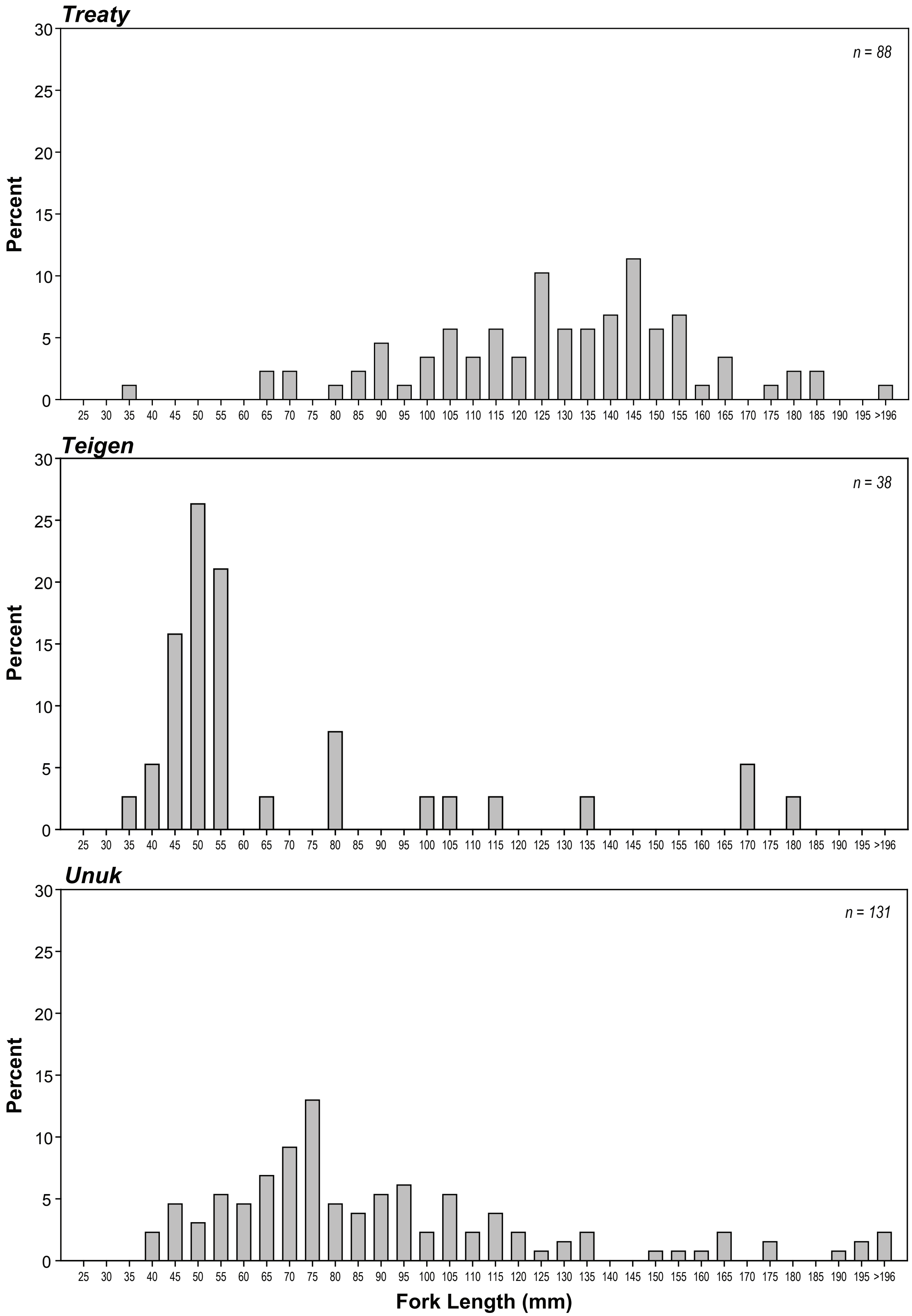
Von Bertalanffy growth models were fit to the age and length data of fish from Treaty and Unuk watersheds (Figure 6.3-17). Age explained between 51 and 68% of the variation in fish length. The maximum attainable length was estimated at 511 mm for Treaty Watershed and 527 mm for Unuk Watershed. However, interpretation of this dataset should be applied with caution because of low sample size, and wide fork length ranges for certain age classes due to difficulties in accurately determining age.

6.3.3.4 Habitat Quality

Habitat quality varied between and within watersheds. Furthermore, the various fish species present in Teigen, Treaty and Unuk watersheds have different life history requirements (i.e., spawning, rearing, over-wintering and migration). Tables 6.3-11 and 6.3-12 provide a summary of life history periodicity, distribution, and habitat preferences within the Teigen and Treaty watersheds. The information presented in these tables was obtained through fish habitat assessments, spawning survey assessments, fisheries assessments and literature reviews. This analysis was not conducted for the Unuk Watershed due to its distance from the proposed Project infrastructure.

6.3.4 Other Watersheds – Fish Habitat

A number of other watersheds within the study area were assessed for fish and fish habitat values, including: Bowser, South Unuk, and Bell-Irving rivers, Oweegee, Snowbank, West Teigen, Sulphurets and Coulter creeks. Individual stream sites within each of these watersheds were assessed for fish and fish habitat. The locations of these stream sites are shown in Figure 4.1-1. Certain stream sites were only sampled for fisheries values because they were previously assessed for fish habitat during the 2008 fieldwork (Rescan 2009). These stream sites were: West Teigen, Sulphurets and Snowbank creeks.

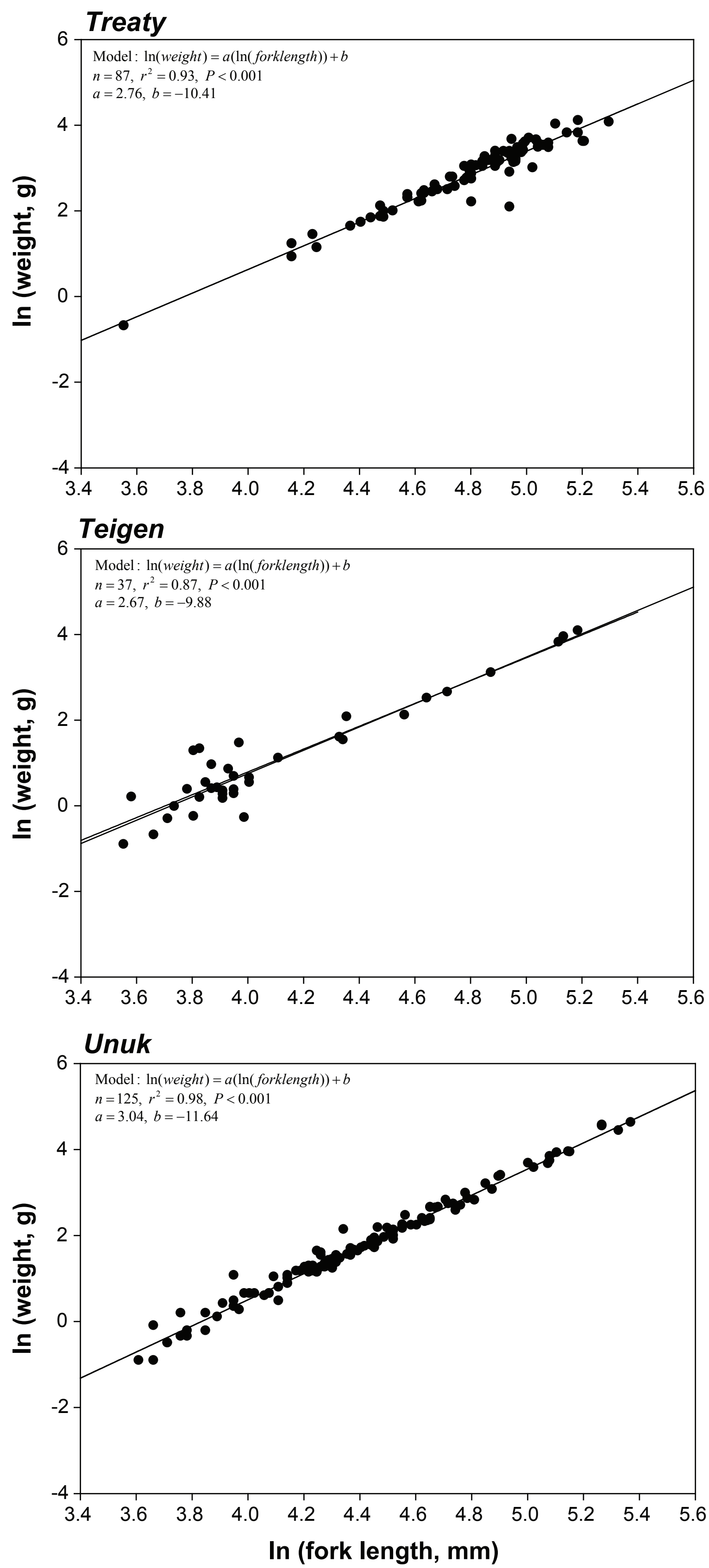


Fork Length Class Distribution of Dolly Varden within Teigen, Treaty and Unuk Watersheds, 2009

FIGURE 6.3-14

SEABRIDGE GOLD

Rescan™



Weight-Length Regression of Dolly Varden within Teigen, Treaty and Unuk Watersheds, 2009

FIGURE 6.3-15

Table 6.3-10. Mean Age of Fish Captured in Teigen, Treaty and Unuk Watersheds, 2009

		Age (years)				
Species	**Watershed**	**n**	**Mean**	**SE**	**Min**	**Max**
Dolly Varden	Teigen	2	2.5	0.5	2	3
	Treaty	58	2.9	0.1	1	5
	Unuk	49	3.0	0.2	2	5
Bull Trout	Teigen	4	3.3	0.5	2	4
	Treaty	2	3.0	0.0	3	3
Rainbow Trout	Teigen	9	2.8	0.2	2	3
	Treaty	16	2.9	0.2	2	5
	Unuk	4	2.0	0.5	1	3
Cutthroat Trout	Unuk	1	4.0	-	4	4
Mountain Whitefish	Teigen	1	9.0	-	9	9
	Treaty	7	2.4	0.2	2	3

Dashes indicates not applicable
SE = standard error

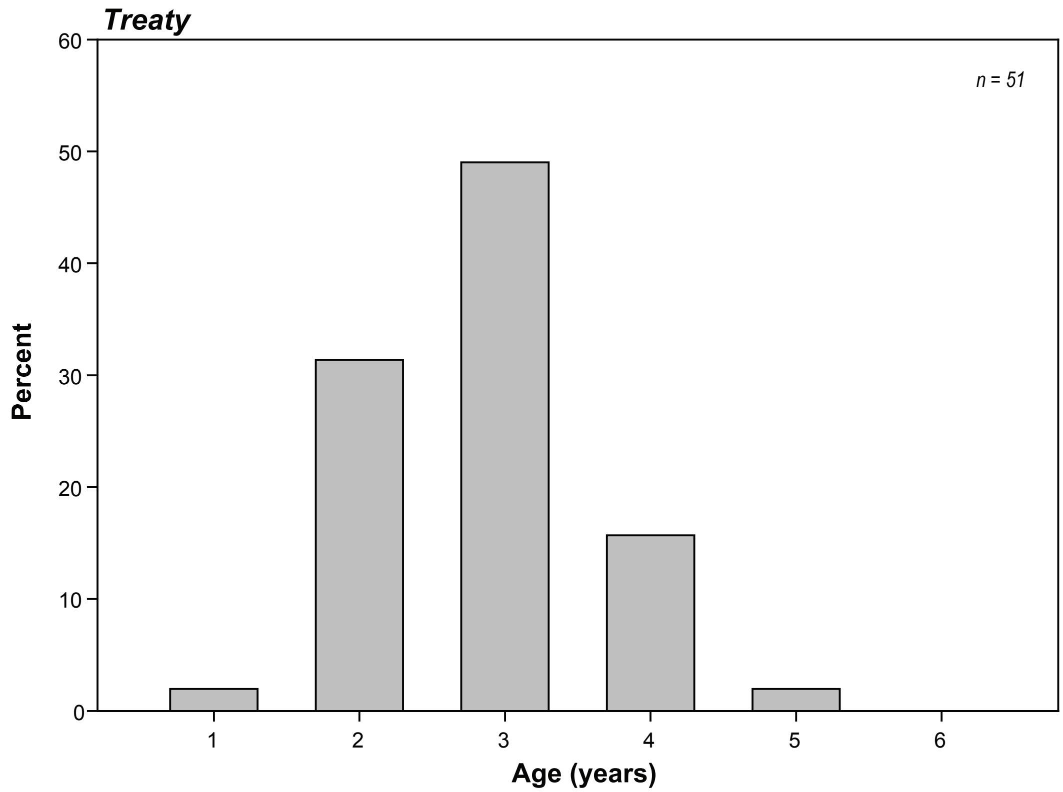
There are two stream sites on the Bell-Irving River, BI1 and BI2. BI1 is located upstream of the Teigen Creek confluence and BI2 is located downstream of the Treaty Creek confluence. The Bowser River site (BR1) is located in the glacial headwaters of the watershed (Plate 6.3-10). The South Unuk River site (SUNR) is located in the middle reaches of the river, and discharges into the Unuk River downstream of Sulphurets Creek (Plate 6.3-11). Coulter Creek (CC1) is located downstream of the falls, and discharges into the Unuk River (Plate 6.3-12). Sulphurets Creek site (SC3) is located downstream of the cascades and discharges into the Unuk River (Plate 6.3-13). West Teigen Creek is a tributary of Teigen Creek and originates from a headwater lake, West Teigen Lake (Plate 6.3-14). Oweegee Creek is tributary of the Bell-Irving River and the site is located downstream of Oweegee Lake (Plate 6.3-15). Snowbank Creek site (SNO1) is located in the lower reaches of the watershed, and discharges into Teigen Creek (Plate 6.3-16).

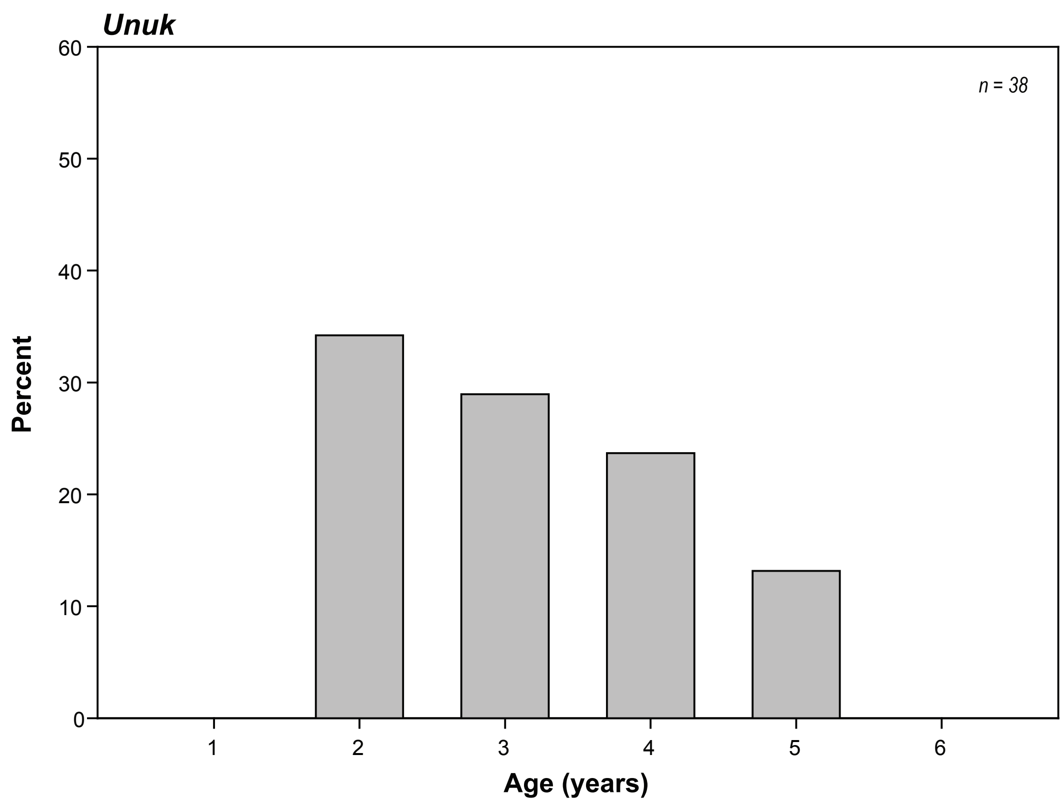
6.3.4.1 Channel Characteristics

Appendix 6.1-1 shows site and stream habitat details presented in the form of completed site cards. Detailed fish habitat (FHAP) data for receiving environment stream sites are presented in Appendix 6.3-1. The locations of receiving environment stream sites are shown in Figure 4.1-1. Tables 6.3-13 and 6.3-14 present a summary of channel statistics and characteristics for stream sites. Table 6.3-15 shows a summary of weighted mean bed substrate composition for stream sites. Channel characteristics are site specific and vary between sites.

6.3.4.2 Habitat

Table 6.3-16 shows a summary of weighted mean habitat unit and habitat cover composition for stream sites. Table 6.3-17 present a summary of LWD abundance, distribution and riparian habitat within stream sites. Table 6.3-18 present a summary of fish habitat quality and suitability within stream sites. Fish habitat cover and quality is site specific and vary between sites.



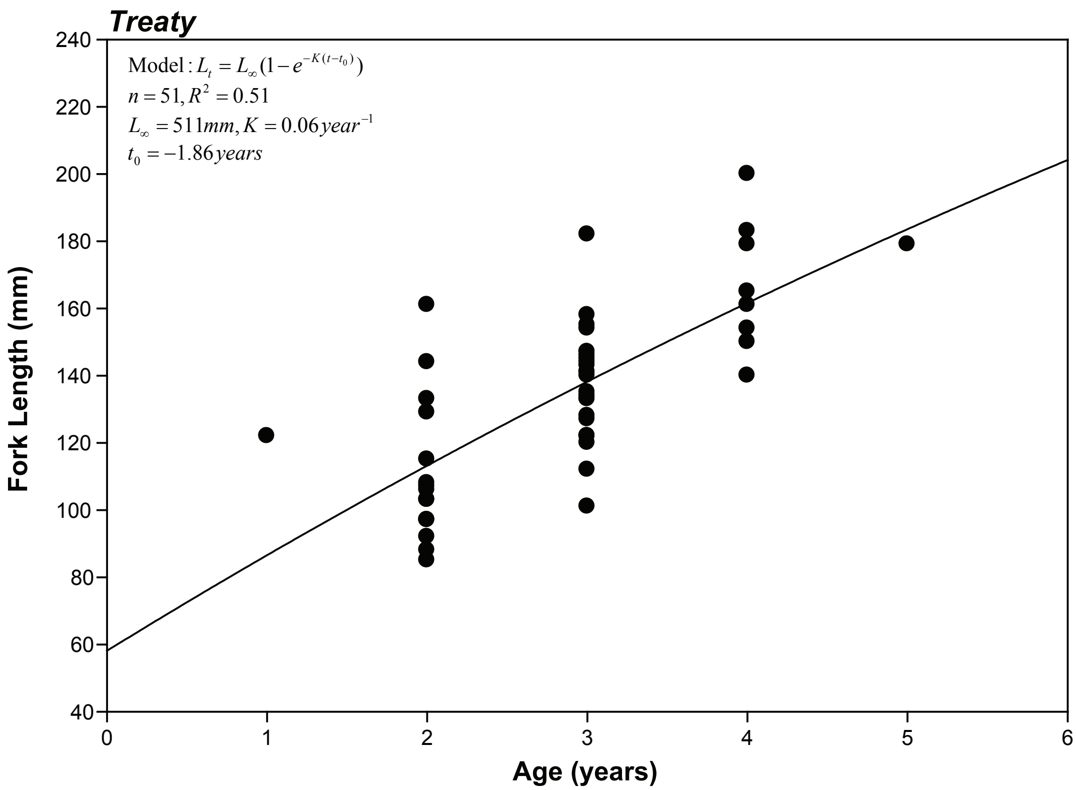


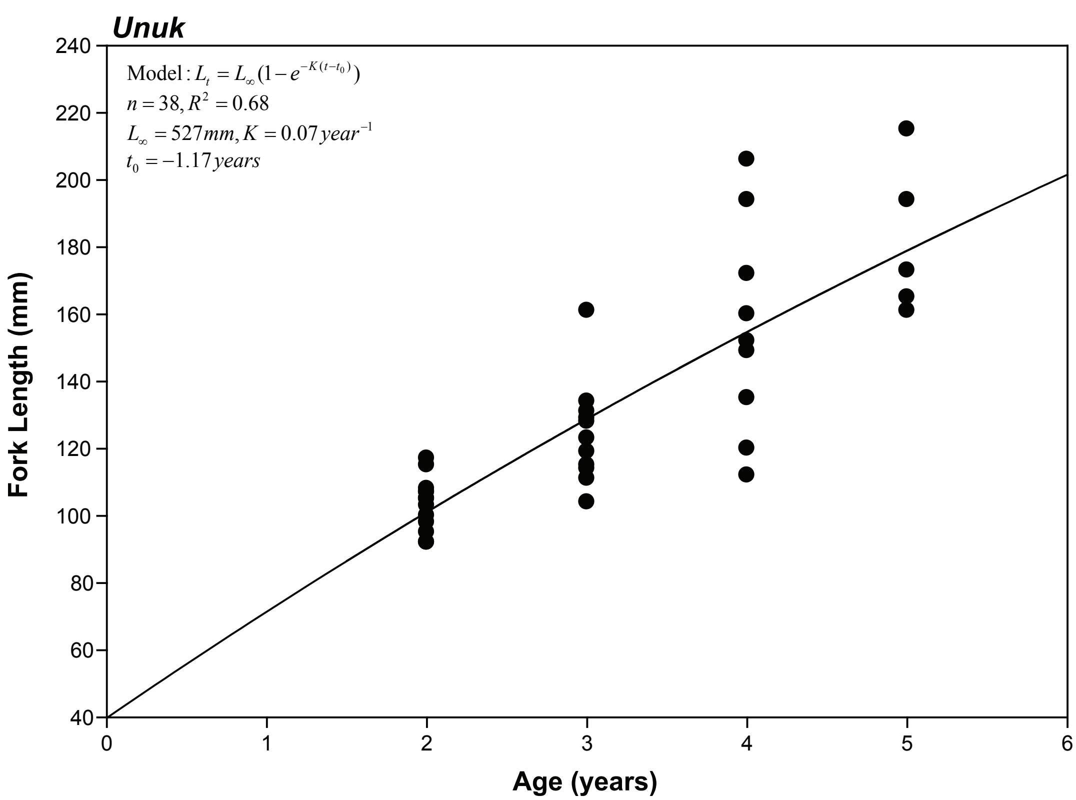
Age Class Distribution of Dolly Varden within Treaty and Unuk Watersheds, 2009

FIGURE 6.3-16

SEABRIDGE GOLD

Rescan™





Von Bertalanffy Growth Models of Dolly Varden Sampled within Treaty and Unuk Watersheds, 2009

FIGURE 6.3-17

Table 6.3-11. Species Life History Periodicity and Distribution for Teigen Watershed

	Specific Life History							
	Spawning			Fry Emergence	Fry Rearing (0+)		Parr Rearing (1+)	Smoltification
Species	**Timing**	**Habitat**	**Distribution**	**Timing**	**Habitat**	**Distribution**	**Habitat and Distribution**	**Timing**
Chinook (Stream Type)	Arrival in late-July, start of spawning in early-August, peak spawning in mid-August and die-off in late-August (Rescan 2008 and 2009; Koski *et al.* 1996).	Only mainstream spawning has been observed in Teigen Creek (Rescan 2008 and 2009; Koski et al. 1996). No spawning habitat or observed spawning within South Teigen Creek. Spawning observed in pool tailouts, depth (cm) and velocity (m/s) of pool tailouts vary. Spawning substrates consist of large gravels.	Spawning observed from the Snowbank Creek confluence, upstream to the outlet of Teigen Lake (Rescan 2008 and 2009; Koski et al. 1996). Majority of suitable spawning habitat between Snowbank Creek confluence and Hodkin Creek confluence. Prime spawning habitat upstream of South Teigen Creek confluence to Hodkin Creek confluence.	Fry emergence is approx. late spring. Fry emergence date is dependent upon water temperature and is 316 days from egg deposition (Quinn 2005). Mean fry length at emergence is 31-35 mm (McPhail 2007).	Fry rear amoung boulder/cobble and pool habitats in Teigen Creek (Rescan 2008 and 2009). Fry migrate downstream upon emergence and take up residency in Teigen Creek and Bell-Irving River.	Field data demonstrates that an abundance of fry (0+) rear throughout Teigen Creek from the Bell-Irving River confluence to Teigen Lake outlet (Rescan 2008 and 2009). Mean fry length in August and September is 57 mm.	Parr (1+) are absent in Teigen Creek during the 2 field sampling seasons (Rescan 2008 and 2009). Field data suggests that parr (1+) migrate downstream out of Teigen Creek in the following spring, downstream into the Bell-Irving River to commence ocean migration.	Ocean migration takes place at 1+ age or older (Quinn 2005).
Sockeye (Stream Type)	Sockeye have been observed spawning in mid-August (Rescan 2008 and 2009).	Only mainstream spawning has been observed in Teigen Creek (Rescan 2008 and 2009). No spawning habitat or observed spawning within South Teigen Creek. Spawning observed in pool tailouts, depth (cm) and velocity (m/s) of pool tailouts vary. Spawning substrates consist of large gravels.	Spawning observed near site TEC1. The distribution of spawning throughout Teigen Creek in unknown at this time, although suitable habitat exists from Snowbank Creek confluence and Teigen Lake outlet. Shore spawning in Teigen Lake and its inlet tributaries are unknown.	Fry emergence is approx. late spring. Fry emergence date is dependent upon water temperature and is 282 days from egg deposition (Quinn 2005). Mean fry length at emergence is 26-29 mm (Quinn 2005).	Lake-type fry migrate upstream are rear in a lake environment for 1-2 years (Quinn 2005; McPhail 2007). However, this upstream migration is not likely given the large distance from Teigen Lake. Therefore, only stream-type sockeye are assumed to be present.	Sockeye fry have not been sampled in Teigen Creek (Rescan 2008 and 2009).	Sockeye parr have not been sampled in Teigen Creek (Rescan 2008 and 2009). Stream-type sockeye parr are known to commence migration after 1-2 years (McPhail 2007).	Ocean migration takes place at 1+ age or older (Quinn 2005).
Coho (Stream Type)	Arrival in late-September (Rescan 2009), start of spawning in mid-October (Tripp 1987).	Spawning has not been observed in Teigen Creek (Rescan 2008; Rescan 2009). Snowbank Creek is the primary Coho producing creek (Bocking and Peacock 2004). Spawning occurs in small tribuaries and side channel habitat (McPhail 2007).	Majority of Coho spawning habitat occurs in Snowbank Creek and lower reaches of Teigen Creek (downstream of Snowbank Creek confluence). Limited Coho spawning habitat is available upstream of Snowbank Creek confluence (Rescan 2009).	Fry emergence is approx. late spring. Fry emergence date is dependent upon water temperature and is 228 days from egg deposition (Quinn 2005). Mean fry length at emergence is 25-28 mm (McPhail 2007).	Fry rear amoung low velocity side channels/ponds/wetlands in Teigen Creek with cobble, LWD and pool cover (Rescan 2008 and 2009).	Field data demonstrates that fry (0+) rear within Teigen Creek side channels/ponds/wetlands. Majority of rearing habitat is between Snowbank Creek confluence and the Bell-Irving River confluence. Fry rearing habitat is limited upstream of South Teigen Creek confluence. Mean fry length is 51 mm (Rescan 2009)	Field data demonstrates that parr (1+) rear within Teigen Creek side channels/ponds/wetlands. Majority of rearing habitat is between Snowbank Creek confluence and the Bell-Irving River confluence. Parr rearing habitat is limited upstream of South Teigen Creek confluence. Mean parr length is > 100 mm. Stream-type coho parr are known to commence migration after 1-2 years (McPhail 2007).	Ocean migration takes place at 1+ age or older (Quinn 2005).
Rainbow Trout/Steelhead (Summer Run)	Arrival in mid-September. Spawning in mid-April to mid-May (LGL 1995). May 10, steelhead tag was retrieved from Teigen Creek (LGL 1995).	Spawning has not been observed in Teigen Creek (Rescan 2009). No spawning habitat or observed spawning in South Teigen Creek. Water levels were too high on June 5, 2009 and prevented effective spawning survey.	Abundance of fry in upper reaches of Teigen Creek (upstream of Hodkin Creek confleunce and Teigen Lake outlet) suggest suitable spawning in this area (Rescan 2009).	Fry emergence is approx. late June (Bocking et al. 2005). Fry emergence date is dependent upon water temperature and is 42 days from egg deposition (McPhail 2007). Mean fry length at emergence is 18-21 mm (McPahil 2007).	Fry rear in mainstem Teigen Creek, amoung stream margins within cobble unembeded substrate (Rescan 2008 and 2009; McPhail 2007).	Field data demonstrates that an abundance of fry (0+) rear in the upper reaches of mainstem Teigen Creek (upstream of Hodkin Creek confluence to Teigen Lake outlet (Rescan 2009). Fry also rear in Hodkin Creek. Mean fry length is 54 mm (Rescan 2008 and 2009).	Field data demonstrates that parr (1+) rear in the lower reaches of mainstem Teigen Creek (downstream of Hodkin Creek confluence to Snowbank Creek confluence (Rescan 2009). Parr also rear in Hodkin Creek and lower reach of South Teigen Creek. Parr are present in pool habitat, side channels and riffles with large substrates.	Smolt age is 4 years for Teigen Creek (Bocking et al. 2005).
Dolly Varden (stream resident)	Dolly Varden commence spawning by the last week in September in small tributaries. Spawning peak is likely early October (Rescan 2008; Rescan 2009; Bustard 2006).	Spawning has not been observed in Teigen Creek (Rescan 2009). Spawning has been observed in small tributaries and seepages of Teigen Creek with small gravels.	High densities of Dolly Varden are not present in mainstem Teigen Creek, rather dominanted by bull trout. Spawning habitat is restricted to small tributaries and seepages along Teigen Creek that provide suitable small gravels and winter baseflows.	Fry emergence is approx. April or early May (McPhail 2007). Eggs hatch is 3 months from egg deposition (McPhail 2007). Mean fry length at emergence is 20 mm (McPahil 2007).	Fry rear in small tributaries of Teigen Creek, in low gradient reaches with gravels and fines substrates, and woody debris cover (Rescan 2008; Rescan 2009).	Field data demonstrates that fry (0+) don't rear in mainstem Teigen Creek rather in smaller tributaries, mainstem side channels and off-channel wetlands/ponds (Rescan 2008; Rescan 2009). Mean fry length at end of first summer is 40 mm (Rescan 2009). Dolly Varden fry are distributed throughout Teigen Creek sidechannels, off-channel wetlands/ponds, and tributaries; however the majority of these habitat types are downstream of the Snowbank Creek confluence.	Field data demonstrates that parr (1+) rear don't generally rear in mainstem Teigen Creek; rather in smaller tributaries, mainstem side channels and off-channel wetlands/ponds (Rescan 2008 and 2009). Mean parr length at end of 2nd summer is 60 mm, 3rd summer is 80 mm (McPhail 2007). Both sexes reach maturity by their fourth summer (>115 mm) (McPhail 2007). Dolly Varden parr are distributed throughout Teigen Creek sidechannels, off-channel wetlands/ponds, and tributaries; however the majority of these habitat types are downstream of the Snowbank Creek confluence.	NA
Bull trout (stream resident/fluvial/adfluvial)	Bull trout likely commence spawning by mid September in smaller tributaries of Teigen Creek and Teigen Lake. Spawning peak is likely late September (McPhail and Baxter 1996; Bustard 2006).	Spawning has not been observed in Teigen Creek, South Teigen Creek or its tributaries (Rescan 2009).	Bull trout are present in Teigen Lake, mainstem Teigen Creek and lower reaches of South Teigen Creek. Location of spawning is unknown; however they likely do not spawn in mainstem Teigen Creek or South Teigen Creek and are known to prefer small streams with large gravels (McPhail 2007).	Fry emergence is approx. April or early May (McPhail 2007). Emergence is 223 days from egg deposition (McPhail and Baxter 1996). Mean fry length at emergence is 25 mm (McPahil 2007).	Fry likely rear in small tributaries ans side channels of Teigen Creek (McPhail 2007)	Field data demonstrates that fry (0+) don't rear in mainstem Teigen Creek (Rescan 2008 and 2009). Fry likely rear in small tributaries and migrate to larger streams to overwinter (McPhail 2007) Mean fry length at end of first summer is 30-50 mm (McPhail 2007). Bull trout fry have not been sampled in 2008 and 2009 field programs, therefore their distribution and habitat preferences within the watershed is unknown (Rescan 2008 and 2009).	Field data demonstrates that parr (1+) rear in mainstem Teigen Creek, South Teigen Creek, and likely Teigen Lake and larger tributaries (Rescan 2008; Rescan 2009). Juvenile parr are known to rear in streams until their 3rd (2+) or 4th (3+) year (McPhail 2007). Parr are found in deep pool habitat and within boulders (Rescan 2009). Bull trout parr were sampled upstream of Snowbank Creek confluence and downstream of West Teigen Creek confluence.	NA

NA = not applicable

Table 6.3-12. Species Life History Periodicity and Distribution for Treaty Watershed

	Specific Life History							
	Spawning			Fry Emergence	Fry Rearing (0+)		Parr Rearing (1+)	Smoltification
Species	Timing	Habitat	Distribution	Timing	Habitat	Distribution	Habitat and Distribution	Timing
Chinook (Stream Type)	Timing of Chinook in Treaty Creek is unknown, but is likely similar to that of Teigen Creek. Arrival in late-July, start of spawning in early-August, peak spawning in mid-August and die-off in late-August (Rescan 2008 and 2009; Koski *et al.* 1996).	Spawning has not been observed in Treaty and Todedada Creek tributaries. Chinook likely do not spawning in mainstem Treaty because of high trubidity.	The distribution of Chinook spawning habitat in Todedada Creek is unknown. Chinook do not spawn in North Treaty Creek because no fish were observed spawning and habitat is not suitable for Chinook spawning.	Fry emergence is approx. late spring. Fry emergence date is dependent upon water temperature and is 316 days from egg deposition (Quinn 2005). Mean fry length at emergence is 31-35 mm (McPhail 2007).	Fry rear amoung boulder/cobble and pool habitats (Rescan 2008 and 2009).	Chinnok fry (0+) have not been sampled in Treaty Creek mainstem during the two field seasons. Field data suggests that Treaty Creek provides limited fry rearing habitat (Rescan 2008 and 2009).	Parr (1+) are absent in Treaty Creek during the 2 field sampling seasons (Rescan 2008 and 2009). Field data suggests that parr (1+) migrate downstream out of Treaty Creek in the following spring, downstream into the Bell-Irving River to commence ocean migration.	Ocean migration takes place at 1+ age or older (Quinn 2005).
Coho (Stream Type)	Arrival in late-October, start of spawning in mid-October (Tripp 1987).	Spawning has been observed in Todedada Creek in clear headwater tributaries (Tripp 1987). Spawning likely does not occur in mainstem Treaty Creek or in tributaries upstream of the Todedada Creek confluence.	Majority of Coho spawning habitat occurs in clear tributaries of Todedada Creek (Tripp 1987). Coho spawning habitat does not appear to be available upstream of Todedada Creek confluence (Rescan 2009). Habitat is not suitable for Coho spawning in North Treaty Creek.	Fry emergence is approx. late spring. Fry emergence date is dependent upon water temperature and is 228 days from egg deposition (Quinn 2005). Mean fry length at emergence is 25-28 mm (McPahil 2007).	Fry rear amoung off-channel ponds/wetlands in Treaty Creek with cobble, LWD and pool cover (Rescan 2008 and 2009;Tripp 1987). Fry likely rear in Todedada Creek (Tripp 1987).	Field data demonstrates that fry (0+) rear within Treaty Creek off-channel ponds/wetlands downstream of the Todedada Creek confluence (Rescan 2008 and 2009) and in Todedada Creek (Tripp 1987). Majority of rearing habitat is between the Todedada Creek confleunce and the start of the canyon on Treaty Creek.	Field data demonstrates that fry (0+) rear within Treaty Creek off-channel ponds/wetlands downstream of the Todedada Creek confluence. Majority of rearing habitat is between the Todedada Creek confleunce and the start of the canyon on Treaty Creek. Mean parr length is > 100 mm. Stream-type coho parr are known to commence migration after 1-2 years (McPhail 2007).	Ocean migration takes place at 1+ age or older (Quinn 2005).
Rainbow Trout/Steelhead (Summer Run)	Arrival in mid-September. Spawning in mid-April to mid-May (LGL 1995).	Spawning has not been observed in Treaty Creek (Rescan 2009). Water levels were too high on June 5, 2009 and prevented effective spawning survey.	The distribution of spawning Treaty Creek is unknown, but likely does not extend upstream further then the Todedada Creek confluence based upon the distribuion of parr sampled. Habitat is not suitable for steelhead spawning in North Treaty Creek.	Fry emergence is approx. late June (Bocking et al. 2005). Fry emergence date is dependent upon water temperature and is 42 days from egg deposition (McPhail 2007). Mean fry length at emergence is 18-21 mm (McPahil 2007).	Fry rearing habitat in Treaty Creek and tributaries is unknown, but is likely amoung stream margins within cobble unembeded substrate (Rescan 2008; Rescan 2009; McPhail 2007).	Fry (0+) distribution in Treaty Creek and its tributaries is unknown, but fry distribution likely does not extend upstream further then the Todedada Creek confluence based upon the distribuion of parr sampled and suitable habitat is Todedada Creek.	Field data demonstrates that parr (1+) rear in the lower reaches of mainstem Treaty Creek (between Todedada Creek confluence and Bell-Iving River confluence) (Rescan 2009). Parr are present in pool habitat, side channels and riffles with large substrates.	Smolt age of 4 years for Teigen Creek is likely similar to that of Treaty Creek (Bocking *et al.* 2005).
Dolly Varden (stream resident)	Dolly Varden commence spawning by the last week in September in small tributaries. Spawning peak is likely early October (Rescan 2008 and 2009; Bustard 2006).	Spawning has not been observed in Treaty Creek (Rescan 2009). Spawning has been observed in small tributaries and seepages of Treaty Creek with small gravels.	Dolly Varden are present throughout mainstem Treaty Creek (glacial headwaters to confluence with the Bell-Irving River) and its tributaries. Spawning habitat is restricted to small tributaries and seepages along Treaty Creek that provide suitable small gravels and winter baseflows.	Fry emergence is approx. April or early May (McPhail 2007). Eggs hatch is 3 months from egg deposition (McPhail 2007). Mean fry length at emergence is 20 mm (McPahil 2007).	Fry rear in small tributaries of Treaty Creek, in low gradient reaches with gravels and fines substrates, and woody debris cover. Fry also rear in side channels of mainstem Treaty Creek (Rescan 2008 and 2009).	Field data demonstrates that fry (0+) rear in side channels of mainstem Treaty Creek and in small tributaries (Rescan 2008 and 2009). Mean fry length at end of first summer is 45 mm (McPhail 2007; Rescan 2008 and 2009). Dolly Varden fry are distributed throughout Treaty Creek sidechannels from the Bell-Irving River confluence to the glacial headwaters.	Field data demonstrates that parr (1+) rear in mainstem Teigen Creek, smaller tributaries, mainstem side channels and off-channel wetlands/ponds (Rescan 2008 and 2009). Mean parr length at end of 2nd summer is 60 mm, 3rd summer is 80 mm. Both sexes reach maturity by their fourth summer (>115 mm) (McPhail 2007). Dolly Varden parr are distributed throughout Treaty Creek mainstem, sidechannels, off-channel wetlands/ponds from the Bell-Irving River confluence to the glacial headwaters.	NA
Bull trout (stream resident/fluvial)	Bull trout likely commence spawning by mid September in smaller tributaries of Treaty Creek and Todedada Creek tributaries. Spawning peak is likely late September (McPhail and Baxter 1996; Bustard 2006).	Spawning has not been observed in Treaty Creek or its tributaries (Rescan 2009).	Bull trout are only present in Treaty Creek mainstem, downstream of Todedada Creek confluence. Location of spawning is unknown; however they likely do not spawn in mainstem Treaty Creek and are known to prefer small streams with large gravels (McPhail and Baxter 1996).	Fry emergence is approx. April or early May (McPhail 2007). Emergence is 223 days from egg deposition (McPhail and Baxter 1996). Mean fry length at emergence is 25 mm (McPhail 2007).	Fry likely rear in small tributaries ans side channels of Treaty Creek (McPhail 2007)	Field data demonstrates that fry (0+) don't rear in mainstem Treaty Creek (Rescan 2008; Rescan 2009). Fry likely rear in small tributaries and migrate to larger streams to overwinter (McPhail 2007) Mean fry length at end of first summer is 30-50 mm (McPhail 2007). Bull trout fry have not been sampled in 2008 and 2009 field programs, therefore their distribution and habitat preferences within the watershed is unknown (Rescan 2008 and 2009).	Field data demonstrates that parr (1+) rear in mainstem Treaty Creek, downstream of Todedada Creek confluence to the Bell-Irving River confleunce, and likely Todedada Creek (Rescan 2008 and 2009). Juvenile parr are knonw to rear in streams until their 3rd (2+) or 4th (3+) year (McPhail 2007). Parr are found in deep pool habitat and within boulders (Rescan 2009).	NA

Plate 6.3-10. Bowser River.

Plate 6.3-11. South Unuk River – Side Channel.

Plate 6.3-12. Coulter Creek.

Plate 6.3-13. Sulphurets Creek.

Plate 6.3-14. West Teigen Creek.

6.3.5 Other Watersheds – Fish Community

6.3.5.1 Fish Presence and Distribution

Table 6.3-5 presents the known fish species presence/distribution for all streams by watershed.

There are a number of fish species present in the Bowser River; however only Dolly Varden were present in the glacial headwaters at site BR1. Only Dolly Varden was present in West Teigen Creek.

Dolly Varden were present in Sulphurets Creek below a 200 m cascade, which was approximately 300 m upstream from the Unuk River (Plate 6.3-17). A total of 3,046 s of electrofishing effort was exerted above the cascade at three sites; however no fish were caught. Sulphurets Creek and its tributaries (McTagg, Mitchell, and Ted Morris creeks) were sampled in 2008 and no fish were caught despite 6,698 s of electrofishing effort above the cascade (Rescan 2009). Previous fisheries sampling effort by Environment Canada (1990) resulted in no fish caught above the cascade on Sulphurets Creek. Therefore, all stream reaches above the cascade were classified as non-fish bearing.

Plate 6.3-15. Oweegee Creek.

Plate 6.3-16. Snowbank Creek.

Table 6.3-13. Summary of Channel Statistics for Other Watersheds, 2009

		Bankful Width (m)			Wetted Width (m)			Bankful Depth (m)			Wetted Depth (m)			Gradient (%)			Residual Pool (m)		
Watershed	Site Name	n	Mean	SE	n	Mean	SE	n	Mean	SE	n	Mean	SE	n	Mean	SE	n	Mean	SE
Bowser River	BR1	7	238.0	29.0	7	138.0	11.0	4	0.8	0.4	3	0.5	0.1	5	3.2	0.2	-	-	-
Bell-Irving	BI1	1	104.0	-	1	40.0	-	-	-	-	-	-	-	1	1.0	-	-	-	-
Bell-Irving	BI2	1	298.0	-	1	95.0	-	-	-	-	-	-	-	1	1.0	-	-	-	-
South Unuk River	SUNR	7	11.0	2.5	7	7.9	2.5	6	0.6	0.1	9	0.3	0.0	4	4.0	0.7	-	-	-
Oweegee Creek	-	4	7.7	1.1	4	7.0	0.4	3	0.7	0.2	-	-	-	2	1.0	-	4	0.4	0.1
Coulter Creek	CC1	6	12.5	1.5	6	5.1	0.8	3.00	1.5	0.1	-	-	-	2	1.5	0.5	6.00	0.5	0.1

Dashes indicate no data available or not applicable

SE = standard error

Table 6.3-14. Summary of Channel Characteristics for Other Watersheds, 2009

Watershed	Site Name	Channel Morphology	Channel Pattern	Channel Confinement
Bowser River	BR1	Large Channel	Irregular Wandering	Unconfined
Bell-Irving	BI1	Riifle Pool	Sinuous	Unconfined
Bell-Irving	BI2	Riifle Pool	Sinuous	Unconfined
South Unuk River	SUNR	Riifle Pool	Sinuous	Unconfined
Oweegee Creek	-	Riifle Pool	Irregular Meandering	Unconfined
Coulter Creek	CC1	Riifle Pool	Irregular Meandering	Unconfined

Dashes indicate not applicable

Table 6.3-15. Summary of Weighted Mean Substrate Composition for Other Watersheds, 2009

		Weighted Mean Substrate Composition (%)				
Watershed	Site Name	Sand	Gravel	Cobble	Boulder	Bedrock
Bowser River	BR1	20	40	40	0	0
Bell-Irving	BI1	10	15	70	5	0
Bell-Irving	BI2	5	35	65	5	0
South Unuk River	SUNR	17	10	37	36	0

Table 6.3-16. Summary of Habitat and Fish Cover Characteristics for Other Watersheds, 2009

Watershed	Site Name	Weighted Mean Habitat Composition (%)				Weighted Mean Cover Composition (%)					
		Cascade	Pool	Glide	Riffle	Pool	Boulder	IV	OV	UB	LWD
Bowser River	BR1	-	-	-	100	0	0	0	0	0	0
Bell-Irving	BI1	-	-	100	-	25	1	0	1	5	15
Bell-Irving	BI2	-	-	100	-	30	3	0	2	0	5
South Unuk River	SUNR	-	-	4	96	0	0	0	12	0	0

Dashes indicate not applicable
IV = Instream Vegetation, OV = Overhanging Vegetation, UB = Undercut Bank, LWD = Large Woody Debris

Table 6.3-17. Summary of LWD Abundance and Distribution, and Riparian Characteristics for Other Watersheds, 2009

Watershed	Site Name	LWD Abundance	LWD Distribution	Riparian Cover	Riparian Stage
Bowser River	BR1	Few	Clumped	None	Not Applicable
Bell-Irving	BI1	Few	Clumped	Mixed	Mature
Bell-Irving	BI2	Few	Clumped	Mixed	Mature
South Unuk River	SUNR	-	-	-	-
Oweegee Creek	-	Abundant	Even	Mixed	Pole Sapling
Coulter Creek	CC1	Abundant	Even	Coniferous	Young Forest

Dashes indicate no data available
LWD = Large Woody Debris

Table 6.3-18. Summary of Fish Habitat Suitability and Quality in Other Watersheds, 2009

Watershed	Site Name	Spawning	Rearing	Over-Wintering	Overall
Bowser River	BR1	Fair	Poor	Poor	Marginal
Bell-Irving	BI1	Poor	Good	Good	Important
Bell-Irving	BI2	Poor	Good	Good	Important
South Unuk River	SUNR	Poor	Good	Poor	Important
Oweegee Creek	-	Good	Good	Fair	Important
Coulter Creek	CC1	Fair	Fair	Good	Important

Dashes indicate not applicable

Dolly Varden and coho salmon were present below a large falls in Coulter Creek (Plate 6.3-18). A total of 3,056 s of electrofishing effort was exerted above the falls at three sites; however no fish were caught. Coulter Creek and its tributaries were sampled in 2008 and no fish were caught despite 1,607 s of electrofishing effort above the falls (Rescan 2009). Therefore, all stream reaches above the falls were classified as non-fish bearing.

Plate 6.3-17. Sulphurets Creek Cascade.

6.3.5.2 *Relative Abundance and Density*

Appendix 6.1-3 shows all electrofishing effort and catch data for each stream site. Table 6.3-19 summarizes sampling effort, catch and individual species CPUE for all stream sites by watershed. Comparisons of mean CPUE between watersheds was not conducted because of catch variability of one pass electrofishing methods and efficiency of electrofishing gear in sampling different habitats (e.g., large rivers vs. small streams).

Plate 6.3-18. Coulter Creek Falls.

Three-pass electrofishing surveys were completed in mid-August at 3 sites in West Teigen Creek. Appendix 6.1-3 shows all electrofishing effort and catch data for each density sampling site. Appendix 6.2-4 shows the results of density calculations with upper and lower confidence limits for each site. Electrofishing sampling conditions were good across all sites with good water visibility, effective block nets preventing fish movement, low flows and suitable water temperatures.

One site was excluded from the population density analysis because it failed to meet model assumptions (i.e., increasing catch probability with each successive pass) (Johnson et al. 2007). Dolly Varden population estimates were obtained with maximum likelihood methods for one site and Bayesian method for the other site. Mean Dolly Varden population density was 7.28 fish/100 m^2; however the SE was high because few fish were caught at one site.

6.3.5.3 Population Demography

Appendix 6.1-2 shows all species biological data for each stream site. Table 6.3-20 summarizes length, weight and condition data for fish species captured for all stream sites by watershed. Dolly Varden was selected as the keystone species for data analysis because they are present within all fish bearing streams. Statistical comparisons between watersheds were not conducted because the 2008 data determined that Dolly Varden in West Teigen Creek was significantly longer and heavier compared to other watersheds (Rescan 2009). Length-frequency distributions were plotted for all Dolly Varden caught in West Teigen Creek (Figure 6.3-18). Length classes present in West Teigen Creek was shifted towards longer length classes with two modes of 125 and >196 mm.

Dolly Varden weight-length regressions were conducted by watershed (Figure 6.3-19). All regressions were highly significant and explained between 89 to 99% of the variation in ln(weight). Regression slopes were close to the expected value of 3.0, typical for the length-weight geometry of fish.

Table 6.3-19. Summary Statistics of Electrofishing Effort, Catch and CPUE in Other Watershed Mainstems, 2009

Watershed		**Bell-Irving**	**Bowser**	**Coulter**	**Oweegee**	**Snowbank**	**South Unuk**	**West Teigen**
No. of Sites		2	1	1	1	1	1	2
Total Effort (s)		2,075	1,046	1,012	1,115	1,017	1,001	1,259
Species								
Dolly Varden	No. of Fish	0	1	8	0	5	8	53
	Mean CPUE	-	0.1	0.8	-	0.5	0.8	6.5
	SE	-	-	-	-	-	-	6.5
Rainbow Trout	No. of Fish	9	0	0	10	5	0	0
	Mean CPUE	0.4	-	-	0.9	0.5	-	-
	SE	0.2	-	-	-	-	-	-
Coho Salmon	No. of Fish	78	0	22	0	15	0	0
	Mean CPUE	3.8	-	2.2	-	1.5	-	-
	SE	1.5	-	-	-	-	-	-
Chinook Salmon	No. of Fish	2	0	0	0	0	0	0
	Mean CPUE	0.1	-	-	-	-	-	-
	SE	0.1	-	-	-	-	-	-
Mountain Whitefish	No. of Fish	3	0	0	1	0	0	0
	Mean CPUE	0.2	-	-	0.1	-	-	-
	SE	0.2	-	-	-	-	-	-

Dashes indicate no data available

CPUE = catch-per-unit-effort; fish/100 s

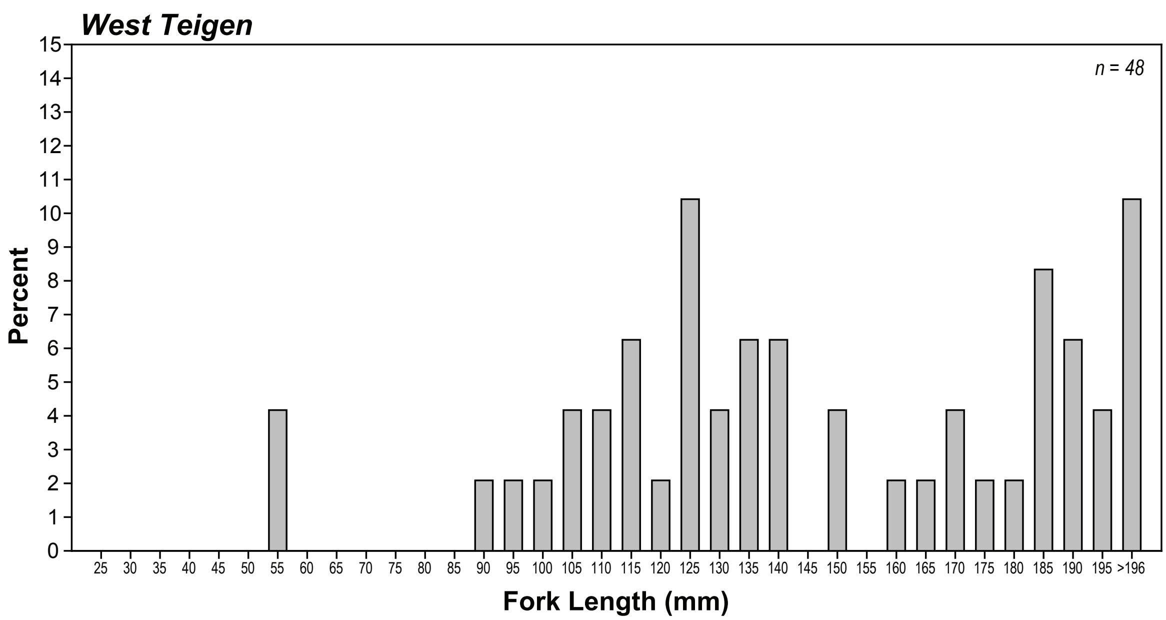
SE = standard error of the mean

Table 6.3-20. Mean Length, Weight and Condition of Fish Captured in Other Watersheds, 2009

		Length (mm)					**Weight (g)**					**Condition (g/mm^3)**				
Species	**Watershed**	**N**	**Mean**	**SE**	**Min**	**Max**	**N**	**Mean**	**SE**	**Min**	**Max**	**N**	**Mean**	**SE**	**Min**	**Max**
Dolly Varden																
	Bowser	1	130	-	130	130	1	23.1	-	23.1	23.1	1	1.05	-	1.05	1.05
	Coulter	8	54	3.6	34	67	8	1.6	0.4	0.4	3.1	8	0.94	0.13	0.17	1.46
	Snowbank	5	88	10.3	59	115	5	7.8	2.3	2.0	15.0	5	1.00	0.04	0.93	1.17
	South Unuk	8	88	22.1	30	183	8	22.1	10.5	0.3	73.6	8	1.24	0.09	1.02	1.88
	West Teigen	48	144	5.7	51	205	47	35.3	3.7	1.2	85.9	48	0.96	0.03	0.00	1.41
Rainbow Trout																
	Bell-Irving	9	97	6.4	75	121	9	11.0	2.1	3.9	20.6	9	1.09	0.03	0.92	1.21
	Oweegee	10	66	8.0	13	98	10	6.2	1.9	1.0	20.4	10	1.04	0.05	0.89	1.47
	Snowbank	5	120	15.3	64	157	5	22.4	5.6	3.0	38.0	5	1.13	0.05	0.98	1.24
Coho Salmon																
	Bell-Irving	78	51	0.8	32	81	76	1.5	0.1	0.0	6.0	75	1.13	0.03	0.70	2.00
	Coulter	22	47	4.7	21	96	22	2.1	0.5	0.3	8.9	21	1.79	0.44	0.81	8.64
	Snowbank	15	57	6.0	40	97	6	7.3	1.3	2.0	11.0	6	1.24	0.05	1.13	1.45
Chinook Salmon																
	Bell-Irving	2	57	6.5	50	63	2	2.0	0.8	1.2	2.8	2	1.04	0.08	0.96	1.12
Mountain Whitefish																
	Bell-Irving	3	77	18.5	40	97	3	6.1	2.9	0.6	10.4	3	0.99	0.08	0.89	1.14
	Oweegee	1	31	-	31	31	1	1.2	-	1.2	1.2	-	-	-	-	-

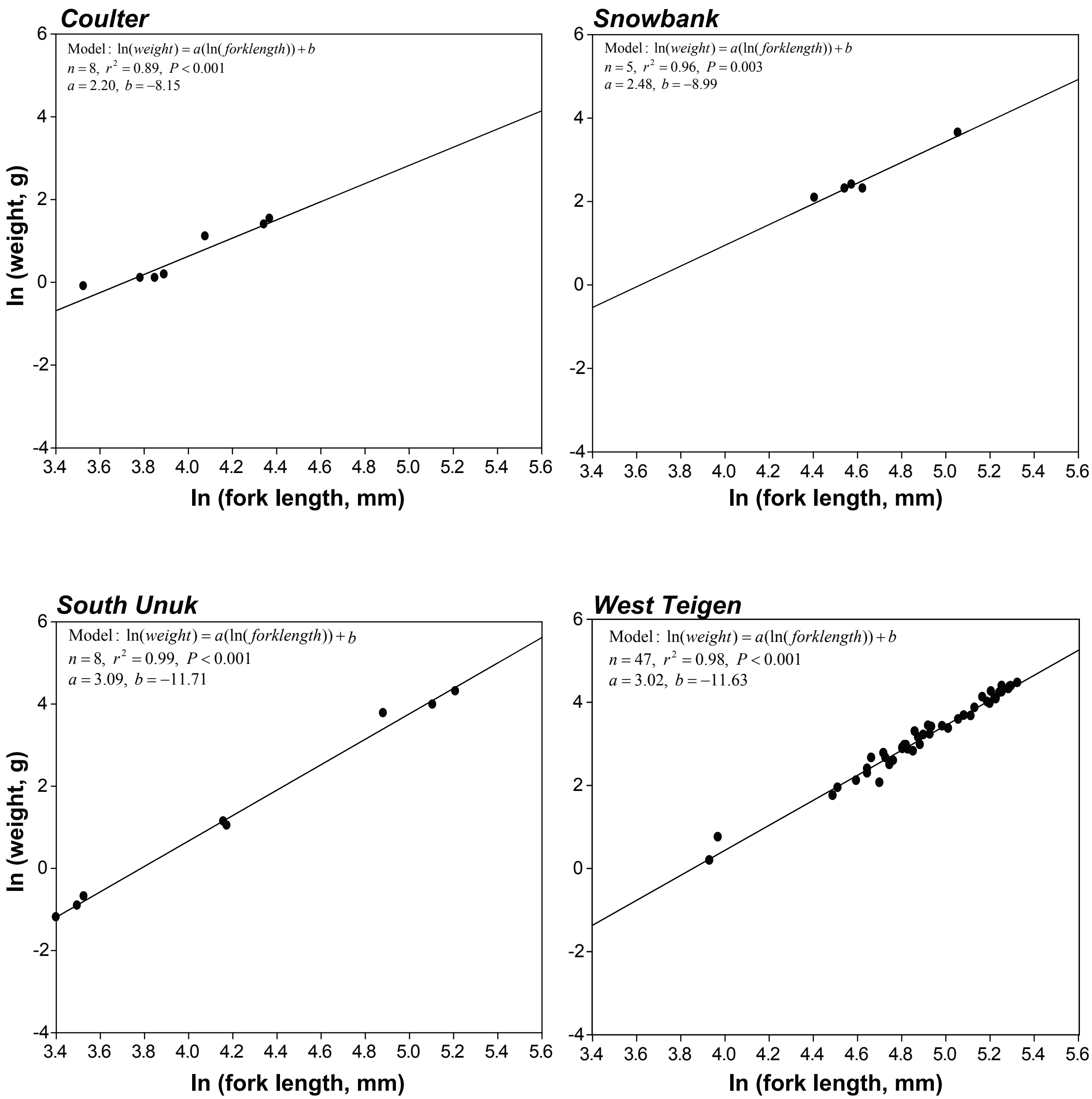
Dashes indicates not applicable

SE = standard error



Fork Length Class Distribution of Dolly Varden within West Teigen Watershed, 2009

FIGURE 6.3-18



Weight-Length Regression of Dolly Varden within Other Watersheds, 2009

FIGURE 6.3-19

Age data for rainbow trout captured are summarized in Table 6.3-21 and had a mean age of 3 years.

Table 6.3-21. Mean Age of Fish Captured in the Bell-Irving Watershed, 2009

		Age (years)				
Species	**Watershed**	**n**	**Mean**	**SE**	**Min**	**Max**
Rainbow Trout	Bell-Irving	5	3.2	0.3	2	4

SE = standard error

6.3.6 Instream Flow Habitat

Appendix 6.3-2 presents the cross sectional instream flow habitat data details for transects in South Teigen and North Treaty creeks. Twenty-two instream flow habitat transects were established in South Teigen Creek downstream of the TMF (Figure 6.3-20). Fifteen instream flow habitat transects were established in North Treaty Creek downstream of the TMF (Figure 6.3-21). Transects were established based upon the hydraulic category of the site (i.e., pool, riffle, glide and cascade). A total of 6 pools, 2 riffles and 14 cascades were assessed in South Teigen Creek (Table 6.3-22). A total of 5 pools, 5 riffles and 5 cascades were assessed in North Treaty Creek (Table 6.3-22).

Bankfull width, wetted width, mean depth, mean velocity and discharge for each transect and survey period was summarized in Table 6.3-22. Mean velocity and discharge was less in North Treaty Creek than South Teigen Creek. Table 6.3-23 shows a summary of substrate and habitat cover composition at each transect. Habitat cover composition did not change between sampling events because the discharge reduction between the two sampling events was not significant enough to change the cover composition. Boulders and deep pools were the dominant cover types in South Teigen Creek. Cobble and boulders were the dominant substrate types in South Teigen Creek. Boulders, deep pools, and overhanging vegetation were the dominant cover types in North Treaty Creek. Cobble, small gravel and boulders were the dominant substrate types in North Treaty Creek.

6.3.7 MMER

For the purposes of the MMER, receiving and reference environment sites were the following (Figure 4.1-1):

- Receiving Environment
  - North Treaty Creek (NTR2)
  - South Teigen Creek (STE2)
  - Sulphurets Creek (SC3)
- Reference Environment
  - Scott Creek (SCR)

Dolly Varden was selected as the keystone species for monitoring fish and aquatic environment health for numerous ecological reasons. Dolly Varden was present at all sites and was the most abundant species, which allows for site comparisons. Dolly Varden is a resident fish species with limited movement and dispersal (Ihlenfeldt 2005; Bryant and Lukey 2004). The species possesses short-medium term longevity (8 to 9 years), prey preference is benthic invertebrates, age and length to maturation is short (3 to 5 years; 130 to 162 mm); spawning is site-specific, and diet is primarily aquatic based (Ihlenfeldt 2005; McPhail 2007; EC 2002).

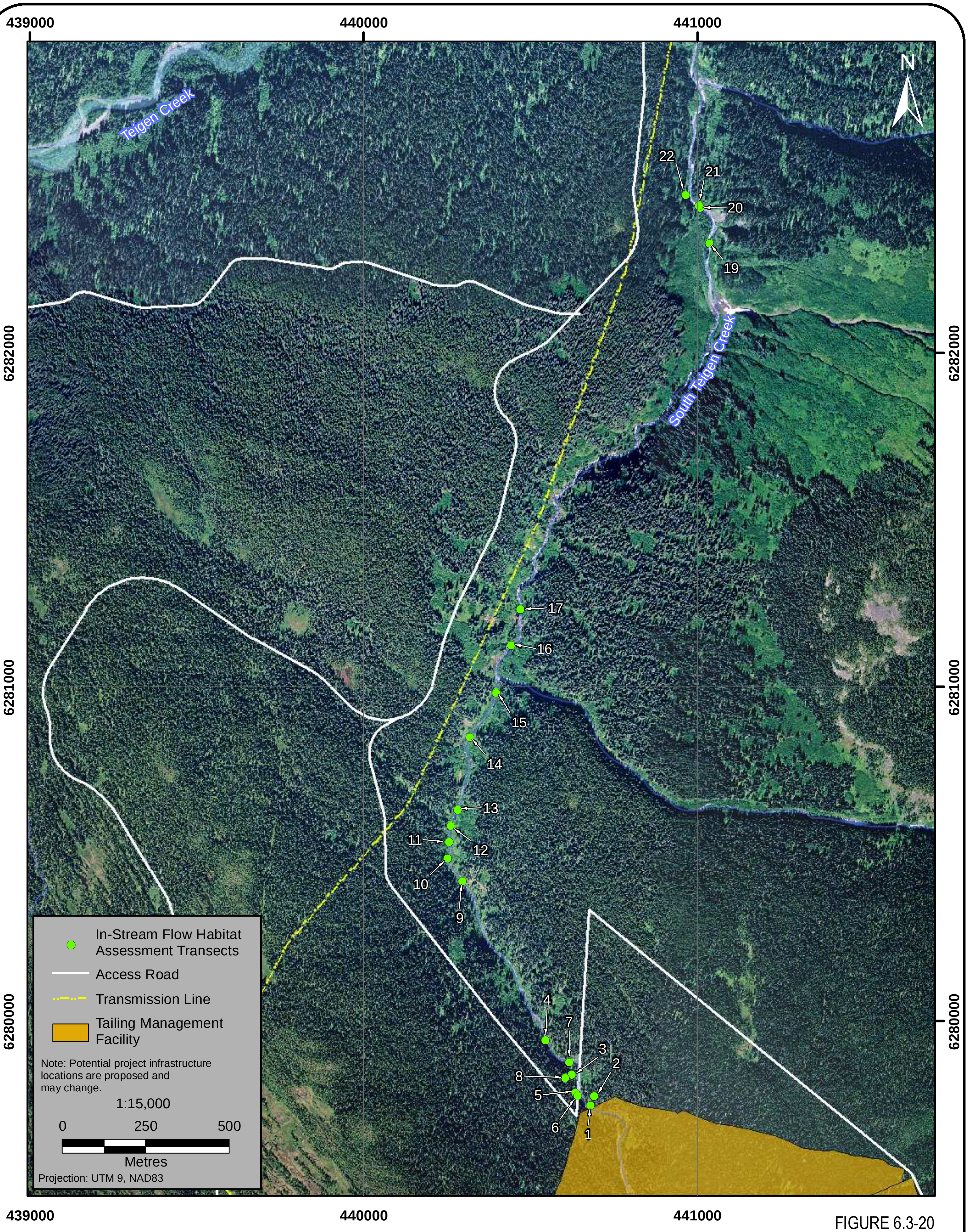


FIGURE 6.3-20

SEABRIDGE GOLD

Instream Flow Habitat Assessment Transects within South Teigen Creek, 2009

Rescan
Engineers & Scientists

gis no. KSM-06-040b Job No. 0868-06-10 January 28 2010

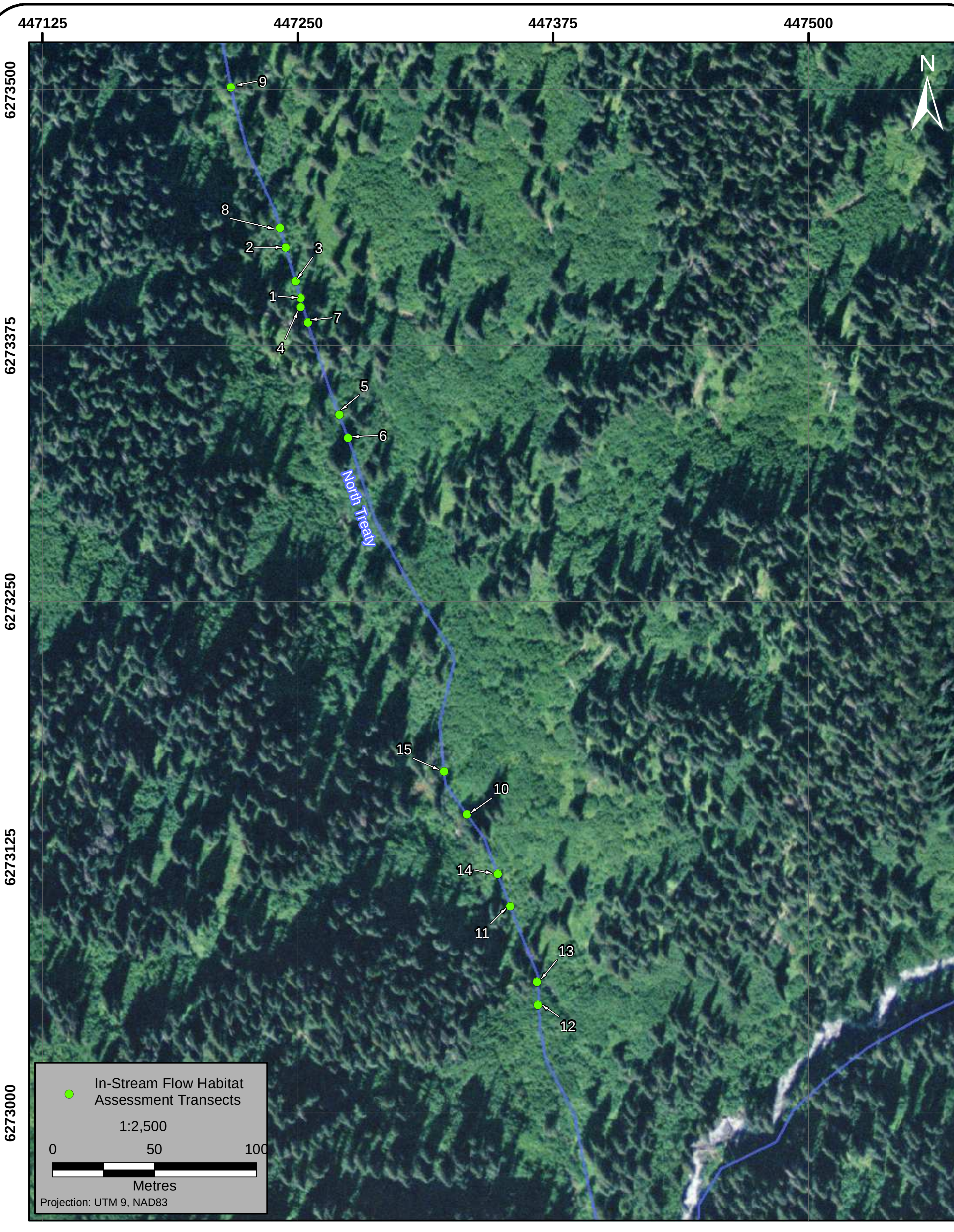


FIGURE 6.3-21

SEABRIDGE GOLD

Instream Flow Habitat Assessment Transects within North Treaty Creek, 2009

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Table 6.3-22. Summary of Instream Flow Transect Data within South Teigen and North Treaty Creeks, 2009

Watershed	Transect #	Flow #	Flow Date (dd/mm/yy)	Hydraulic Unit Type	Bankfull Width (m)	Wetted Width (m)	Wetted Depth (cm)		Velocity (cm/s)		Discharge (m3/s)
							Mean	SE	Mean	SE	
South Teigen	1	1	13-Aug-09	Pool	9.15	5.80	41	6.5	32.41	6.94	1.39
		2	15-Sep-09		9.15	5.85	37	6.0	28.78	7.68	1.34
	2	1	13-Aug-09	Cascade	8.60	7.20	18	3.0	53.80	9.46	0.96
		2	15-Sep-09		8.60	7.30	19	2.9	30.00	8.91	0.66
	3	1	13-Aug-09	Cascade	8.89	7.88	28	3.6	28.41	5.08	0.96
	4	1	13-Aug-09	Cascade	10.30	9.60	19	3.0	47.83	9.02	1.24
		2	15-Sep-09		10.30	9.60	21	3.3	41.45	7.72	1.14
	5	1	14-Aug-09	Pool	12.50	12.00	22	3.6	29.58	8.75	1.12
		2	15-Sep-09		12.50	12.50	22	3.8	24.50	7.08	0.83
	6	1	14-Aug-09	Riffle	11.10	9.50	19	2.7	47.95	6.92	1.18
	7	1	14-Aug-09	Pool	11.40	10.35	27	4.2	29.87	7.44	1.02
		2	15-Sep-09		11.40	10.60	27	4.5	24.17	6.38	1.06
	8	1	14-Aug-09	Cascade	9.55	7.50	21	4.4	37.24	8.56	1.02
		2	15-Sep-09		9.55	7.50	21	3.3	34.52	6.35	0.91
	9	1	14-Aug-09	Cascade	9.70	7.70	22	3.4	34.57	7.35	0.86
		2	15-Sep-09		9.70	8.00	22	3.4	40.76	9.58	0.98
	10	1	14-Aug-09	Pool	8.30	7.05	46	6.0	17.68	3.43	0.95
		2	14-Sep-09		8.30	7.10	47	6.1	16.24	3.47	0.90
	11	1	14-Aug-09	Cascade	9.60	8.03	22	2.4	41.52	7.92	0.93
		2	14-Sep-09		9.60	7.40	24	2.6	35.86	7.56	0.88
	12	1	14-Aug-09	Riffle	9.50	6.60	26	2.9	44.88	6.14	0.98
		2	14-Sep-09		9.50	7.14	26	3.0	30.33	5.70	0.69
	13	1	14-Aug-09	Pool	11.10	9.85	55	6.4	14.19	5.38	1.10
		2	14-Sep-09		11.10	9.80	48	7.0	10.77	4.09	0.81
	14	2	14-Sep-09	Cascade	9.00	8.60	20	3.3	32.68	7.60	0.87
	15	2	14-Sep-09	Cascade	12.60	10.40	16	2.8	43.65	11.01	0.97
	16	2	14-Sep-09	Pool	12.90	9.30	38	5.4	15.33	4.93	0.96
	17	2	14-Sep-09	Cascade	14.70	7.80	18	5.4	25.00	10.50	0.86
	18	2	15-Sep-09	Cascade	14.40	10.30	17	3.9	27.75	10.25	1.29
	19	2	15-Sep-09	Cascade	10.70	10.00	18	4.2	22.15	8.28	1.03
	20	2	16-Sep-09	Cascade	13.00	11.75	33	4.3	46.00	7.31	2.54
	21	2	16-Sep-09	Cascade	20.70	16.50	18	3.2	30.88	7.11	2.03
	22	2	16-Sep-09	Cascade	17.40	14.60	21	4.0	45.90	11.37	2.46
North Treaty	1	1	12-Aug-09	Pool	5.05	4.62	34	2.6	22.77	5.45	0.27
		2	16-Sep-09		5.05	4.70	29	3.1	23.69	5.76	0.36
	2	1	12-Aug-09	Cascade	9.15	3.78	9	1.3	34.58	8.51	0.23
		2	16-Sep-09		9.15	3.70	10	1.7	46.48	10.56	0.29
	3	1	12-Aug-09	Riffle	7.33	3.95	11	1.7	32.55	7.09	0.23
		2	16-Sep-09		7.33	5.10	9	1.6	28.37	5.78	0.23
	4	1	12-Aug-09	Riffle	5.70	3.99	13	1.7	33.00	5.04	0.22
		2	16-Sep-09		5.70	3.85	15	1.7	31.57	5.50	0.25
	5	1	12-Aug-09	Pool	4.20	3.61	29	3.0	17.76	5.03	0.25
		2	16-Sep-09		4.20	3.90	31	3.4	21.88	5.35	0.31
	6	1	12-Aug-09	Cascade	5.60	4.78	10	1.7	32.27	7.90	0.20
		2	16-Sep-09		5.60	4.50	11	1.7	38.43	8.41	0.30
	7	1	12-Aug-09	Pool	6.45	6.19	25	3.1	14.45	4.80	0.30
		2	16-Sep-09		6.45	6.70	27	3.4	15.57	5.48	0.36
	8	1	12-Aug-09	Riffle	6.01	3.30	17	2.8	24.30	4.50	0.21
		2	16-Sep-09		6.01	3.50	22	2.6	25.17	5.82	0.28
	9	1	12-Aug-09	Cascade	6.70	4.05	14	2.0	40.14	7.77	0.24
		2	16-Sep-09		6.70	4.20	13	1.8	48.62	10.52	0.28
	10	1	13-Aug-09	Cascade	6.80	5.25	9	1.9	31.50	7.94	0.21
		2	17-Sep-09		6.80	5.20	11	1.9	28.70	8.15	0.25
	11	1	13-Aug-09	Pool	8.30	4.25	38	4.0	7.64	2.08	0.14
		2	17-Sep-09		8.30	4.50	38	4.3	9.09	2.46	0.19
	12	1	13-Aug-09	Riffle	8.40	6.25	11	2.4	23.43	7.29	0.21
		2	17-Sep-09		8.40	6.65	10	2.3	13.52	4.93	0.18
	13	1	13-Aug-09	Riffle	5.50	4.03	20	2.7	19.91	4.67	0.22
		2	17-Sep-09		5.50	4.00	21	2.6	19.22	4.95	0.24
	14	1	13-Aug-09	Cascade	5.90	4.60	12	1.6	26.00	5.25	0.19
		2	17-Sep-09		5.90	4.75	11	1.6	32.08	6.24	0.24
	15	1	13-Aug-09	Pool	7.50	4.80	31	4.5	6.08	2.50	0.18
		2	17-Sep-09		7.50	5.10	25	4.5	8.67	2.85	0.23

SE = standard error of the mean

Table 6.3-23. Summary of In-Stream Flow Substrate Composition and Habitat Cover within South Teigen and North Treaty Creeks, 2009

					Mean Bed Substrate Composition (%)							Cover Composition (%)[a]						
Watershed	Transect #	Flow #	Flow Date (dd/mm/yy)	Hydraulic Unit Type	Bedrock	Boulder	Large Cobble	Small Cobble	Large Gravel	Small Gravel	Fines	Deep pool	Boulder	Instream vegetation	Overhanging vegetation	Undercut bank	LWD	SWD
	1	1	13-Aug-09	Pool	29	28	20			18	6	93	69					
		2	15-Sep-09															
	2	1	13-Aug-09	Cascade	7	22	65		6				38		23			
		2	15-Sep-09															
	3	1	13-Aug-09	Cascade		12	36	36	2		14		20			5		
	4	1	13-Aug-09	Cascade	10	18	54	11	7				43					
		2	15-Sep-09															
	5	1	14-Aug-09	Pool		39	24	25	5	7		37	37					
		2	15-Sep-09															
	6	1	14-Aug-09	Riffle		25	34	30		12			33					
	7	1	14-Aug-09	Pool		53	4	22	7	10	4	24	67		17		26	
		2	15-Sep-09															
	8	1	14-Aug-09	Cascade			49	42		8	1				17			
		2	15-Sep-09															
	9	1	14-Aug-09	Cascade		19	34	36		12			56		22			
		2	15-Sep-09															
South Teigen	10	1	14-Aug-09	Pool			4	4	20	50	22	92			45			
		2	14-Sep-09															
	11	1	14-Aug-09	Cascade		15	61		12	12			19		38			
		2	14-Sep-09															
	12	1	14-Aug-09	Riffle			68	23	5		4				15		13	
		2	14-Sep-09															
	13	1	14-Aug-09	Pool		35	7	6		20	32	74	47		34			
		2	14-Sep-09															
	14	2	14-Sep-09	Cascade		46	30	21	3				68		46			
	15	2	14-Sep-09	Cascade		28	28	38	6				63					
	16	2	14-Sep-09	Pool		27	21	9	0	23	21	69	50					
	17	2	14-Sep-09	Cascade		41	40	7			11	12	100					
	18	2	15-Sep-09	Cascade		15	33	27	12	13			59		28			
	19	2	15-Sep-09	Cascade		46	36	12		6			50			2		
	20	2	16-Sep-09	Cascade		32	55	12	1				31					
	21	2	16-Sep-09	Cascade		15	35	14	29	7			26		13			
	22	2	16-Sep-09	Cascade		29	21	39			11		52				5	
	Mean	-	-	-	**3**	**29**	**35**	**22**	**6**	**11**	**8**	**19**	**42**		**14**	**0.3**	**2**	

Note:
a - percentage calculated from wetted width
No data represents not present
Dashes indicate not applicable

(continued)

Table 6.3-23. Summary of In-Stream Flow Substrate Composition and Habitat Cover within South Teigen and North Treaty Creeks, 2009 (completed)

Watershed	Transect #	Flow #	Flow Date (dd/mm/yy)	Hydraulic Unit Type	Mean Bed Substrate Composition (%)							Cover Composition (%)[a]					
					Bedrock	Boulder	Large Cobble	Small Cobble	Large Gravel	Small Gravel	Fines	Deep pool	Boulder	Instream vegetation	Overhanging vegetation	Undercut bank	LWD	SWD
North Treaty	1	1	12-Aug-09	Pool		7	25	40		29		57	43					
		2	16-Sep-09															
	2	1	12-Aug-09	Cascade			5	93	2							19		
		2	16-Sep-09															
	3	1	12-Aug-09	Riffle			10	64		26						14		
		2	16-Sep-09															
	4	1	12-Aug-09	Riffle		3		66	8	23			11					
		2	16-Sep-09															
	5	1	12-Aug-09	Pool		6	10	10	8	66		52	28		24		48	
		2	16-Sep-09															
	6	1	12-Aug-09	Cascade		31	58	8		3			34		58			
		2	16-Sep-09															
	7	1	12-Aug-09	Pool		18	20	12	3	48		64					20	
		2	16-Sep-09															
	8	1	12-Aug-09	Riffle			31	30	18	21					16			
		2	16-Sep-09															
	9	1	12-Aug-09	Cascade		38	60		3				61		32			
		2	16-Sep-09															
	10	1	13-Aug-09	Cascade		22	24	20		15	19		30		50		15	
		2	17-Sep-09															
	11	1	13-Aug-09	Pool		15	23	30	21	6	6	100	24					
		2	17-Sep-09															
	12	1	13-Aug-09	Riffle		15		24	22	19	19		37		16			
		2	17-Sep-09															
	13	1	13-Aug-09	Riffle		26	31	14		10	19		47		51			
		2	17-Sep-09															
	14	1	13-Aug-09	Cascade		41		40	7	4	7		80		100			
		2	17-Sep-09															
	15	1	13-Aug-09	Pool		52		44		2	2	87	79		21			
		2	17-Sep-09															
	Mean	-	-	-		**18**	**21**	**33**	**6**	**18**	**5**	**24**	**32**		**24**	**2**	**6**	

Note:
a - percentage calculated from wetted width
No data represents not present
Dashes indicate not applicable

6.3.7.1 Relative Abundance

Table 6.3-24 summarizes sampling effort, catch and CPUE for all receiving and reference environment sites. A total of two species were captured, Dolly Varden and bull trout, at the sites. Bull trout were only captured in Scott Creek. A total of 1,000 s of electrofishing effort were exerted on Sulphurets Creek; however only three fish were captured. Statistical comparisons of mean CPUE between sites were not conducted because of low sample sizes. In general, Scott Creek had the highest Dolly Varden CPUE at 4.47 fish/100 s, while South Teigen Creek had the second highest Dolly Varden CPUE at 2.29 fish/100 s. Results of the 2008 baseline indicated that South Teigen Creek possessed a higher CPUE than Scott Creek (Rescan 2009). This difference is attributed to an abundance of Dolly Varden present in a side channel of Scott Creek, which allowed for a high CPUE.

Table 6.3-24. Summary Statistics of Electrofishing Effort, Catch and CPUE in Receiving and Reference Environment Sites, 2009

		No. Sample	Total Effort	Dolly Varden		Bull Trout		Mountain Whitefish	
Environment	Site	Events	(s)	No. of Fish	CPUE	No. of Fish	CPUE	No. of Fish	CPUE
Receiving	North Treaty	1	1,257	7	0.6	0	-	1	0.1
	South Teigen	1	699	16	2.3	0	-	0	-
	Sulphurets	1	1,000	3	0.3	0	-	0	-
Reference	Scott	1	425	19	4.5	1	0.2	0	-

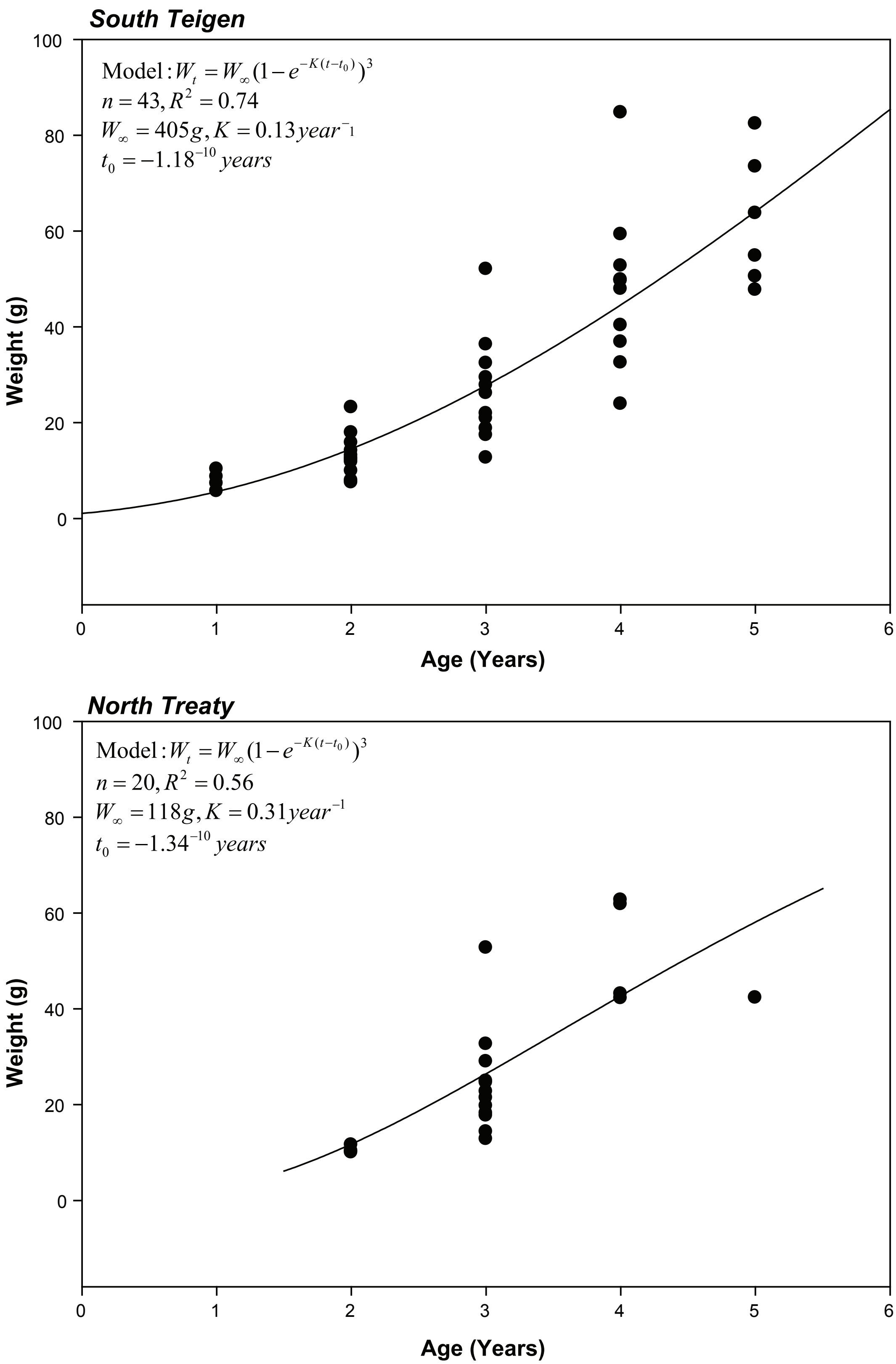
Dashes indicate not applicable
CPUE = catch-per-unit-effort; fish/100 s

6.3.7.2 Energy Use

Energy use by fish can be assessed using growth models and reproductive investment. The low number of fish captured during this sampling period was not sufficient to produce meaningful size (weight and length) at age growth models for Sulphurets and Scott creeks. Von Bertalanffy growth models were fit to the age and weight data of Dolly Varden from North Treaty and South Teigen creeks (Figure 6.3-22). Data was pooled from sites downstream of the TMF to provide sufficient sample size for analysis. Age explained between 56 and 74% of the variation in fish weight. The maximum attainable weight ranged between 118 and 405 g. Energy use response variable of Von Bertalanffy growth models were fit to the age and length data of fish from North Treaty and South Teigen creeks (Figure 6.3-23). Age explained between 66 and 81% of the variation in fish length. The maximum attainable length ranged between 242 and 596 mm.

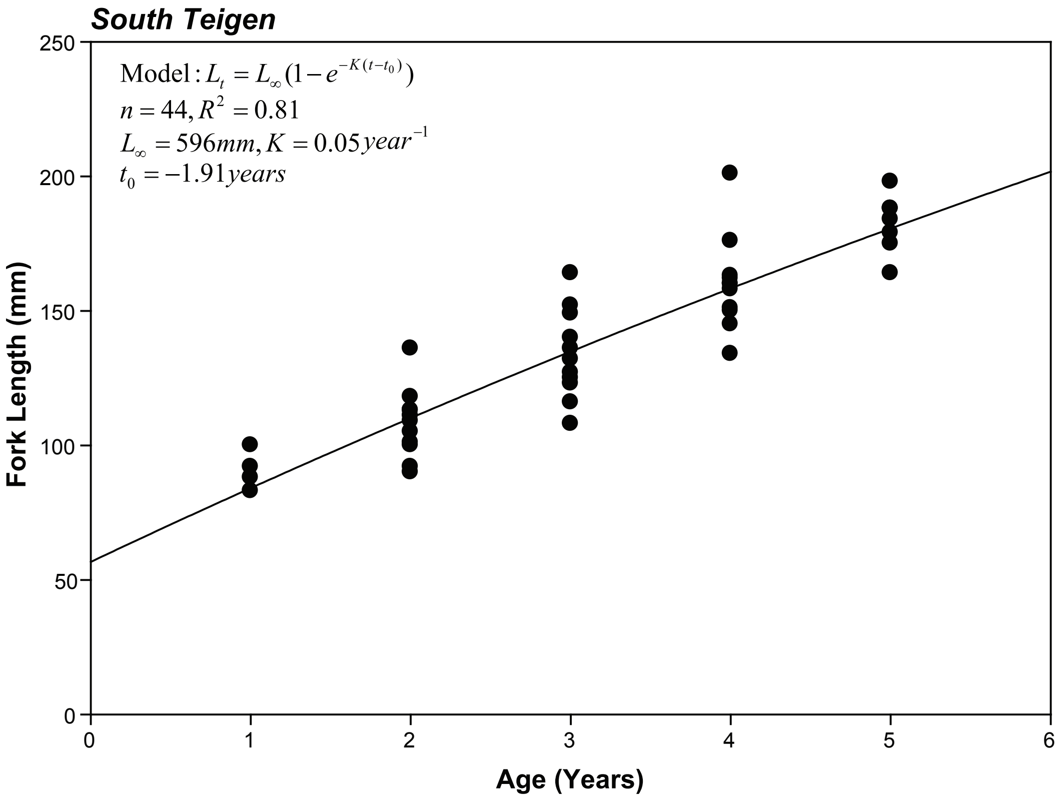
Supporting energy use response variables of fish weight and length sampled in the receiving and reference environment sites are presented in Table 6.3-25 and Figure 6.3-24. There were no significant differences in Dolly Varden mean length (ANOVA; $F_{3,41}$ = 1.54, P = 0.22) and mean weight (ANOVA; $F_{3,41}$ = 1.86, P = 0.15) among sites. Generally, Dolly Varden in North Treaty Creek were longer and heavier compared to other sites.

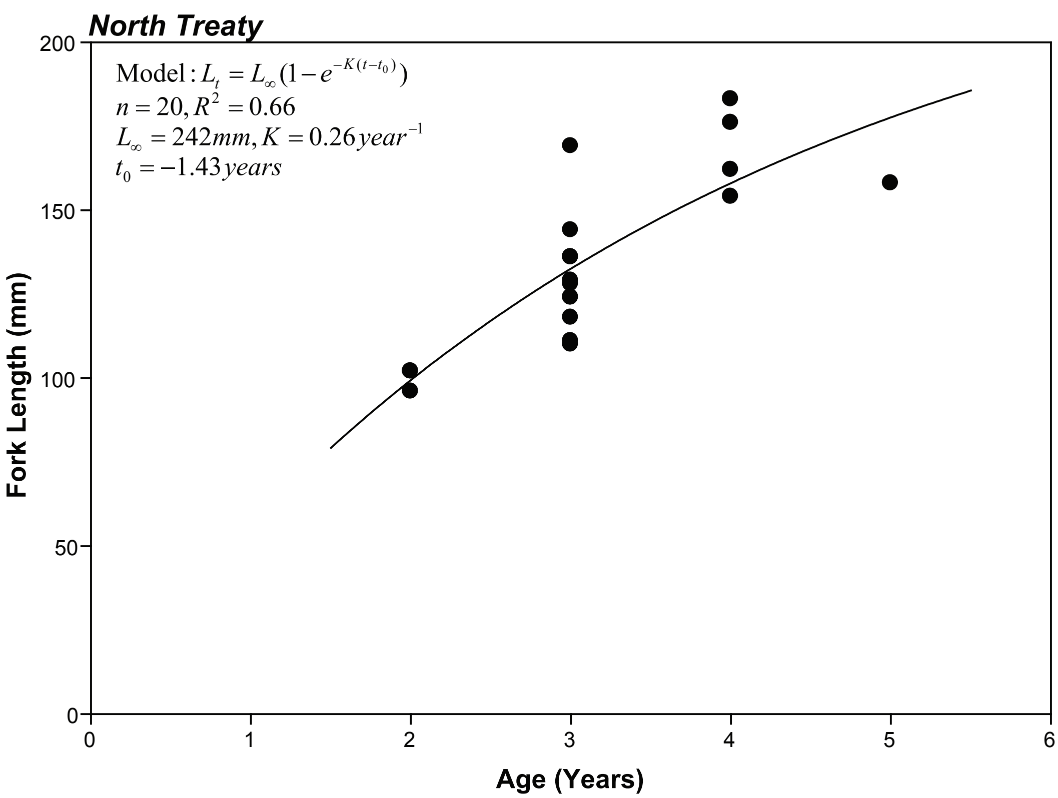
Reproductive investment was not evaluated through analyses of relative gonad weight (gonad weight at body weight) and relative gonad size (gonad weight at fork length) at receiving and reference environment sites because the low number of fish captured during this sampling period was not sufficient to produce meaningful analysis of results.



Von Bertalanffy Growth Models (Weight) of Dolly Varden from Receiving and Reference Environment Sites, 2009

FIGURE 6.3-22





Von Bertalanffy Growth Models (Length) of Dolly Varden from Receiving and Reference Environment Sites, 2009

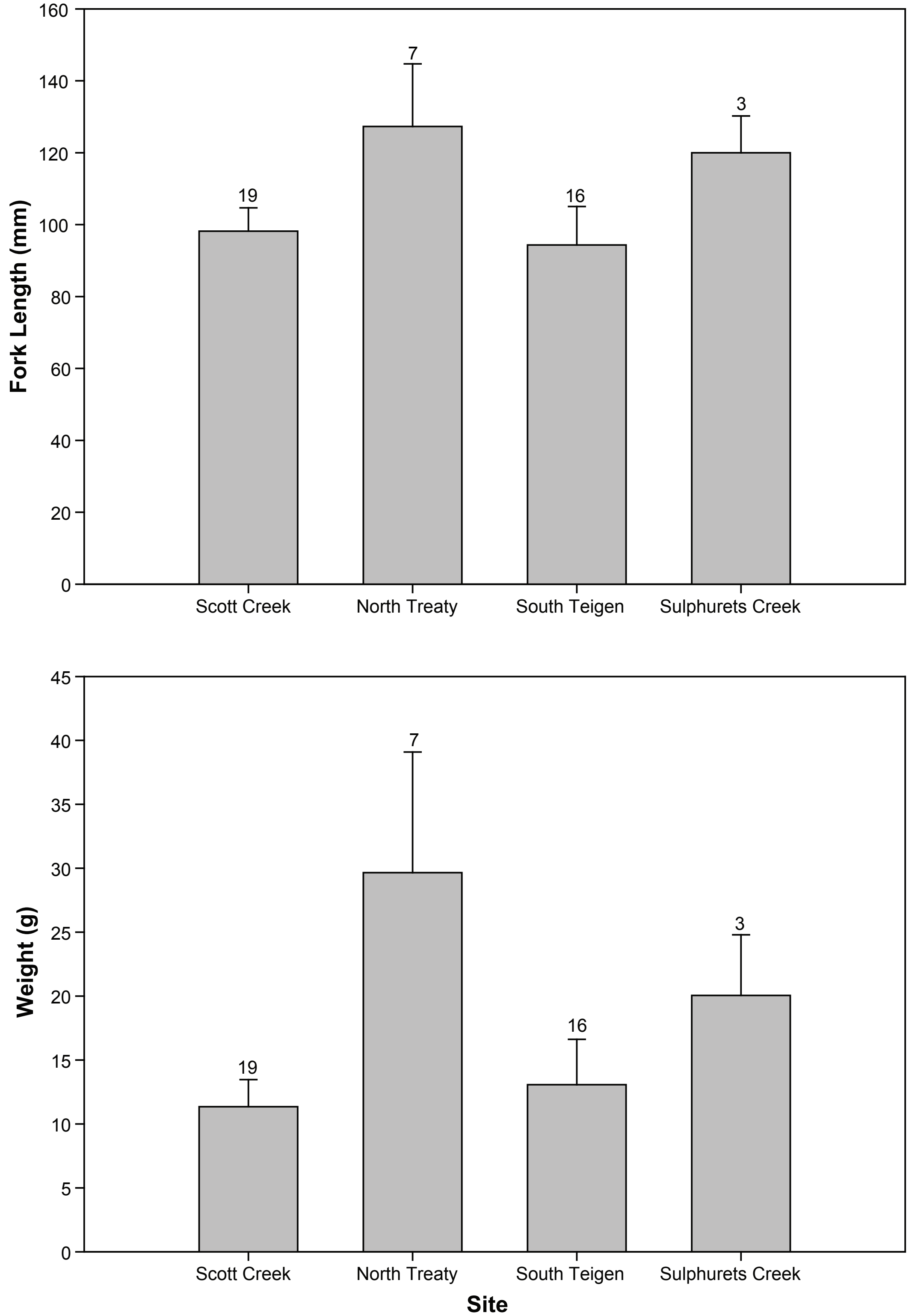
FIGURE 6.3-23

Table 6.3-25. Summary Fork Length and Weight Statistics for Dolly Varden Captured in Receiving and Reference Environment Sites, 2009

			Length (mm)					Weight (g)				
Environment	**Site**	**Sex**	**N**	**Mean**	**SE**	**Min**	**Max**	**N**	**Mean**	**SE**	**Min**	**Max**
	Bell-Irving / Bowser											
Reference	Scott Creek	Female	4	120	7.3	109	141	4	15.2	2.9	10.8	23.7
		Male	4	130	7.1	117	148	4	23.6	4.6	15.5	34.8
		Combined	19	98	6.5	54	148	19	11.4	2.1	1.9	34.8
Receiving	South Teigen	Female	4	136	14.2	108	175	4	25.6	7.7	12.7	47.7
		Male	3	131	12.1	109	151	3	25.0	7.1	12.2	36.8
		Combined	16	94	10.7	30	175	16	13.1	3.5	0.2	47.7
Receiving	North Treaty	Female	0	-	-	-	-	0	-	-	-	-
		Male	5	150	13.1	112	183	5	40.1	9.5	14.6	62.7
		Combined	7	127	17.4	63	183	7	29.6	9.4	2.7	62.7
	Unuk											
Receiving	Sulphurets Creek	Female	0	-	-	-	-	0	-	-	-	-
		Male	3	120	10.2	101	136	3	20.0	4.8	11.4	27.8
		Combined	3	120	10.2	101	136	3	20.0	4.8	11.4	27.8

Dashes indicate not applicable

SE = standard error of the mean



Note: Error bars represent standard error of the mean.
Numbers above bar indicate sample size.

Mean Fork Length and Weight of Dolly Varden Sampled in Reference and Receiving Environment Sites, 2009

FIGURE 6.3-24

Relative fecundity (the number of eggs per female against weight and length) was not compared among receiving and reference environment sites due to the low number of mature female fish captured (Appendix 6.3-3). Length and age at maturity was determined to be 168 mm and 4 years of age for female, and 135 mm and 3 years of age for male stream resident Dolly Varden (Rescan 2009).

Mean Dolly Varden gonadosomatic index was not statistically compared among sites because of low sample size. Mean gonadosomatic index for sites are presented in Table 6.3-26 and Figure 6.3-25.

6.3.7.3 Energy Storage

Energy storage was evaluated through analyses of condition at receiving and reference environment sites. Weight-length regressions were significant for all sites ($P \leq 0.01$), and length explained 99% of the variation in weight (Figure 6.3-26). The slopes of the regressions were not significantly different among sites (GLM, $F_{3,40} = 3,37$, $P = 0.453$), thus the y-intercepts of the regressions could be compared. Fish weight at all lengths did not differ significantly among sites (ANCOVA, $F_{3,40} = 2.71$, $P = 0.06$), therefore fish at a given length had the same mean weight at each site. Furthermore, mean condition (Figure 6.3-27) was not significantly different among sites (ANOVA, $F_{3,41} = 3.59$, $P = 0.06$),

Energy storage was also evaluated through analyses of relative liver size at receiving and reference environment sites. The regressions were significant for all sites ($P \leq 0.02$), except Sulphurets Creek , which was likely due to low sample size. Total weight explained between 79 and 94% of the variation in liver ln(weight) (Figure 6.3-28). The slopes of the regressions were not significantly different among South Teigen and Scott creeks (GLM, $F_{1,12} = 0.40$, $P = 0.54$), thus the y-intercepts of the regressions could be compared. Liver weight at all fish weights did not differ significantly among South Teigen and Scott creeks (ANCOVA, $F_{1,12} = 0.33$, $P = 0.58$), therefore fish at a given weight had the same liver weight at each site.

The supporting energy storage response variable of relative liver size was compared in receiving and reference environment sites. The regressions were significant for all sites ($P \leq 0.02$), and length explained between 77 and 91% of the variation in liver weight (Figure 6.3-29). The slopes of the regressions were not significantly different among South Teigen and Scott creeks (GLM, $F_{1,12} = 1.68$, $P = 0.22$); thus, the y-intercepts of the regressions could be compared. Liver weight at all lengths did not differ significantly among South Teigen and Scott creeks (ANCOVA, $F_{1,12} = 0.46$, $P = 0.51$), therefore fish at a given length had the same liver weight at each site.

Mean Dolly Varden liversomatic index (i.e., liver weight vs. body weight) did not significantly differ among South Teigen and Scott creeks (ANOVA, $F_{1,14} = 1.28$, $P = 0.28$) (Figure 6.3-30).

Relative egg size was not compared among receiving and reference environment sites because of the low sample size of mature female fish captured (Appendix 6.3-4).

6.3.7.4 Survival

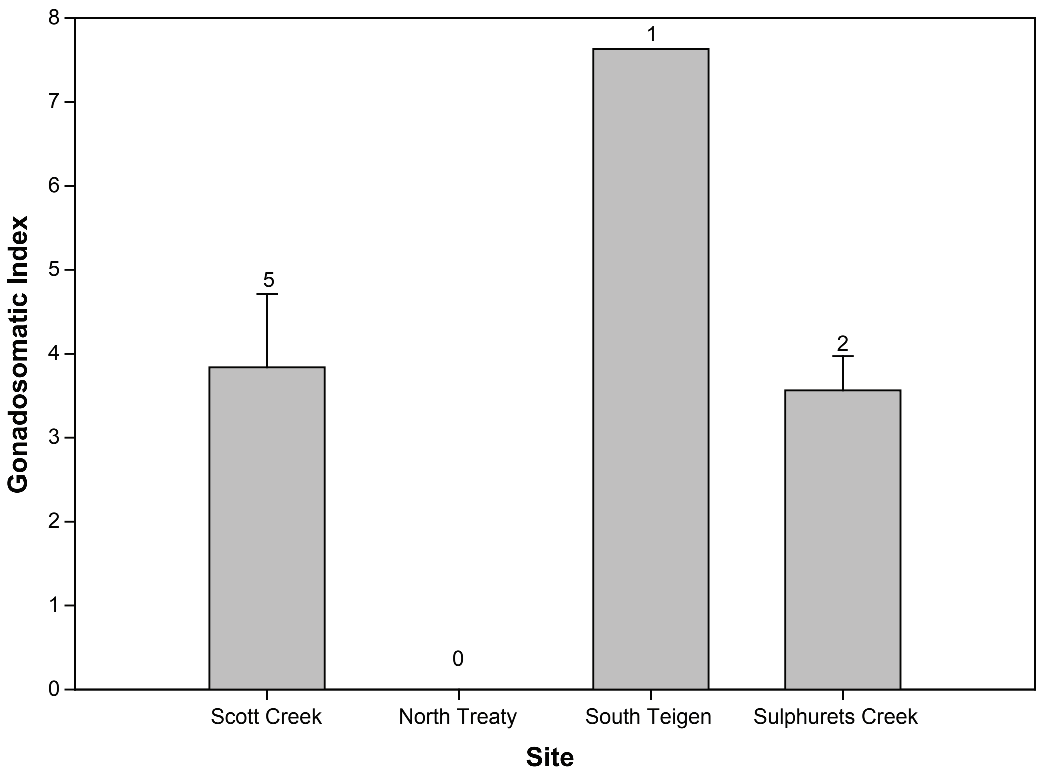
Survival was evaluated through analyses of mean age at receiving and reference environment sites according to the MMER. Mean age reflects the age distribution of adult fish collected from each site. Mean age did not significantly differ among South Teigen and Scott creeks (ANOVA, $F_{1,17} = 1.20$, $P = 0.29$) (Figure 6.3-31).

Table 6.3-26. Summary Gonad Statistics for Dolly Varden Captured in Receiving and Reference Environment Sites, 2009

			Gonad Weight (g)					Gonadosomatic Index				
Environment	Site	Sex	N	Mean	SE	Min	Max	N	Mean	SE	Min	Max
	Bell-Irving / Bowser											
Reference	Scott Creek	Female	2	0.6	0.5	0.1	1.1	2	2.7	2.1	0.6	4.8
		Male	3	1.1	0.2	0.7	1.5	3	4.6	0.6	3.5	5.7
		Combined	5	0.9	0.2	0.1	1.5	5	3.8	0.9	0.6	5.7
Receiving	South Teigen	Female	1	3.4	-	3.4	3.4	1	7.6	-	7.6	7.6
		Male	0	-	-	-	-	0	-	-	-	-
		Combined	0	-	-	-	-	1	7.6	-	7.6	7.6
	Unuk											
Receiving	Sulphurets Creek	Female	0	-	-	-	-	0	-	-	-	-
		Male	2	0.8	0.0	0.8	0.9	2	3.6	0.4	3.2	4.0
		Combined	2	0.8	0.0	0.8	0.9	2	3.6	0.4	3.2	4.0

Dashes indicate not applicable

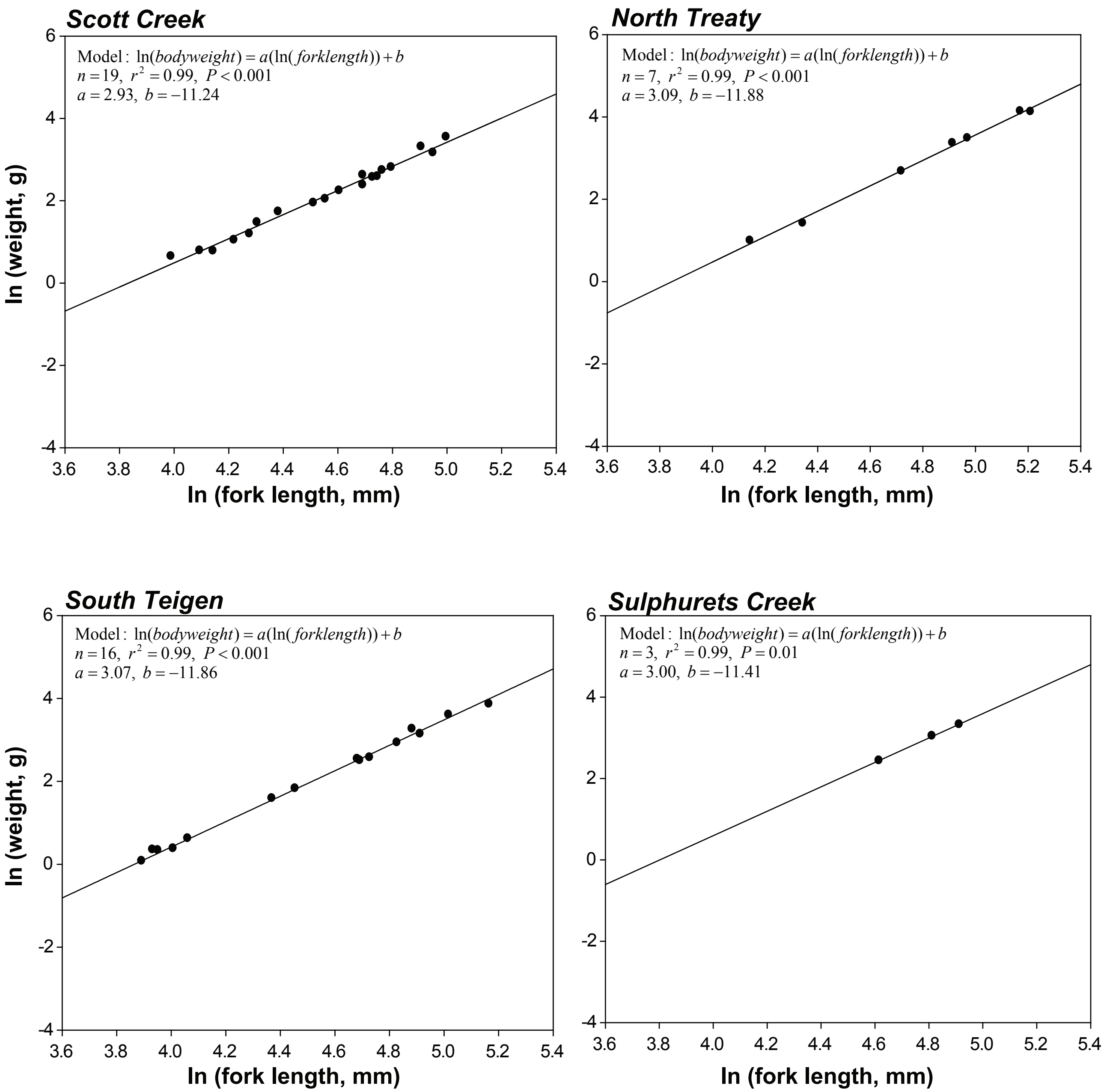
SE = standard error



Note: Error bars represent standard error of the mean.
Numbers above bar indicate sample size.

Mean Gonadosomatic Index of Dolly Varden Sampled in Reference and Receiving Environment Sites, 2009

FIGURE 6.3-25

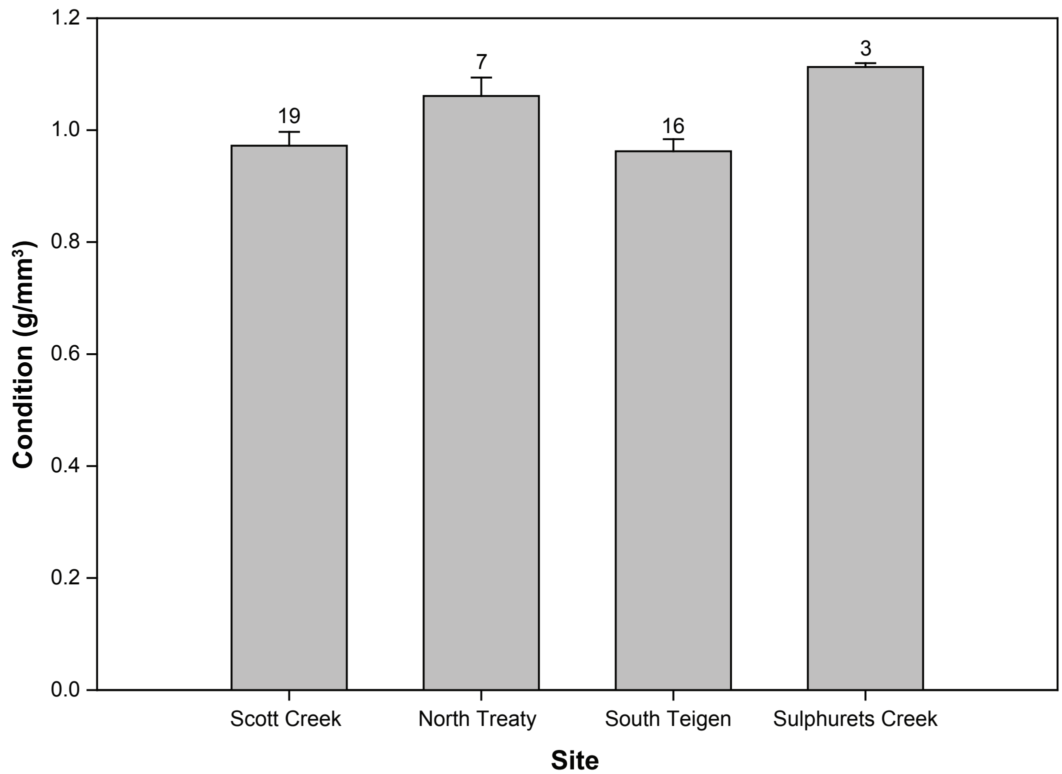


Weight-Length Regressions for Dolly Varden Sampled from Receiving and Reference Environment Sites, 2009

FIGURE 6.3-26

SEABRIDGE GOLD

Rescan™

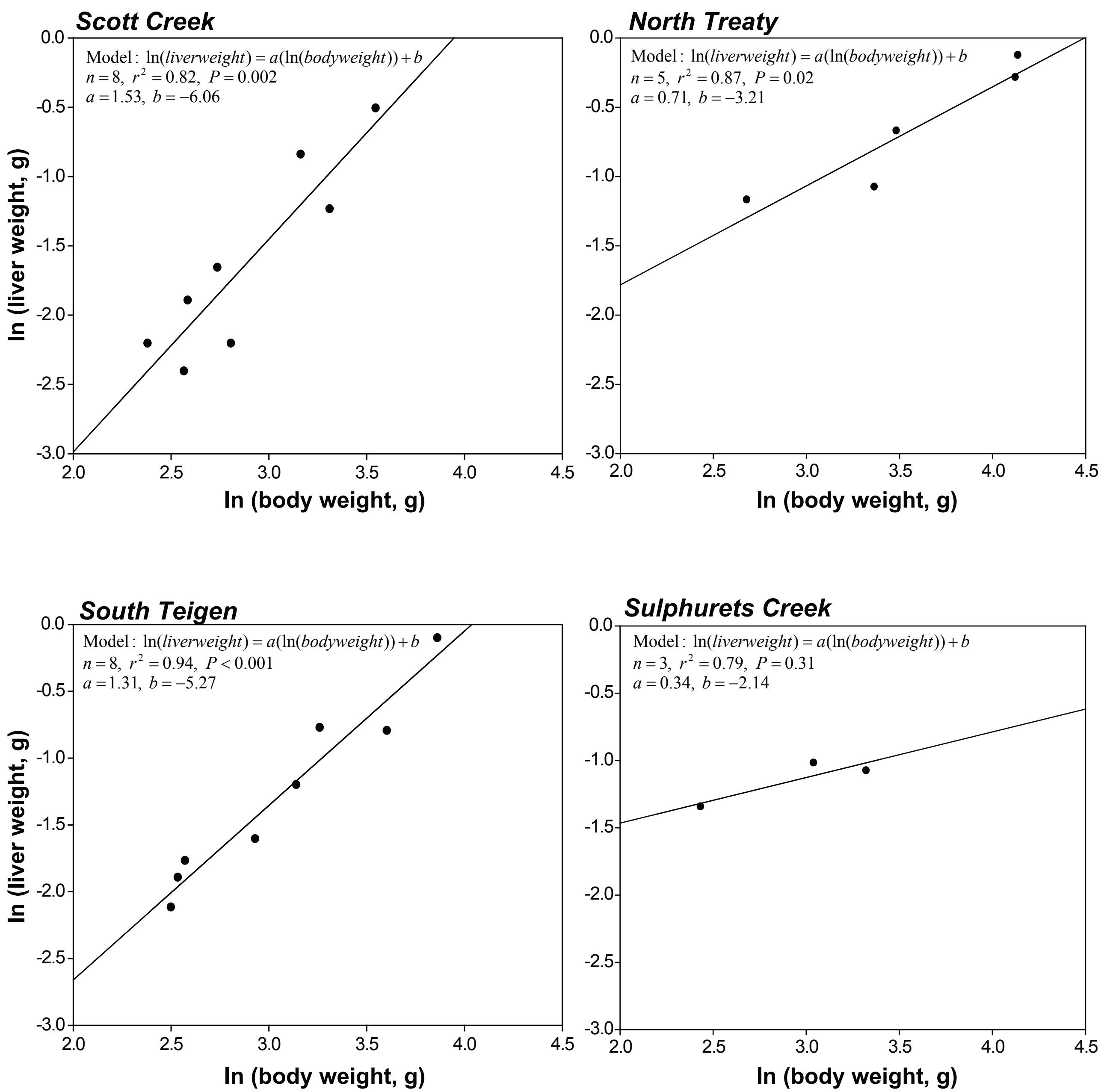


Note: Error bars represent standard error of the mean.
Numbers above bar indicate sample size.

Mean Condition of Dolly Varden Sampled in Reference and Receiving Environment Sites, 2009

FIGURE 6.3-27

SEABRIDGE GOLD

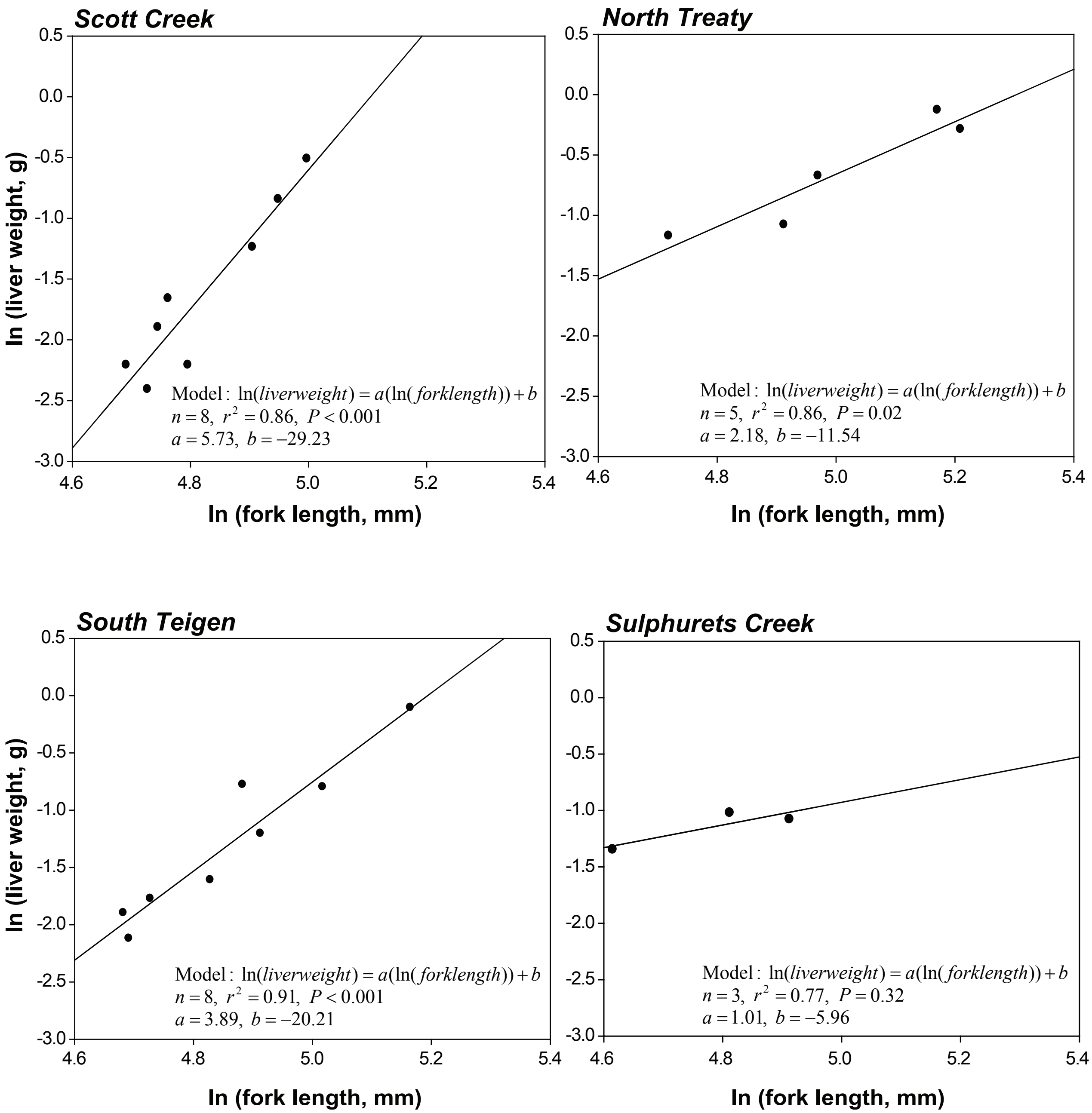


Liver Weight-Body Weight Regressions for Dolly Varden Sampled from Receiving and Reference Environment Sites, 2009

FIGURE 6.3-28

SEABRIDGE GOLD

Rescan

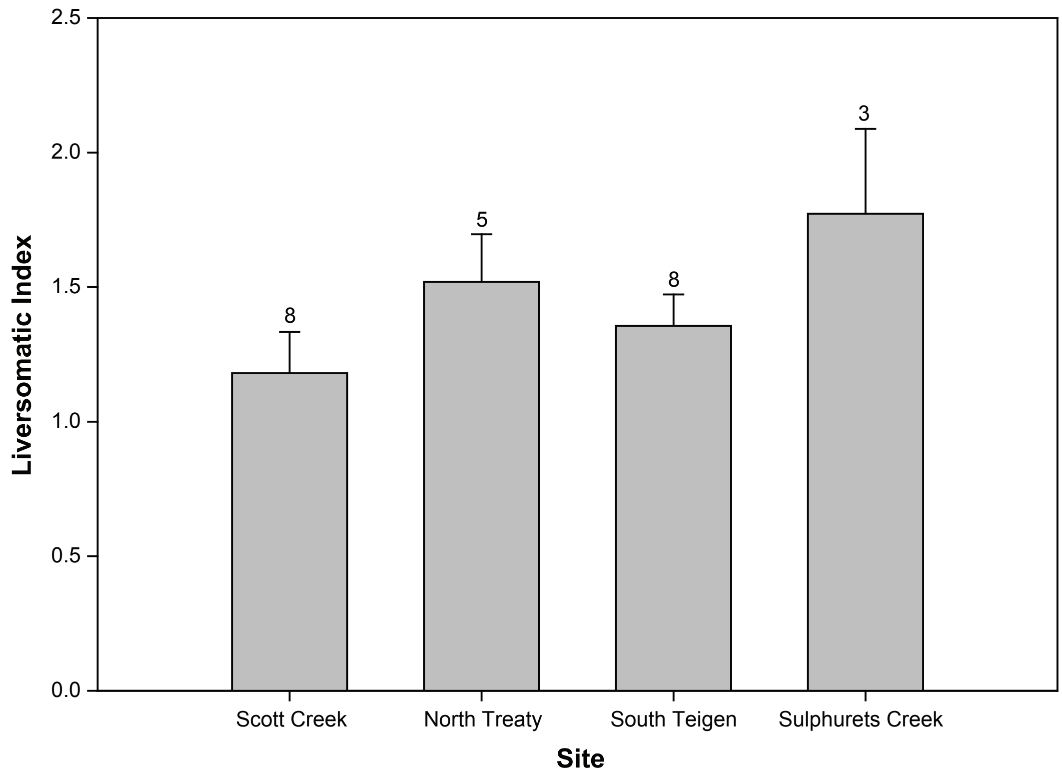


Liver Weight-Fork Length Regressions for Dolly Varden Sampled from Receiving and Reference Environment Sites, 2009

FIGURE 6.3-29

SEABRIDGE GOLD

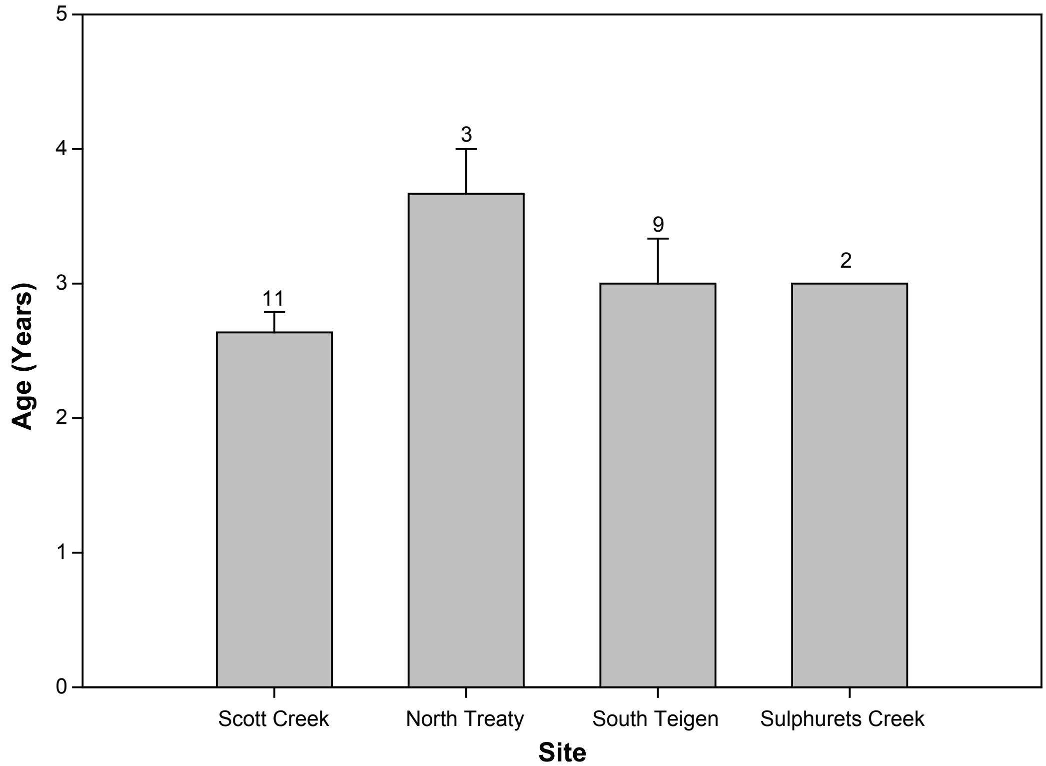
Rescan™



Note: Error bars represent standard error of the mean.
Numbers above bar indicate sample size.

Mean Liversomatic Index of Dolly Varden Sampled in Reference and Receiving Environment Sites, 2009

FIGURE 6.3-30



Note: Error bars represent standard error of the mean.
Numbers above bar indicate sample size.

Mean Age of Dolly Varden Sampled in Reference and Receiving Environment Sites, 2009

FIGURE 6.3-31

6.3.8 Whole Body Tissue Metals

Appendix 6.3-5 shows the measured metal concentrations in each whole body fish tissue sample collected from KSM Project study area in 2009. Appendix 6.3-3 shows the fork lengths of the Dolly Varden. Lengths, not weights, are the conventional measure of body size for tissue metals analysis. Since the concentrations of some metals that bind permanently to protein (e.g., mercury) are typically positively correlated with fish body size, the first step in analysis was to conduct a one-way ANOVA of fork length on stream site to test for significant differences in mean body size among sampling sites. (Figure 6.3-32). Only those Dolly Varden used for tissue metal analyses were included. The ANOVA showed no significant (ANOVA, $F_{3,22} = 0.17$, $P = 0.92$) difference in mean fork length of Dolly Varden among sites.

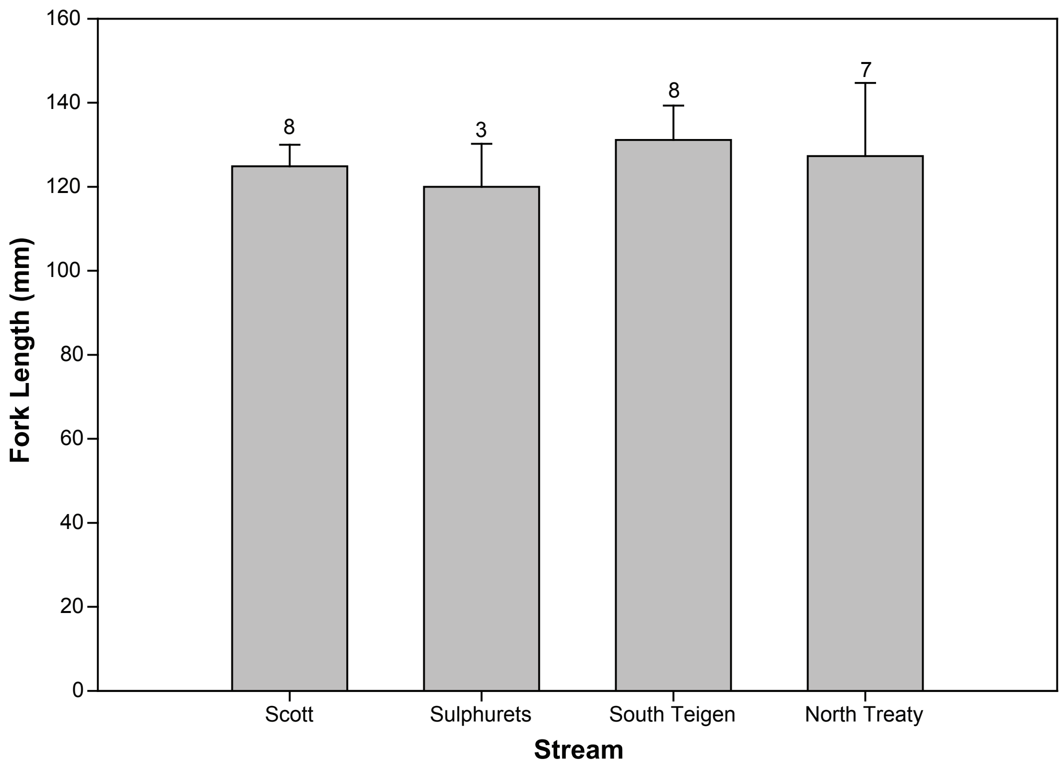
The second step in this analysis was to exclude those metals for which 80% of concentrations were below the metal-specific detection limit. The following five metals were excluded: antimony, beryllium, bismuth, lithium, and tin (Table 6.3-27). Table 6.3-28 shows the mean concentrations of the other 25 whole body fish metals for each of the stream sites. To calculate the means, concentrations below metal-specific detection limit were replaced by one-half of that detection limit.

One-way ANOVAs of ln-transformed metal concentrations for stream sites showed that all 25 metals showed some significant variability between sites (Table 6.3-29). These results represent a combination of environmental differences in metal concentrations and differences of location. Three basic patterns of variability were observed:

- 5 metals (arsenic, cadmium, copper, thallium and titanium) had concentrations that were significantly greater in Sulphurets Creek (downstream of the mineral deposit) compared to North Treaty and South Teigen creeks.
- 2 metals (chromium and selenium) had concentrations that were significantly higher in South Teigen and North Treaty creeks compared to the reference site, Scott Creek.
- 3 metals (calcium, cobalt and sodium) had concentrations that were significantly greater in South Teigen Creek compared to North Treaty Creek.

To interpret this complex and highly inter-correlated data set required factor analysis, a total of 26 ln-transformed variables were entered into PCA: fork length and the 25 tissue metal concentrations. The program extracted five components. The scree plot (not shown here) showed that all five components were important in interpreting the major trends of the data. The first component (PC1) and second component (PC2) accounted for a total of 35.5 and 17.7 % of the explained variance, whereas each of the other three components only accounted between 10.3 and 13.9 % of the explained variance (Table 6.3-30). Therefore, the data set was not reduced for a second run.

PC1 was positively correlated with eleven metals (iron, lead, barium, titanium, cadmium, aluminum, vanadium, manganese, uranium, thallium, molybdenum) and negatively correlated with one metal (arsenic). PC2 was positively correlated with four metals: chromium, nickel, selenium, and magnesium. PC3 was positively correlated with fish length and three metals: phosphorus, potassium, and sodium. PC4 was positively correlated with three metals: mercury, copper, and zinc. PC5 was positively correlated with three metals: calcium, strontium, and cobalt.



Notes: Error bars represent one standard error of the mean
Numbers above bar indicate sample size.

FIGURE 6.3-32

Mean Fork Length of Dolly Varden Sampled for Metals Concentrations from Receiving and Reference Environment Sites, 2009

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Table 6.3-27. Metals Included in Dolly Varden Whole Body Tissue Analysis, 2009

Metal	N<MDL	N>MDL	Percent<MDL	Conclusion
Aluminum (Al)	0	26	0.0	Included
Antimony (Sb)	23	3	88.5	Excluded
Arsenic (As)	1	25	3.8	Included
Barium (Ba)	0	26	0.0	Included
Beryllium (Be)	26	0	100.0	Excluded
Bismuth (Bi)	26	0	100.0	Excluded
Cadmium (Cd)	0	26	0.0	Included
Calcium (Ca)	0	26	0.0	Included
Chromium (Cr)	0	26	0.0	Included
Cobalt (Co)	0	26	0.0	Included
Copper (Cu)	0	26	0.0	Included
Iron (Fe)	0	26	0.0	Included
Lead (Pb)	11	15	42.3	Included
Lithium (Li)	22	4	84.6	Excluded
Magnesium (Mg)	0	26	0.0	Included
Manganese (Mn)	0	26	0.0	Included
Mercury (Hg)	0	26	0.0	Included
Molybdenum (Mo)	1	25	3.8	Included
Nickel (Ni)	18	8	69.2	Included
Phosphorus (P)	0	26	0.0	Included
Potassium (K)	0	26	0.0	Included
Selenium (Se)	0	26	0.0	Included
Sodium (Na)	0	26	0.0	Included
Strontium (Sr)	0	26	0.0	Included
Thallium (Tl)	16	10	61.5	Included
Tin (Sn)	25	1	96.2	Excluded
Titanium (Ti)	0	26	0.0	Included
Uranium (U)	20	6	76.9	Included
Vanadium (V)	12	14	46.2	Included
Zinc (Zn)	0	26	0.0	Included

MDL = Method Detection Limit
N = number of samples
Excluded if Percent > 80%

Figures 6.3-33 to 6.3-35 shows how mean PC scores varied among stream. To interpret the PC plot scores, a one-way ANOVA of PC scores on stream was conducted. It showed that mean PC1 scores were highly significantly different among streams (ANOVA, $F_{3,22} = 8.38$, $P = 0.001$). A one-way ANOVA of mean PC1 score on stream, followed by post-hoc comparisons among streams, showed that the stream effect was due Scott Creek having significantly higher mean PC1 scores than North Treaty ($P = 0.007$) and South Teigen creeks ($P = 0.001$), and Sulphurets Creek having significantly ($P = 0.04$) higher mean PC1 scores than South Teigen Creek.

Table 6.3-28. Summary of Dolly Varden Mean Whole Body Tissue Metal Concentrations, 2009

		Detection	Scott Creek (SCR, n = 8)				Sulphurets Creek (SC3, n = 3)				South Teigen Creek (STE2, n = 8)				North Treaty Creek (NTR2, n = 7)			
Metals	**Units**	**Limit**	**Mean**	**SE**	**Min**	**Max**	**Mean**	**SE**	**Min**	**Max**	**Mean**	**SE**	**Min**	**Max**	**Mean**	**SE**	**Min**	**Max**
Fork Length	mm	NA	124.875	5.115	109	148	120	10.214	101	136	131.125	8.167	108	175	127.285714	17.408	63	183
Percent Moisture	%	0.1	75.3875	0.463	73.8	78	74.3	0.265	73.9	74.8	76.9375	0.402	75.3	79.1	73.7333333	0.317	73	75.1
Aluminum (Al)	mg/kg ww	2.0	59.5	12.9	16.8	118.0	28.2	7.6	13.4	38.3	25.0	6.6	6.7	65.2	39.7	15.9	4.0	103.0
Arsenic (As)	mg/kg ww	0.010	0.145	0.030	0.039	0.325	0.143	0.013	0.126	0.169	0.039	0.005	0.025	0.065	0.050	0.011	0.022	0.100
Barium (Ba)	mg/kg ww	0.010	2.016	0.173	1.070	2.610	1.530	0.071	1.390	1.620	1.017	0.136	0.497	1.780	1.275	0.248	0.604	2.220
Cadmium (Cd)	mg/kg ww	0.0050	0.1145	0.0173	0.0435	0.2100	0.1930	0.0112	0.1710	0.2080	0.0372	0.0031	0.0276	0.0550	0.0492	0.0148	0.0188	0.1230
Calcium (Ca)	mg/kg ww	2.0	5067.5	155.0	4200.0	5540.0	5070.0	397.0	4420.0	5790.0	5413.8	328.1	4220.0	6610.0	4057.1	170.1	3340.0	4650.0
Chromium (Cr)	mg/kg ww	0.10	0.17	0.02	0.11	0.25	0.18	0.01	0.16	0.21	0.29	0.03	0.21	0.50	0.35	0.06	0.19	0.57
Cobalt (Co)	mg/kg ww	0.020	0.152	0.020	0.077	0.247	0.164	0.022	0.121	0.192	0.296	0.028	0.151	0.405	0.148	0.028	0.053	0.255
Copper (Cu)	mg/kg ww	0.010	0.749	0.037	0.631	0.917	3.570	0.563	2.580	4.530	0.985	0.075	0.708	1.360	0.885	0.059	0.679	1.110
Iron (Fe)	mg/kg ww	0.20	103.96	21.81	37.50	199.00	51.90	8.09	35.80	61.40	36.69	6.84	17.60	77.90	47.80	15.31	14.10	103.00
Lead (Pb)	mg/kg ww	0.020	0.044	0.010	0.010	0.096	0.034	0.007	0.021	0.044	0.013	0.002	0.010	0.026	0.017	0.004	0.010	0.030
Magnesium (Mg)	mg/kg ww	1.0	343.3	7.9	309.0	382.0	315.0	3.5	311.0	322.0	355.4	17.4	306.0	458.0	341.6	12.2	303.0	379.0
Manganese (Mn)	mg/kg ww	0.010	5.531	0.851	2.690	9.660	3.247	0.300	2.650	3.600	3.789	0.458	2.290	6.350	2.426	0.457	1.150	4.160
Mercury (Hg)	mg/kg ww	0.0010	0.0070	0.0003	0.0059	0.0082	0.0158	0.0010	0.0145	0.0179	0.0159	0.0019	0.0114	0.0283	0.0059	0.0003	0.0052	0.0075
Molybdenum (Mo)	mg/kg ww	0.010	0.015	0.001	0.011	0.022	0.020	0.002	0.016	0.024	0.017	0.001	0.013	0.024	0.015	0.003	0.005	0.031
Phosphorus (P)	mg/kg ww	5.0	4961.3	164.1	3970.0	5390.0	4616.7	141.1	4350.0	4830.0	5221.3	298.9	4360.0	6910.0	4534.3	172.6	3740.0	5090.0
Potassium (K)	mg/kg ww	20	3570	65	3210	3800	3373	111	3220	3590	3645	168	3340	4800	3417	147	2600	3740
Selenium (Se)	mg/kg ww	0.20	1.01	0.10	0.62	1.51	1.14	0.03	1.08	1.17	1.58	0.09	1.35	2.06	1.41	0.11	1.08	1.85
Sodium (Na)	mg/kg ww	20	803	21	675	858	768	20	732	800	1005	42	844	1250	865	19	800	940
Strontium (Sr)	mg/kg ww	0.010	7.675	0.374	6.360	9.980	6.620	0.294	6.050	7.030	8.671	0.534	6.880	11.000	7.714	0.313	6.310	8.790
Thallium (Tl)	mg/kg ww	0.010	0.016	0.003	0.005	0.025	0.017	0.002	0.013	0.020	0.006	0.001	0.005	0.014	0.005	0.000	0.005	0.005
Titanium (Ti)	mg/kg ww	0.10	1.18	0.20	0.61	2.08	1.57	0.24	1.08	1.84	0.47	0.07	0.19	0.73	0.38	0.10	0.15	0.76
Vanadium (V)	mg/kg ww	0.10	0.16	0.04	0.05	0.33	0.12	0.03	0.05	0.15	0.09	0.02	0.05	0.23	0.15	0.05	0.05	0.37
Zinc (Zn)	mg/kg ww	0.10	27.75	1.39	20.50	34.20	35.33	2.60	31.00	40.00	35.60	2.07	29.30	46.60	28.76	2.78	19.40	39.60
Nickel (Ni)	mg/kg ww	0.10	0.07	0.02	0.05	0.19	0.05	0.00	0.05	0.05	0.10	0.03	0.05	0.27	0.16	0.05	0.05	0.34
Uranium (U)	mg/kg ww	0.0020	0.0019	0.0004	0.0010	0.0036	0.0022	0.0007	0.0010	0.0034	0.0010	0.0000	0.0010	0.0010	0.0010	0.0000	0.0010	0.0010

n = number of samples, SE = standard error of the mean, min - minimum, max = maximum, ww = wet weight
NA = not applicable

Table 6.3-29. Significance of Whole Body Tissue Metal Concentrations in Receiving and Reference Environment Sites, 2009

			ANOVA			
Total Metals	P Value	Significance	North Treaty	Scott	South Teigen	Sulphurets
Aluminum (Al)	0.182	NS				
Arsenic (As)	<0.0001	S	a, b	A, C	c, d	B, D
Barium (Ba)	0.007	S		A	a	
Cadmium (Cd)	<0.0001	S	a, b	A, C	c, d	B, D
Calcium (Ca)	0.003	S	a, b	A	B	
Chromium (Cr)	0.002	S	A	a, b	B	
Cobalt (Co)	0.006	S	a	b	A,B	
Copper (Cu)	<0.0001	S	a	b	c	A, B, C
Iron (Fe)	0.017	S	a	A, B	b	
Lead (Pb)	0.002	S	a	A, B	b	
Magnesium (Mg)	0.405	NS				
Manganese (Mn)	0.006	S	a	A		
Mercury (Hg)	<0.0001	S	a, b	c, d	A, C	B, D
Molybdenum (Mo)	0.396	NS				
Phosphorus (P)	0.163	NS				
Potassium (K)	0.525	NS				
Selenium (Se)	0.001	S	A	a, b	B	
Sodium (Na)	<0.0001	S	a	b	A, B, C	c
Strontium (Sr)	0.063	NS				
Thallium (Tl)	<0.0001	S	a, b	A, C	c, d	B, D
Titanium (Ti)	<0.0001	S	a, b	A, C	c, d	B, D
Vanadium (V)	0.502	NS				
Zinc (Zn)	0.05	NS				
Nickel (Ni)	0.256	NS				
Uranium (U)	0.009	S			a	A

NS = not significant, S = significant
Letters indicate which site they differed significantly at the 0.05 significance level
Capital letters indicate which site had the highest metal concentration

To interpret the PC2 plot, a one-way ANOVA of PC2 scores on stream was conducted. It showed that mean PC2 scores were highly significantly different among streams (ANOVA, $F_{3,22} = 4.20$, $P = 0.02$). A one-way ANOVA of mean PC2 score on stream, followed by post-hoc comparisons among streams, showed that the stream effect was due Scott Creek having significantly ($P = 0.007$) lower mean PC2 scores than North Treaty Creek. This was a similar pattern to that observed for PC1, but reversed in magnitude.

To interpret the PC3 plot, a one-way ANOVA of PC3 scores on stream was conducted. It showed that mean PC3 scores were not significantly different among streams (ANOVA, $F_{3,22} = 0.95$, $P = 0.43$).

To interpret the PC4 plot, a one-way ANOVA of PC4 scores on stream was conducted. It showed that mean PC4 scores were highly significantly different among streams (ANOVA, $F_{3,22} = 49.30$, $P < 0.001$). A one-way ANOVA of mean PC4 score on stream, followed by post-hoc comparisons among streams, showed that the stream effect was due North Treaty and Scott creeks having significantly lower mean PC4 scores than South Teigen and Sulphurets creeks; and Sulphurets Creek having significantly higher mean PC4 scores than South Teigen Creek.

Table 6.3-30. Loadings of Metals on Principal Components

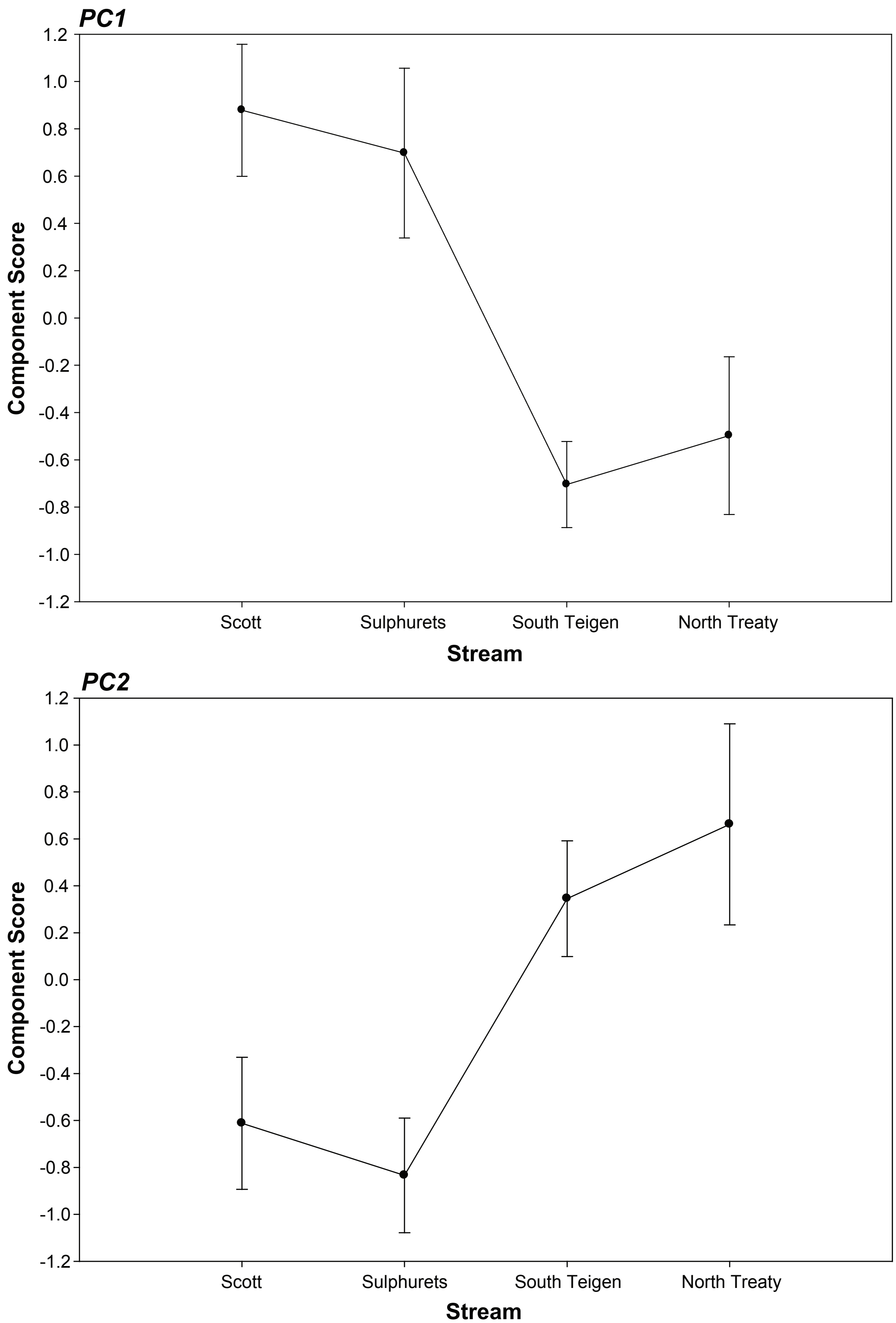
Metal	PC1	PC2	PC3	PC4	PC5
Variance explained (%)	35.535	17.721	10.325	10.928	13.877
AS	-0.928	-0.216	0.083	0.074	0.105
FE	0.924	0.265	0.005	-0.067	0.081
PB	0.920	-0.099	-0.073	-0.043	0.102
BA	0.914	0.092	-0.036	-0.080	0.191
TI	0.908	-0.047	-0.087	0.234	0.084
CD	0.857	-0.279	-0.269	0.246	0.053
AL	0.849	0.419	-0.035	-0.031	0.148
V	0.79	0.567	0.002	-0.052	-0.089
MN	0.789	0.133	0.108	0.105	0.493
U	0.769	-0.191	0.127	0.141	-0.231
TL	0.678	-0.554	0.150	0.130	0.051
MO	0.517	0.364	-0.310	0.487	0.352
CR	-0.159	0.928	-0.098	0.108	0.091
NI	0.200	0.907	-0.078	-0.016	0.173
SE	-0.466	0.602	-0.021	0.248	0.228
MG	0.265	0.591	0.105	-0.097	0.659
K	0.079	0.009	0.921	-0.061	0.143
LENGTH	-0.318	-0.389	0.742	-0.008	-0.257
P	0.102	-0.067	0.726	0.057	0.615
NA	-0.298	0.457	0.529	0.262	0.456
HG	-0.123	-0.028	0.315	0.867	0.162
CU	0.212	-0.052	-0.146	0.831	-0.122
ZN	0.060	0.426	-0.225	0.677	0.396
CA	0.279	-0.109	0.161	0.357	0.845
SR	-0.026	0.481	-0.010	-0.054	0.837
CO	0.184	0.464	0.114	0.482	0.522

Loadings are correlation coefficients between variables and factors
Borders outline significant loadings

To interpret the PC5 plot, a one-way ANOVA of PC5 scores on stream was conducted. It showed that mean PC5 scores were highly significantly different among streams (ANOVA, $F_{3,22} = 3.61$, $P = 0.03$). A one-way ANOVA of mean PC5 score on stream, followed by post-hoc comparisons among streams, showed that the stream effect was due South Teigen Creek having significantly higher mean PC5 scores than North Treaty Creek.

In summary, factor analysis showed that Dolly Varden tissue results were variable depending upon the PC number and stream. Sulphurets Creek had higher concentrations of a subset of metals than the other three streams. This subset included three heavy metals: mercury, copper, and zinc. Since the Sulphurets Creek site is downstream of ore deposits in the Project area, this finding suggests that Sulphurets Creek’s enriched metal loading is due to natural sources.

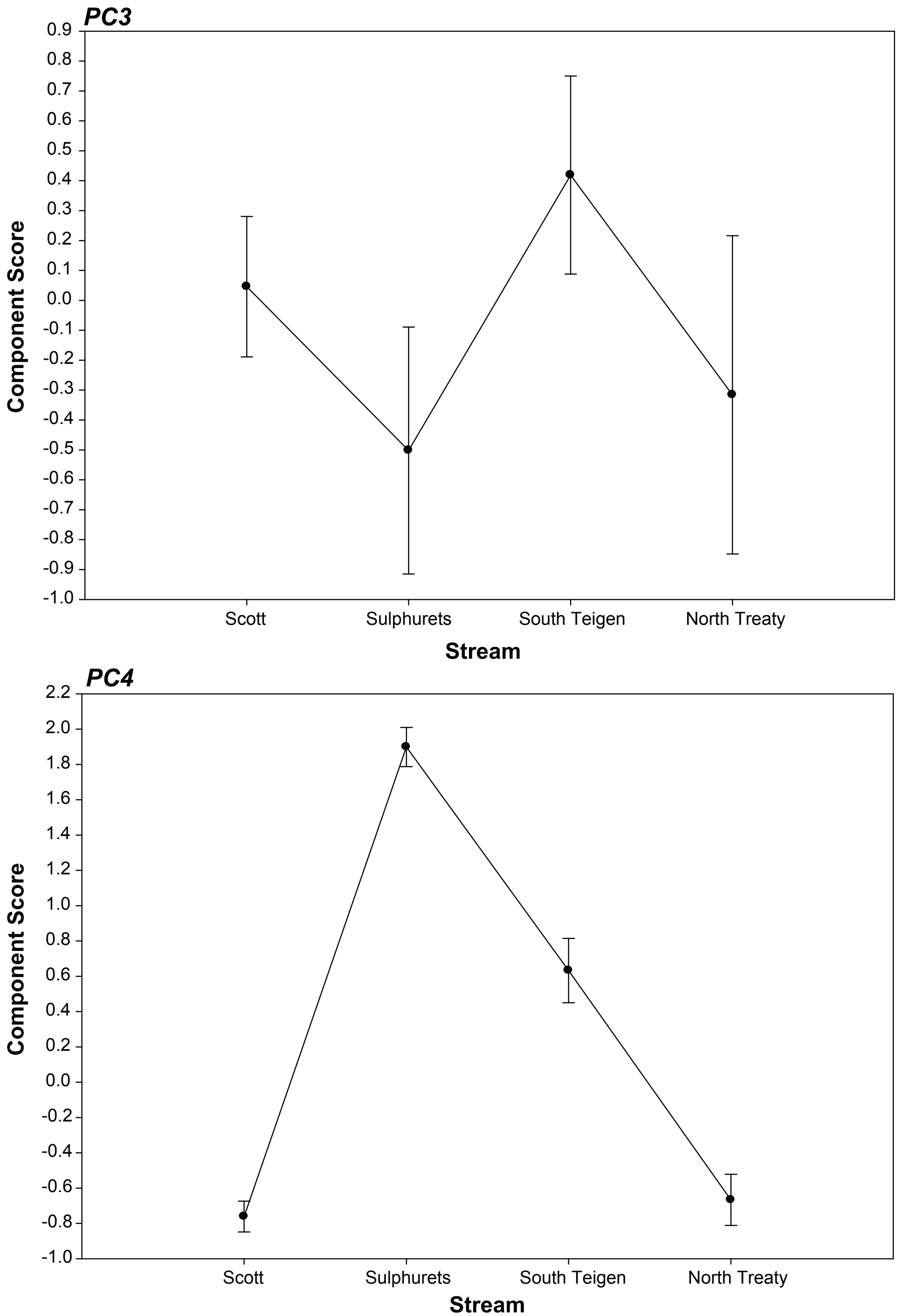
Finally, factor analysis did not show any correlations between fork length and metal concentrations, even for mercury which is often reported to vary directly with body size and age.



Notes: Error bars represent one standard error of the mean

Mean Principle Component Scores (PC1 and PC2) for Dolly Varden Whole Body Tissue Metals Concentrations from Receiving and Reference Environment Stream Sites, 2009

FIGURE 6.3-33



Notes: Error bars represent one standard error of the mean

Mean Principle Component Scores (PC3 and PC4) for Dolly Varden Whole Body Tissue Metals Concentrations from Receiving and Reference Environment Stream Sites, 2009

FIGURE 6.3-34

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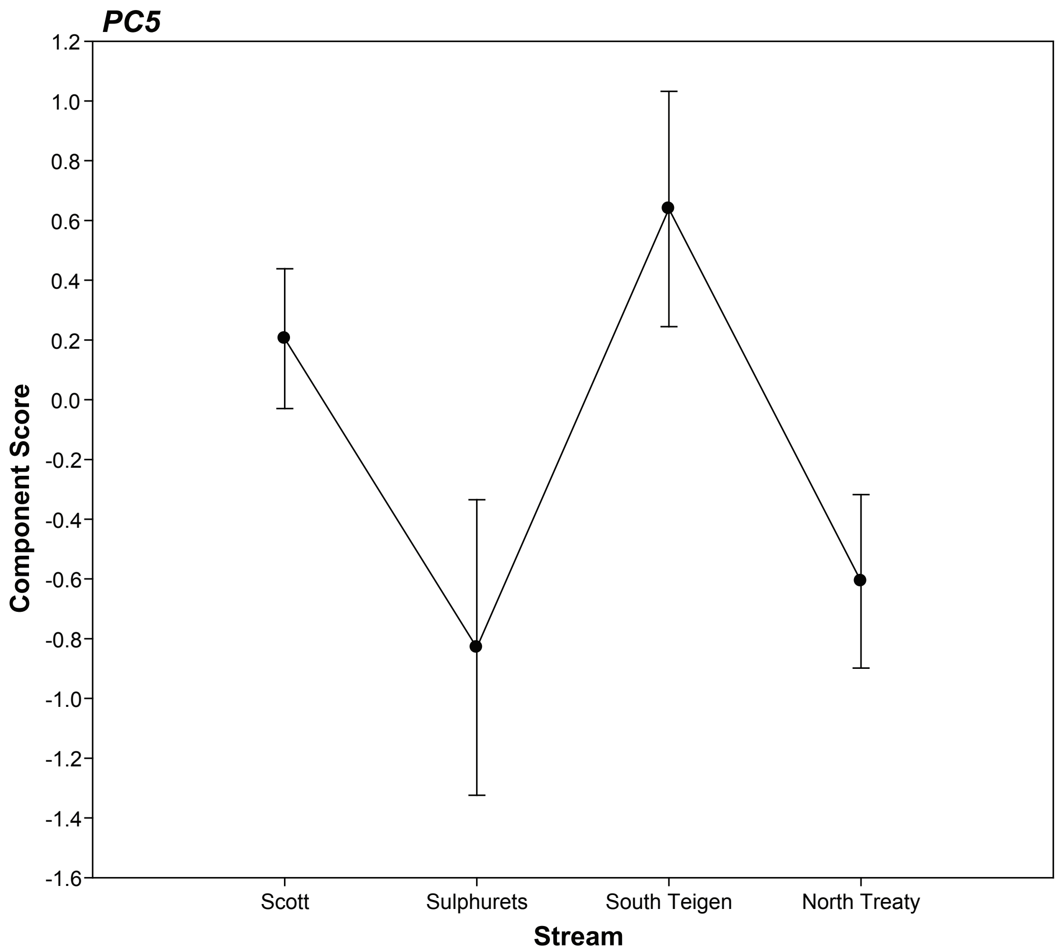


Notes: Error bars represent one standard error of the mean

Mean Principle Component Scores (PC5) for Dolly Varden Whole Body Tissue Metals Concentrations from Receiving and Reference Environment Stream Sites, 2009

FIGURE 6.3-35

6.3.9 Fish Diet

Mean Dolly Varden stomach fullness ranged from 62% in Scott Creek to 91% in South Teigen Creek, while mean percent digestion ranged from 43% in South Teigen Creek to 72% in Scott Creek (Table 6.3-31). Percent digestion is often influenced by the timing of sampling. Fullness may be related to digestion, as well as food abundance. The actual weight of stomach contents is related to the size of fish captured, the amount of food eaten and the percent digested.

Dolly Varden diet composition was analyzed by number and by weight for fish from three receiving environment and one reference environment site (Appendices 6.3-6 and 6.3-7). Diet varied among sites; however, numerically dominant prey items included adult Diptera (true flies), larval Chironomidae (midges) and Ephemeroptera (mayflies) (Figure 6.3-36). The large proportion of aquatic larvae indicates that fish feed primarily from the water column, selecting a few individuals from the surface.

By number, Dolly Varden in South Teigen Creek possessed the highest prey diet diversity. Fish in Scott and Sulphurets creeks fed primarily upon aquatic Chironomidae and diptera larvae. Fish in North Treaty and South Teigen creeks fed primarily upon aquatic Chironomidae, diptera and Ephemeroptera larvae.

By weight, Dolly Varden diet was also variable among streams; however, dominant prey groups included adult Diptera (true flies), larval Tricoptera (caddisflies) and larval Ephemeroptera (mayflies) and “insect parts” (Figure 6.3-37). Unidentifiable insect parts and insect larvae made up a large proportion of diet weight in fish from South Teigen and North Treaty creeks. The large number of partially digested individuals indicates that fish were not feeding at the time of their capture. In Sulphurets Creek, the percentage of the diet weight made up by larval Ephemeroptera was much higher than the percentage by number of these organisms, indicating that these organisms were significantly larger than other organisms in the diet. Other similarities are seen within sites when comparing between diet by numbers and weight.

6.4 RECEIVING ENVIRONMENT – LAKE HABITAT

6.4.1 Fish Habitat

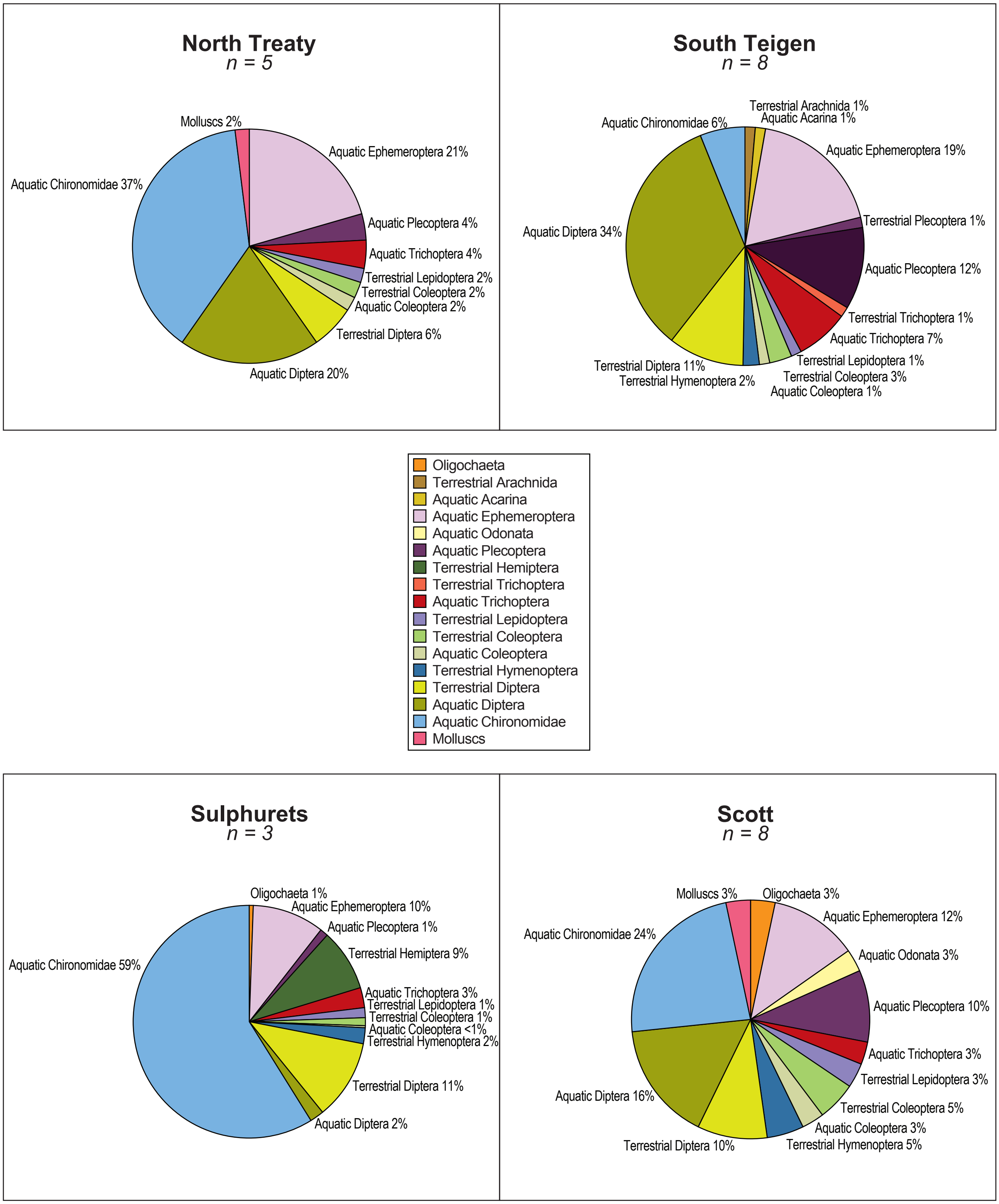
The locations of assessed lakes within the receiving environment are shown in Figure 4.1-1. The three assessed lakes were: West Teigen Lake (LAL, Plate 6.4-1), Sulphurets Lake (SUL, Plate 6.4-2), and Todedada Lake (TDL). Todedada Lake is a reference lake for West Teigen Lake. Fish habitat was only assessed at Todedada Lake, since fish habitat was previous assessed for West Teigen and Sulphurets lakes in 2008 (Rescan 2009). Appendix 6.4-1 shows detailed habitat data for Todedada Lake.

6.4.1.1 Todedada Lake

Todedada Lake is located in the Todedada Creek Watershed at an elevation of 680 m (Plate 6.4-3). It is a small (24.4 ha surface area) productive headwater lake with and maximum depth of 16 m. Shoreline substrates were dominated by sand and gravels (Figure 6.4-1). Shoreline vegetation was dominated by upland shrubs and coniferous trees. Shoreline type was primarily low and rocky. The percentage of littoral zone area (< 2 m water depth) was low within Todedada Lake. Littoral zones substrates were dominated by sand and gravels, and cobbles as sub-dominant. Emergent vegetation was abundant along the shoreline, and LWD was abundant within the littoral zone providing cover for fish (Plate 6.4-4). There was one outlet and eight smaller ephemeral inlets for the lake.

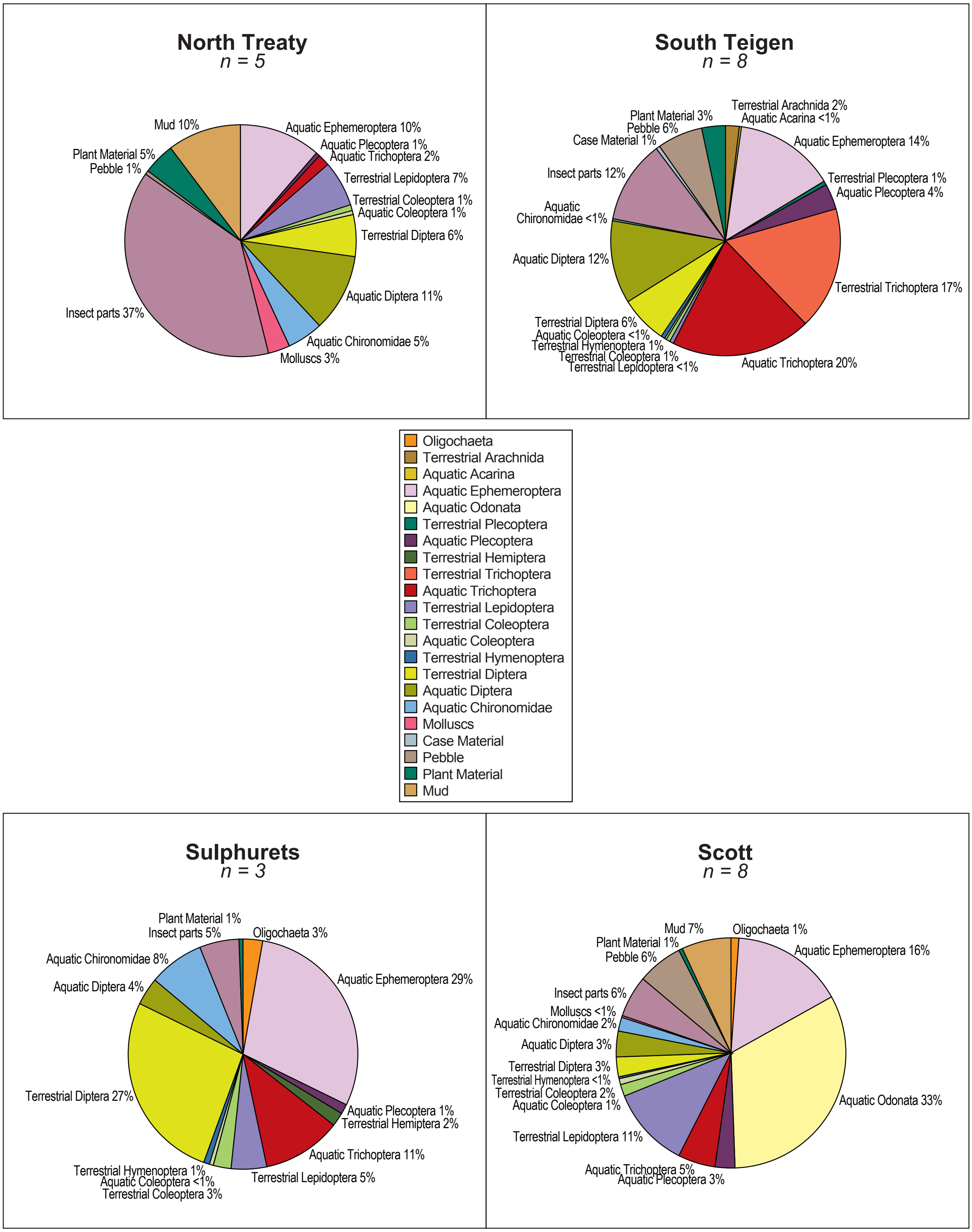
Table 6.3-31. Fullness, Digestion and Stomach Content Weight of Dolly Varden from Receiving and Reference Environment Sites, 2009

	North Treaty					South Teigen					Sulphurets Creek					Scott Creek				
Parameter	**N**	**Mean**	**SE**	**Min**	**Max**	**N**	**Mean**	**SE**	**Min**	**Max**	**N**	**Mean**	**SE**	**Min**	**Max**	**N**	**Mean**	**SE**	**Min**	**Max**
Fullness (%)	5	80	9.4	50	100	8	91	3.3	75	100	3	67	28.1	11	100	8	63	6.5	25	80
Digestion (%)	5	58	11.2	25	90	8	43	9.1	10	75	3	43	3.3	40	50	8	73	5.4	50	90
Actual Weight (mg)	5	278	128.7	83	768	8	338	107.3	64	937	3	707	262.7	384	1227	8	160	34.9	49	371



Percent Diet Composition (by Number) of Dolly Varden Captured in Receiving and Reference Environment Sites, 2009

FIGURE 6.3-36



Percent Diet Composition (by Weight) of Dolly Varden Captured in Receiving and Reference Environment Sites, 2009

FIGURE 6.3-37

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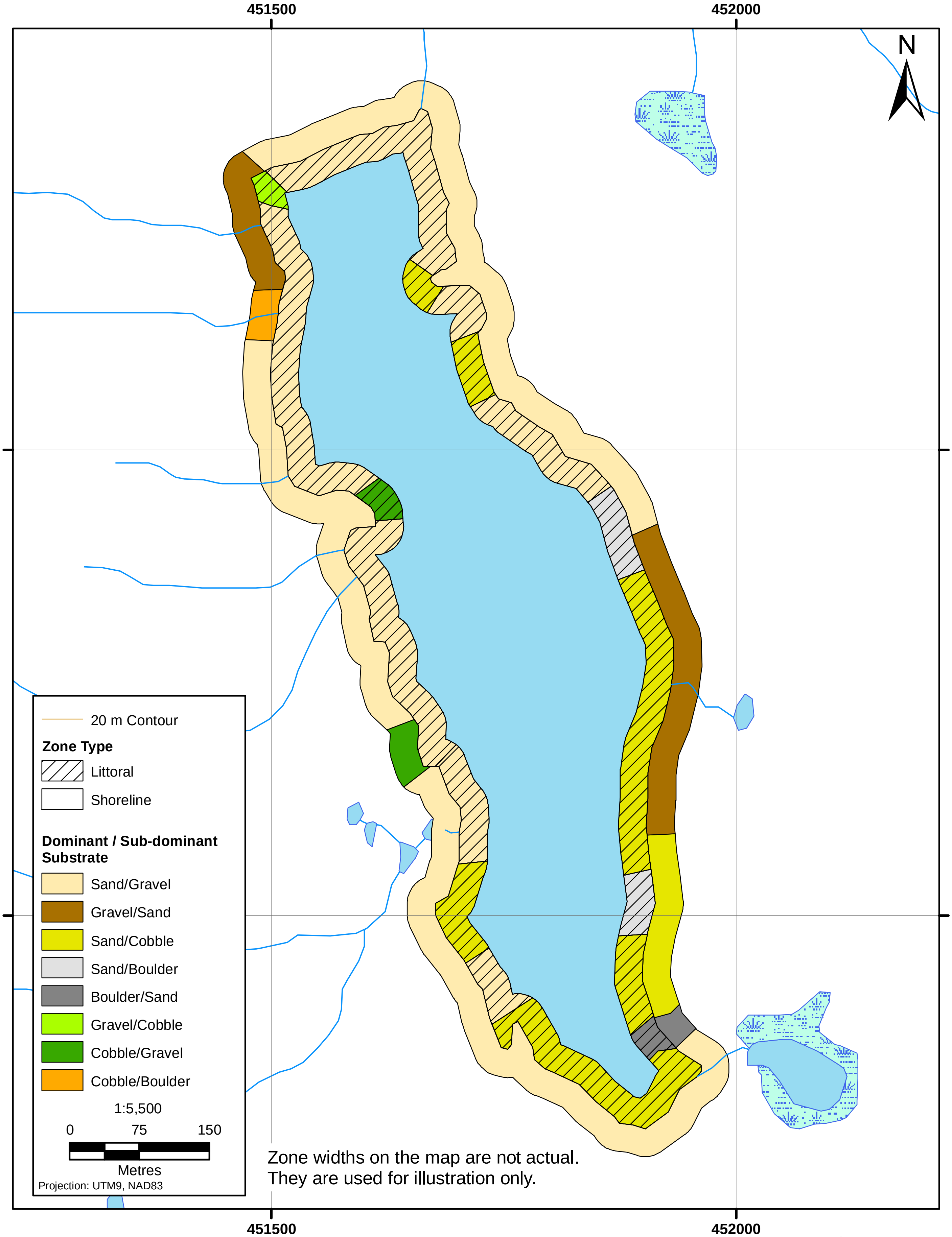

FIGURE 6.4-1

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Shoreline and Littoral Zone Fish Habitat Assessment for Todedada Lake

Rescan

Plate 6.4-1. Aerial view of West Teigen Lake

Plate 6.4-2. Aerial view of Sulphurets Lake.

Plate 6.4-3. Ground view of Todedada Lake.

Plate 6.4-4. Shoreline and LWD within Todedada Lake.

6.4.2 Fish Community

Appendix 6.4-2 shows all species biological data for each lake. Appendices 6.4-3 and 6.4-4 shows all gillnet and minnow trap effort and catch data for each lake.

Dolly Varden was caught in West Teigen Lake. Dolly Varden and rainbow trout were caught in Todedada Lake. No fish were caught in Sulphurets Lake for a total of 45.4 h gillnetting effort and 234.9 h minnow trap effort (Tables 6.4-1 and 6.4-2). Sulphurets Lake was sampled in 2008 (Rescan 2009) and no fish were caught despite a total of 117.7 h gillnetting effort and 297.0 h minnow trap effort.

Table 6.4-1. Summary Statistics of Gillnet Effort, Catch and CPUE in Lakes, 2009

			Dolly Varden			Rainbow Trout		
Lake	No. Gillnet Sets	Total Effort (h)	No. of Fish	Mean CPUE	SE	No. of Fish	Mean CPUE	SE
West Teigen Lake	6	7.8	39	2.5	1.2	0	-	-
Sulphurets Lake	2	45.4	0	-	-	0	-	-
Todedada Lake	5	5.8	31	2.4	0.9	4	0.4	0.2

Dashes indicate not applicable
CPUE = catch-per-unit-effort, fish/net area/day
SE = standard error

Table 6.4-2. Summary Statistics of Minnow Trap Effort, Catch and CPUE in Lakes, 2009

			Dolly Varden			Rainbow Trout		
Lake	No. Minnow Trap Sets	Total Effort (h)	No. of Fish	Mean CPUE	SE	No. of Fish	Mean CPUE	SE
West Teigen Lake	10	243.4	1	0.1	0.1	0	-	-
Sulphurets Lake	10	234.9	0	-	-	0	-	-
Todedada Lake	10	242.8	0	-	-	1	0.1	0.1

Dashes indicate not applicable
CPUE = catch-per-unit-effort, fish/trap/day
SE = standard error

Dolly Varden in West Teigen and Todedada lakes had a similar gillnet CPUE of 2.42 to 2.53 fish/m^2/h. Rainbow trout in Todedada Lake had a lower gillnet CPUE than for Dolly Varden. Dolly Varden in Todedada Lake were longer, heavier and older then in West Teigen Lake (Tables 6.4-3 and 6.4-4). Sexual maturity was determined from incidental gillnet mortalities. Length and age at maturity was determined to be 312 mm and age-4 for females, and 294 mm and age-3 for lake resident male Dolly Varden, which is larger and older than stream resident Dolly Varden (Rescan 2009).

Dolly Varden weight-length regression (linearized by ln-transformation of both variables) was conducted for both lakes (Figure 6.4-2). Regression of fish weight-length was highly significant ($P < 0.001$) and explained between 92 and 93% of the variation in weight. The slope of the regression was close to the expected value of 3.0, typical for the length-weight geometry of fish.

Length-frequency and age frequency distributions were plotted for all Dolly Varden caught (Figures 6.4-3 and 6.4-4). West Teigen Lake lengths had a wider length range then Todedada Lake. The distributions show that larger and older Dolly Varden were abundant in the Todedada Lake. The growth curve predicted a maximum length of 465 and 413 mm for West Teigen and Todedada lakes, respectively (Figure 6.4-5).

Table 6.4-3. Mean Length, Weight and Condition of Fish Captured in Lakes, 2009

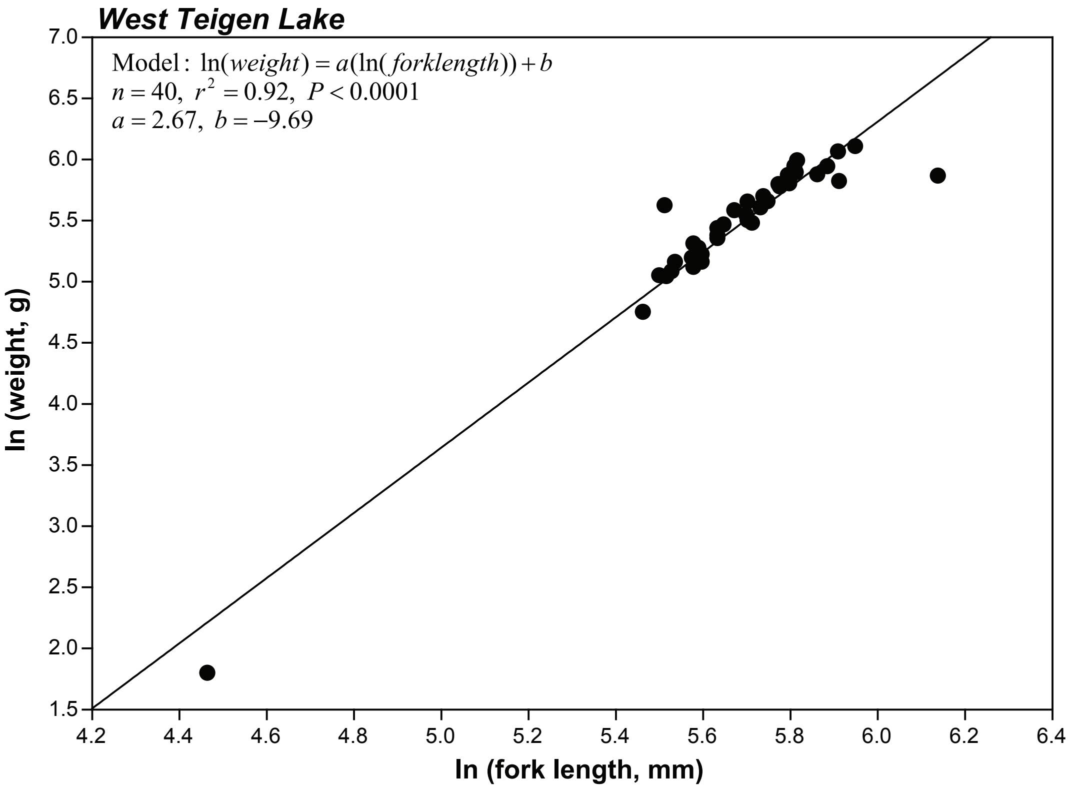
		Fork Length (mm)					Weight (g)					Condition (g/mm^3)				
Species	**Lake**	**N**	**Mean**	**SE**	**Min**	**Max**	**N**	**Mean**	**SE**	**Min**	**Max**	**N**	**Mean**	**SE**	**Min**	**Max**
Dolly Varden	West Teigen Lake	40	298	9.1	87	464	40	260.6	14.9	6	445	40	0.95	0.03	0.35	1.80
	Todedada Lake	30	386	10.2	272	567	30	530.3	26.9	217	758	30	0.93	0.03	0.21	1.20
Rainbow Trout	Todedada Lake	6	285	40.5	113	373	6	322.2	87.3	15	530	6	1.11	0.03	1.02	1.23

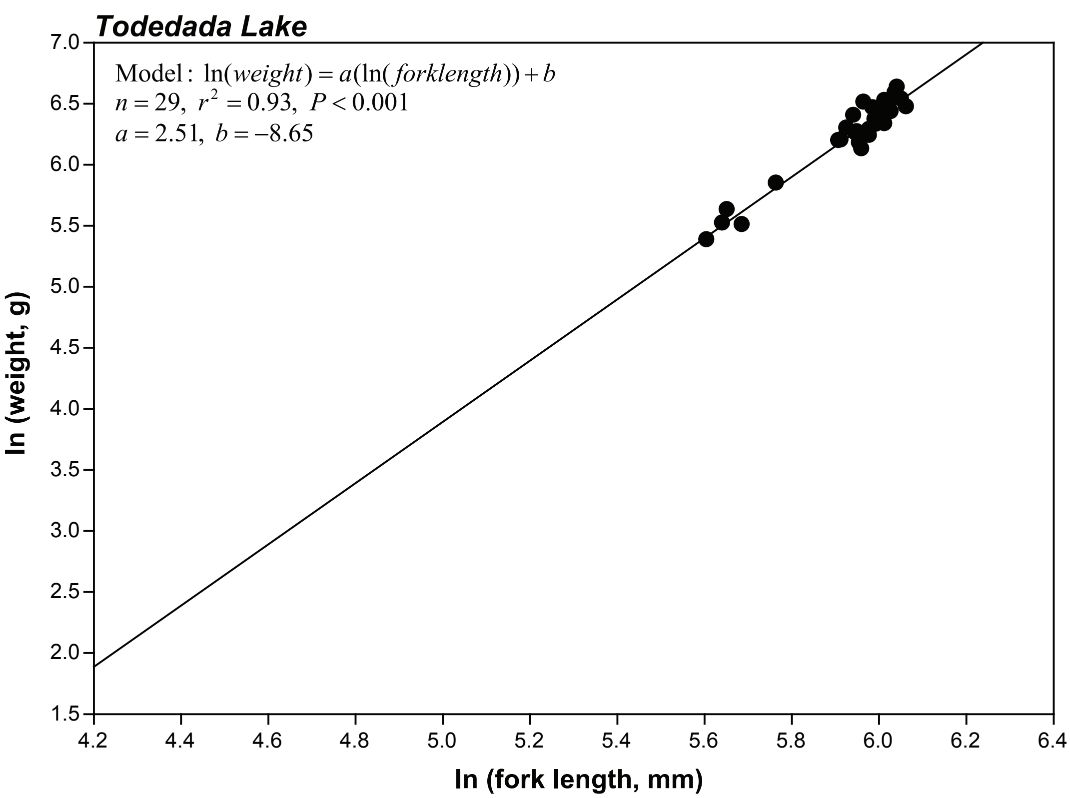
SE = standard error

Table 6.4-4. Mean Age of Fish Captured in Lakes, 2009

		Age (years)				
Species	**Lake**	**n**	**Mean**	**SE**	**Min**	**Max**
Dolly Varden	West Teigen Lake	40	6	0.2	4	9
	Todedada Lake	30	7	0.3	5	12
Rainbow Trout	Todedada Lake	6	5	0.8	2	8

SE = standard error





Weight-Length Regression of Dolly Varden within West Teigen and Todedada lakes, 2009

FIGURE 6.4-2

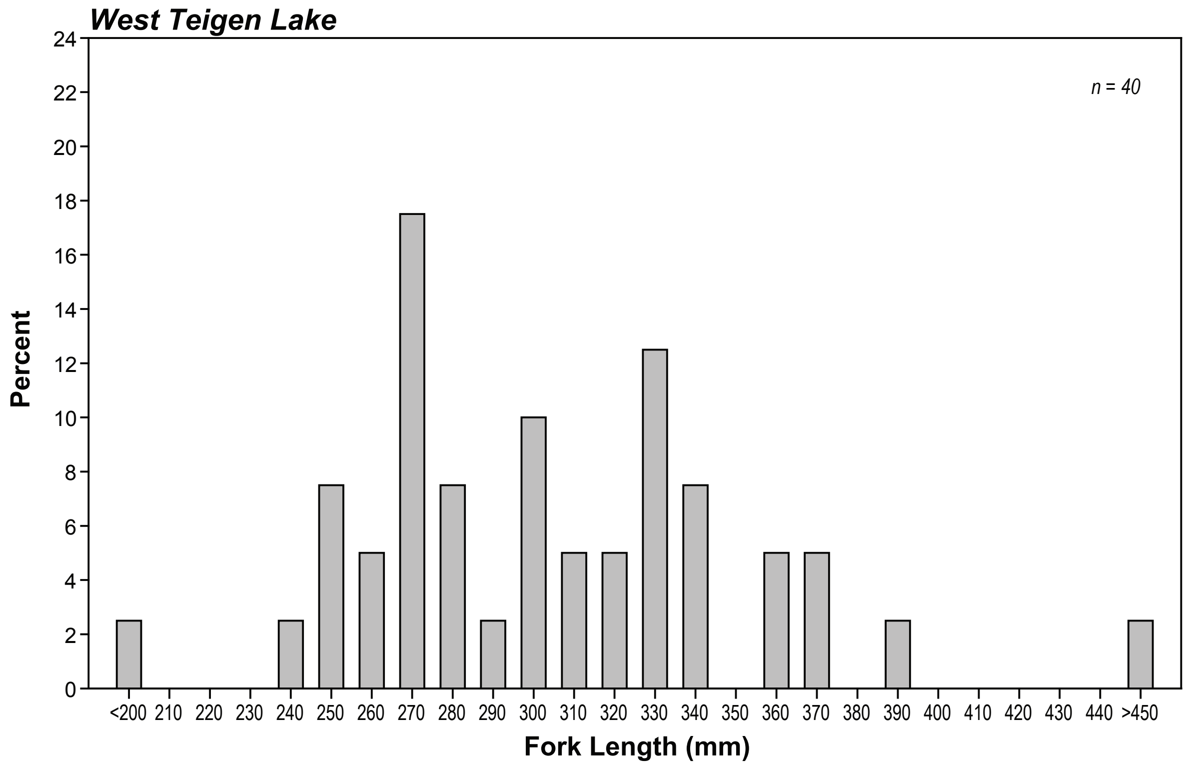
6.4.3 Fish Diet

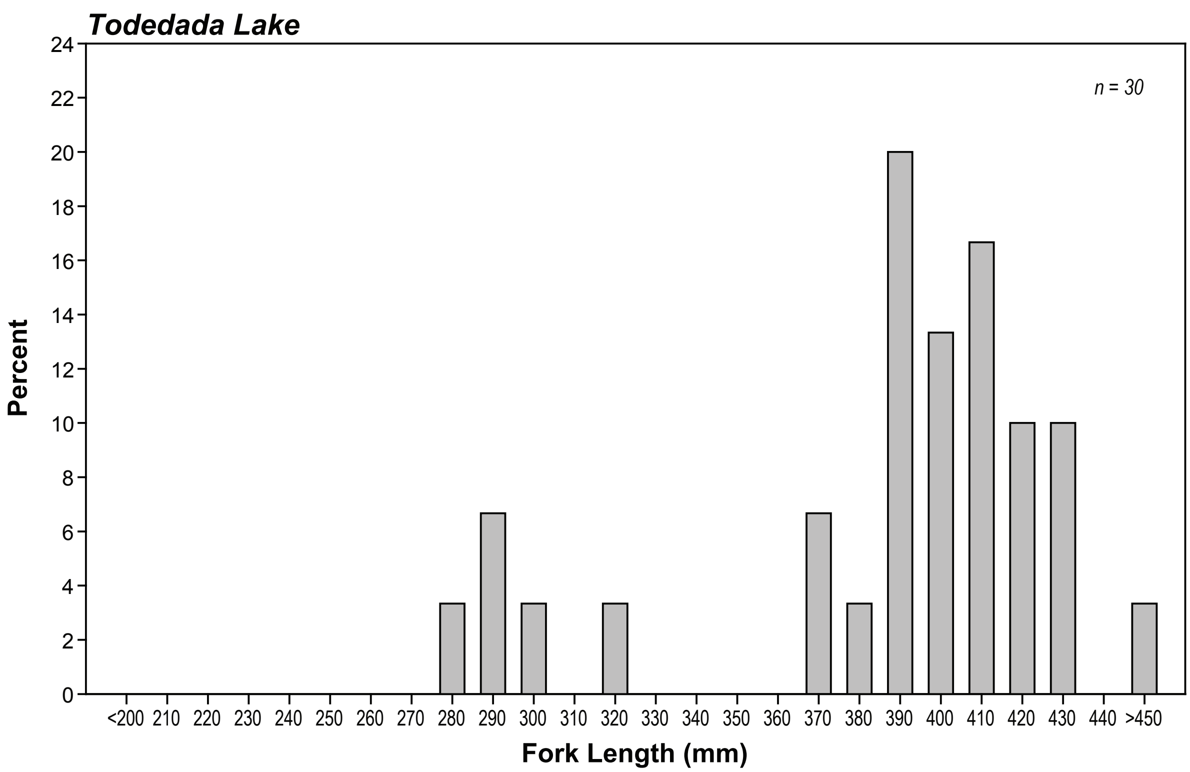
West Teigen and Todedada lakes fish diet analysis data is presented in Appendices 6.3-6 and 6.3-7. Diet analysis was conducted for Dolly Varden because this species was previously selected as the keystone study species. Mean Dolly Varden stomach fullness ranged between 43 to 59% (Table 6.4-5). Mean Dolly Varden stomach digestion ranged between 30 to 23% (Table 6.4-5). Percent digestion is often influenced by the timing of sampling. Fullness may be related to digestion, as well as food abundance.

Table 6.4-5. Fullness, Digestion and Stomach Content Weight of Dolly Varden from West Teigen and Todedada Lakes, 2009

Parameter	West Teigen Lake						Todedada Lake				
	N	Mean	SE	Min	Max		N	Mean	SE	Min	Max
Fullness (%)	5	43	15.3	10	100		6	59	8.6	30	90
Digestion (%)	5	30	5.0	25	50		6	23	8.4	10	50
Actual Weight (mg)	5	1101	693.5	155	3861		6	3215	1013.2	924	8078

Dolly Varden diet composition was analyzed by number and by weight. Numerically dominant prey items included Chironomidae and Cladocera for West Teigen Lake (Figure 6.4-6). Chironomidae were a higher composition in 2009 than 2008 (Rescan 2009), which is likely due to the seasonal availability of prey. Numerically dominant prey items included Cladocera, Chironomidae and Molluscs for Todedada Lake (Figure 6.4-6). A small proportion of aquatic insects composed the remainder of the diet. Similar results are shown for Dolly Varden prey diet by weight, however Todedada Lake had a high composition of case materials (Figure 6.4-7).



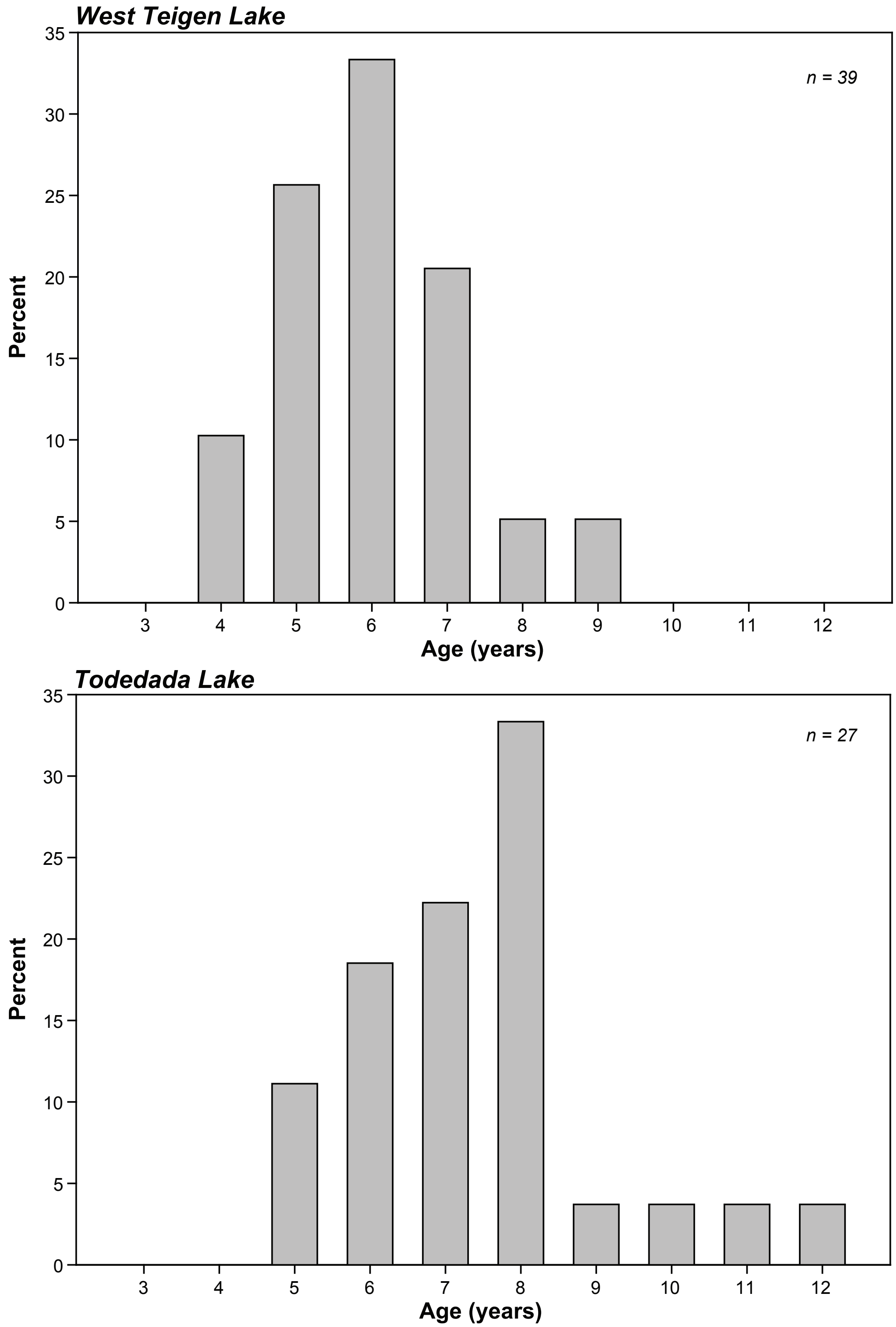


Fork Length Frequency Distribution of Dolly Varden within West Teigen and Todedada lakes, 2009

FIGURE 6.4-3

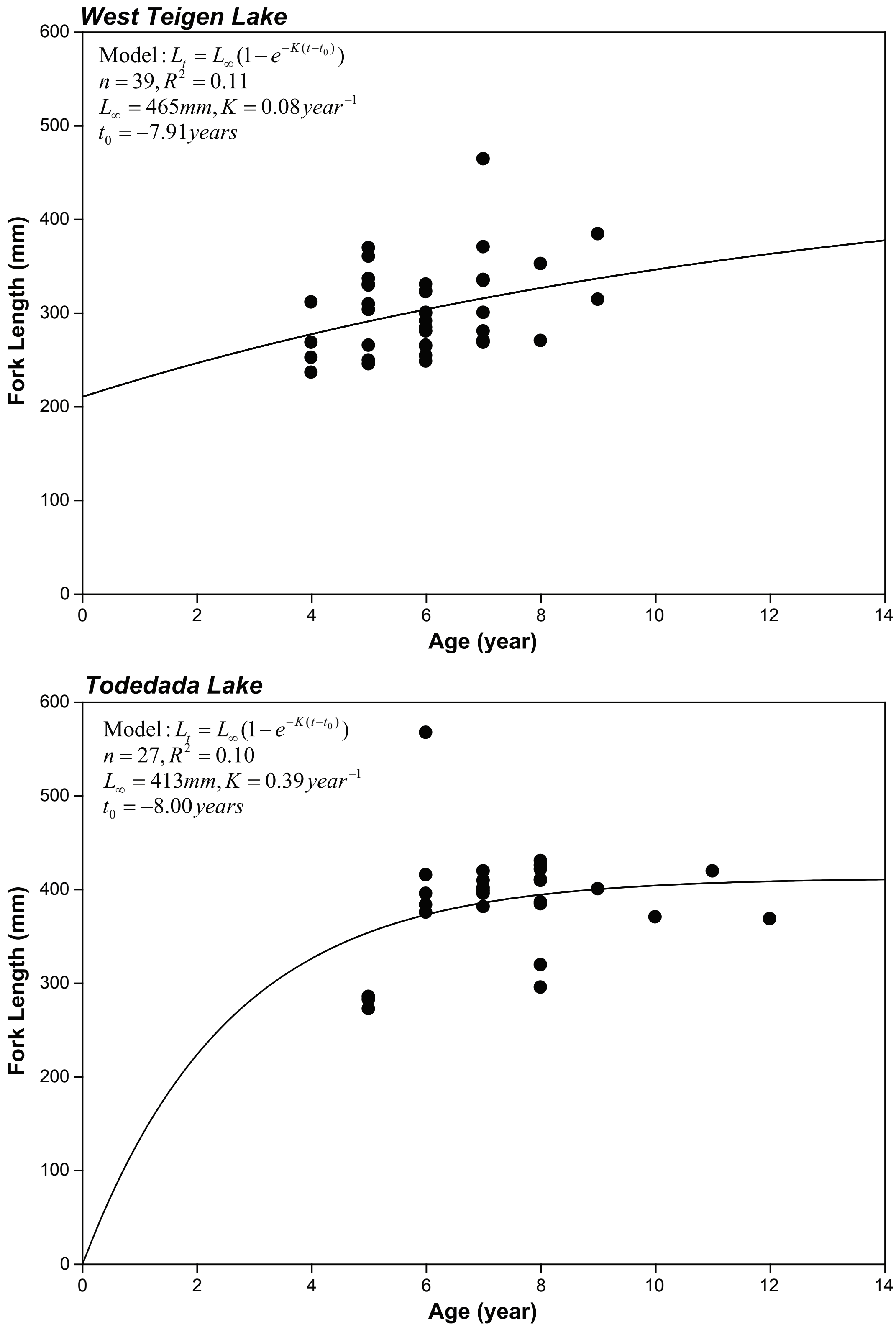
SEABRIDGE GOLD

Rescan™



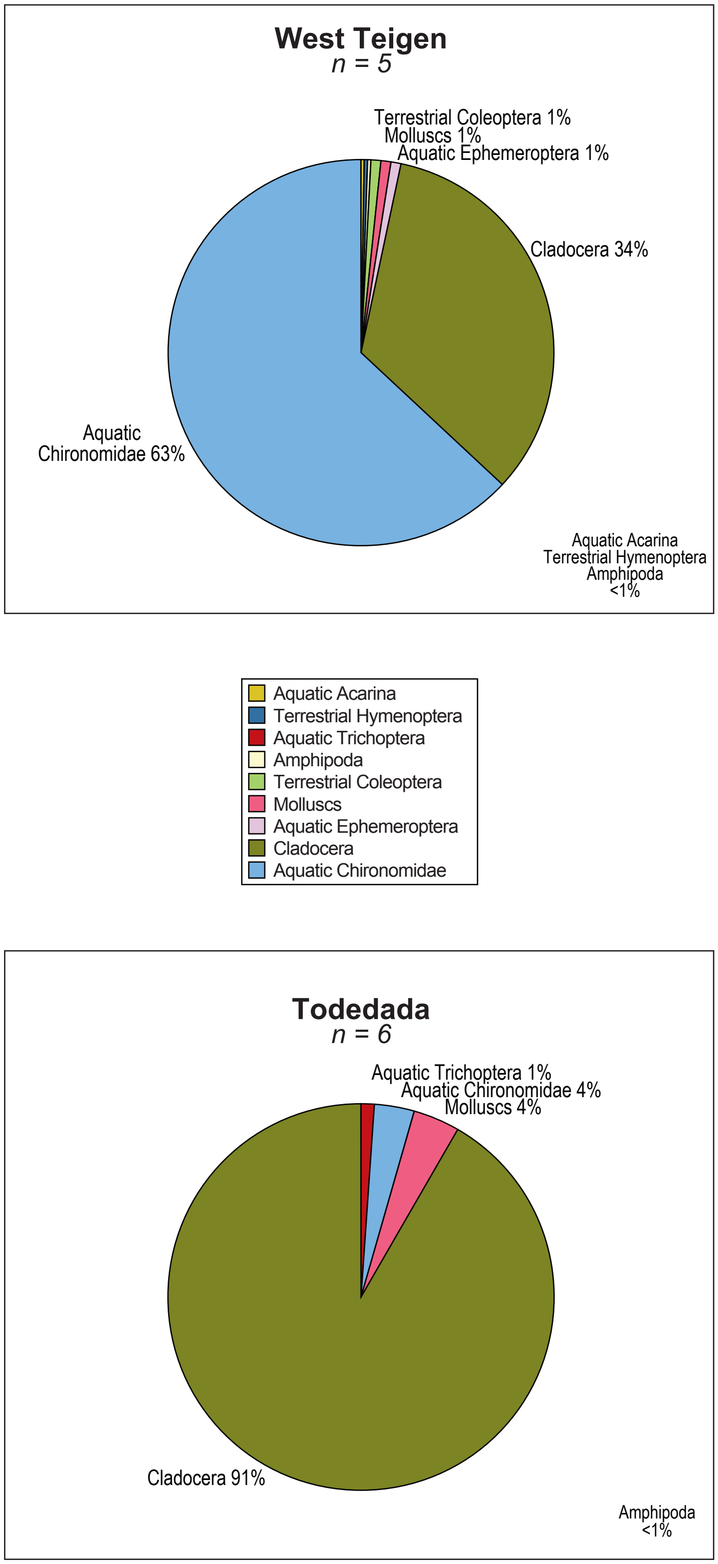
Age Frequency Distribution of Dolly Varden within West Teigen and Todedada lakes, 2009

FIGURE 6.4-4



Von Bertalanffy Growth Model for Dolly Varden within West Teigen and Todedada lakes, 2009

FIGURE 6.4-5



Percent Diet Composition (by Number) of Dolly Varden Captured in West Teigen and Todedada Lakes, 2009

FIGURE 6.4-6

SEABRIDGE GOLD

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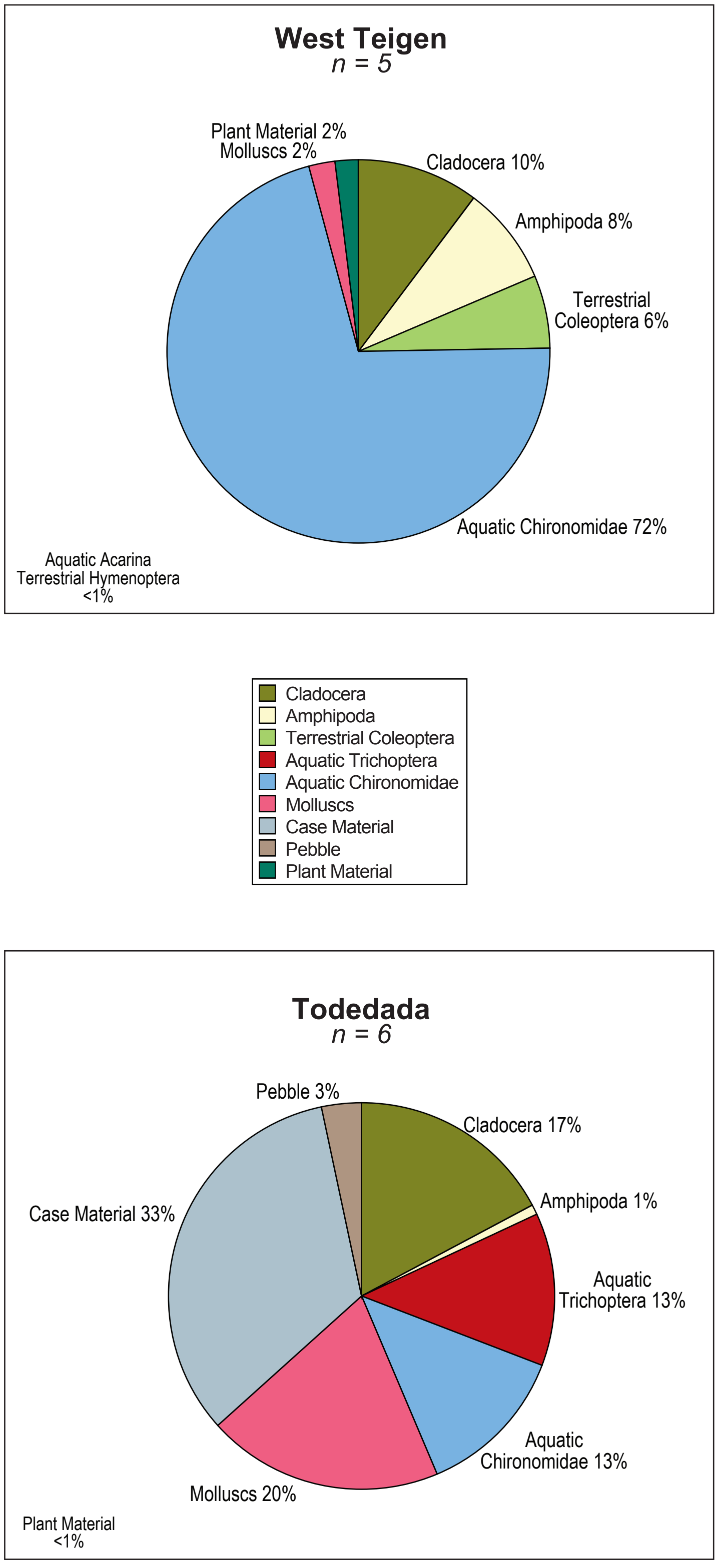

Percent Diet Composition (by Weight) of Dolly Varden Captured in West Teigen and Todedada Lakes, 2009

FIGURE 6.4-7

SEABRIDGE GOLD

7. Conclusion

The purpose of the 2009 KSM Fisheries Baseline Program was to provide baseline information on fish and fish habitat within the Project area that may be impacted by the proposed mine and infrastructure development. This report described sampling procedures and results of the KSM Project Fish and Fish Habitat Baseline Program conducted in 2009. The results presented in this report were a continuation of the 2008 Fisheries Baseline Report.

The KSM fisheries study area includes a diversity of resident and migratory fish species. The study area harbors a diversity of fish habitat types; such as lakes, wetlands, small creeks and large rivers. These habitats support various important fish life history stages (i.e., spawning, rearing, over-wintering and migration), which allows for the persistence of fish populations.

Dolly Varden was selected as the keystone species for monitoring fish and aquatic environment health for numerous ecological reasons. Dolly Varden was the most widely distributed species within the study area watersheds. Dolly Varden is a resident fish species with limited movement and dispersal. The species possesses short-medium term longevity, prey preference is benthic invertebrates, age and length to maturation is short, spawning is site-specific, and diet is primarily aquatic based. Analysis of this species diet, tissue metals concentrations, growth, and fecundity provides baseline conditions of the receiving environment.

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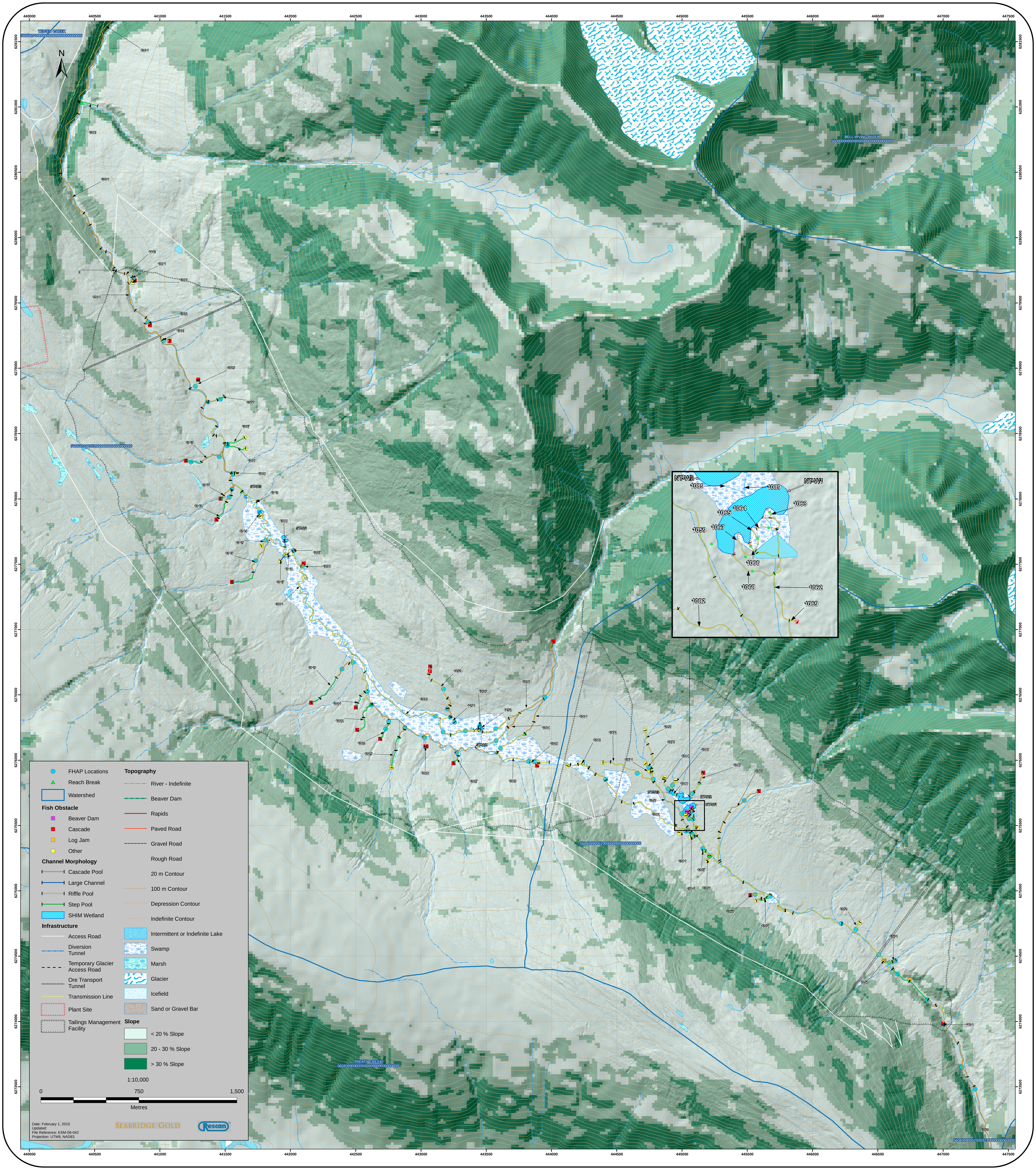
Map Pockets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Watershed
Fish Obstacle
Beaver Dam
Cascade
Log Jam
Other
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Large Channel
Riffle Pool
Step Pool
SHIM Wetland
Infrastructure
Access Road
Diversion Tunnel
Temporary Glacier Access Road
Ore Transport Tunnel
Transmission Line
Plant Site
Tailings Management Facility
Topography
River - Indefinite
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Rapids
Paved Road
Gravel Road
Rough Road
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Depression Contour
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Intermittent or Indefinite Lake
Swamp
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Glacier
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Sand or Gravel Bar
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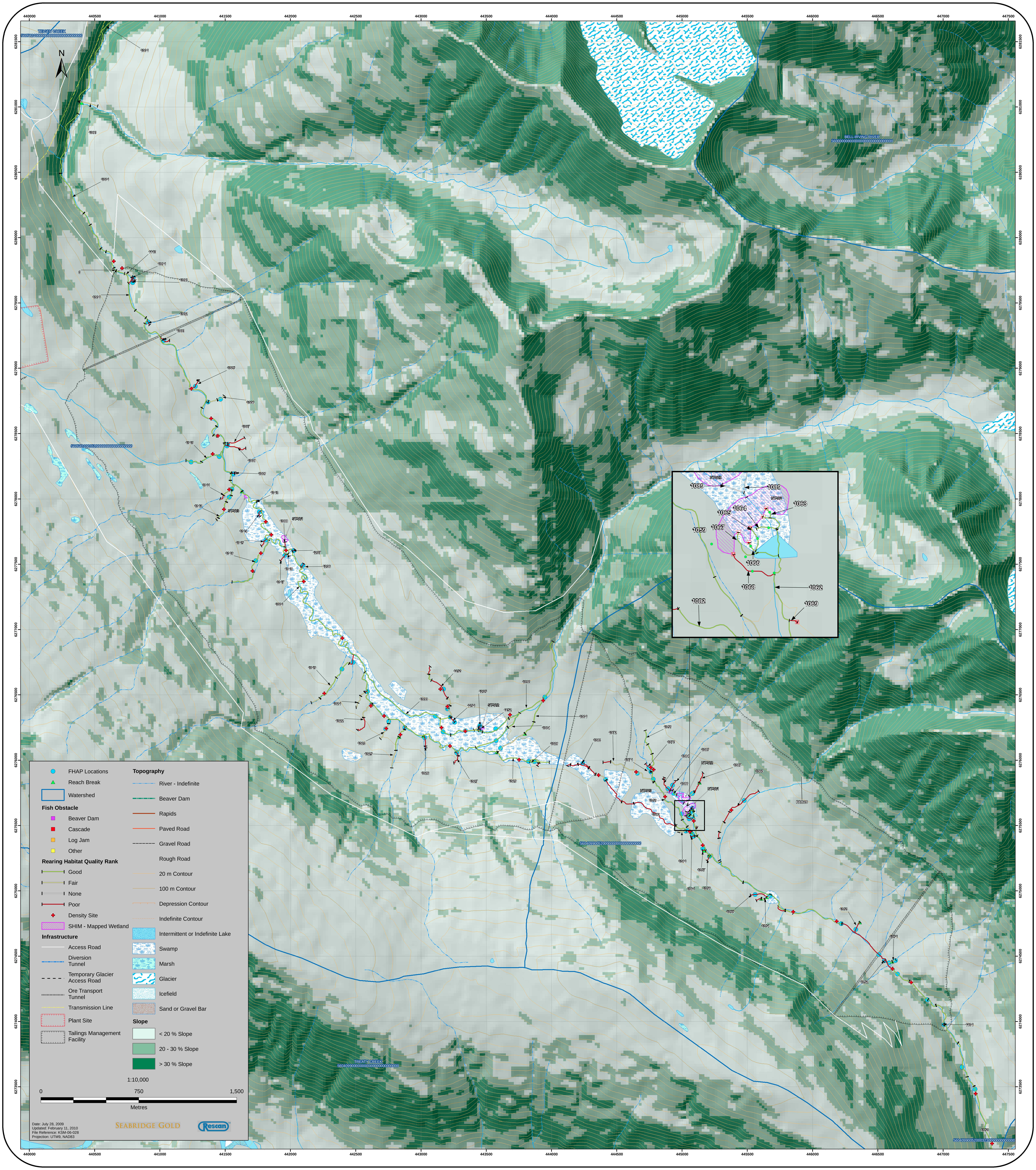

BELL-IRVING RIVER
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FHAP Locations
Reach Break
Watershed
Fish Obstacle
Beaver Dam
Cascade
Log Jam
Other
Rearing Habitat Quality Rank
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Density Site
SHIM - Mapped Wetland
Infrastructure
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Plant Site
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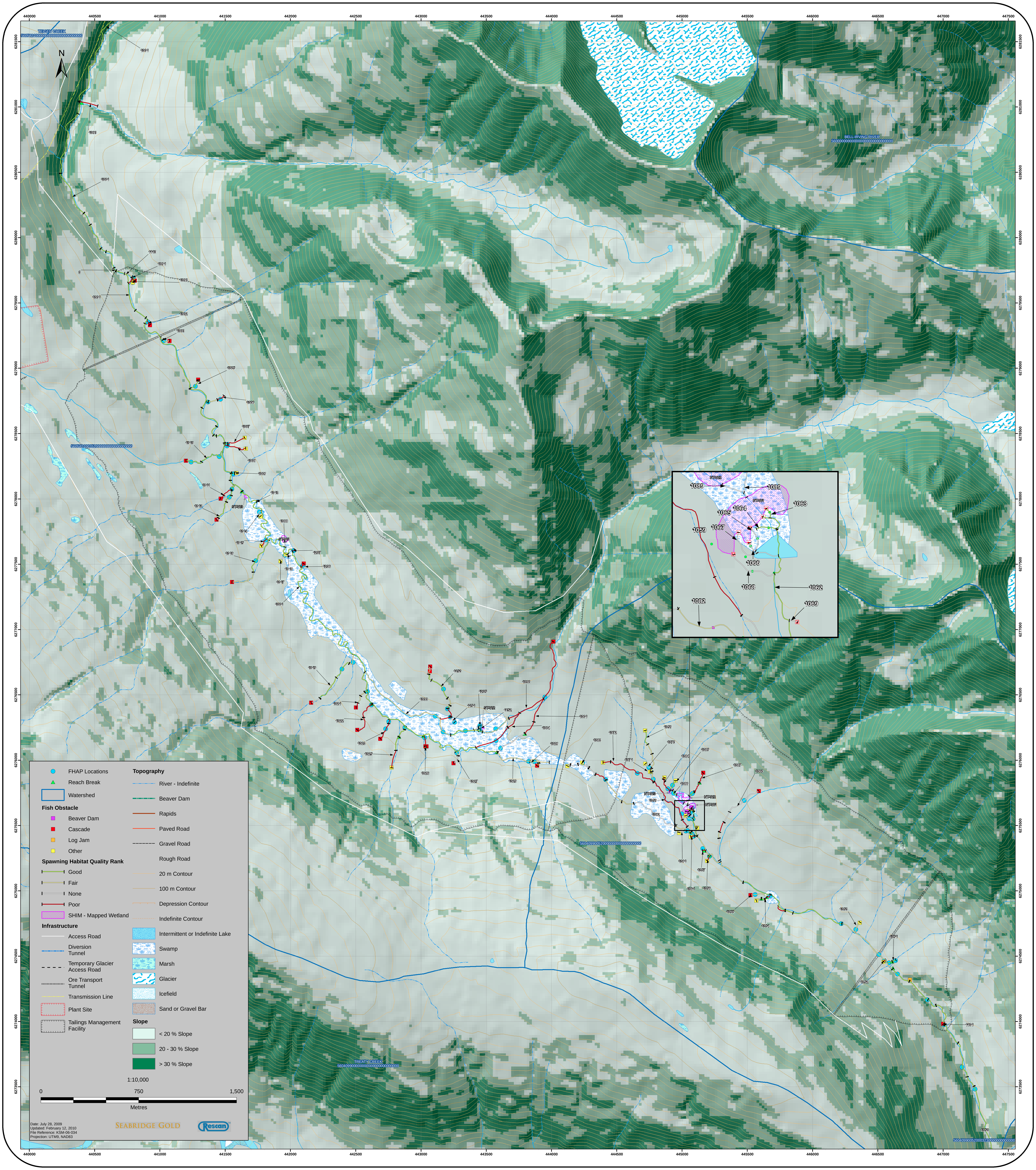
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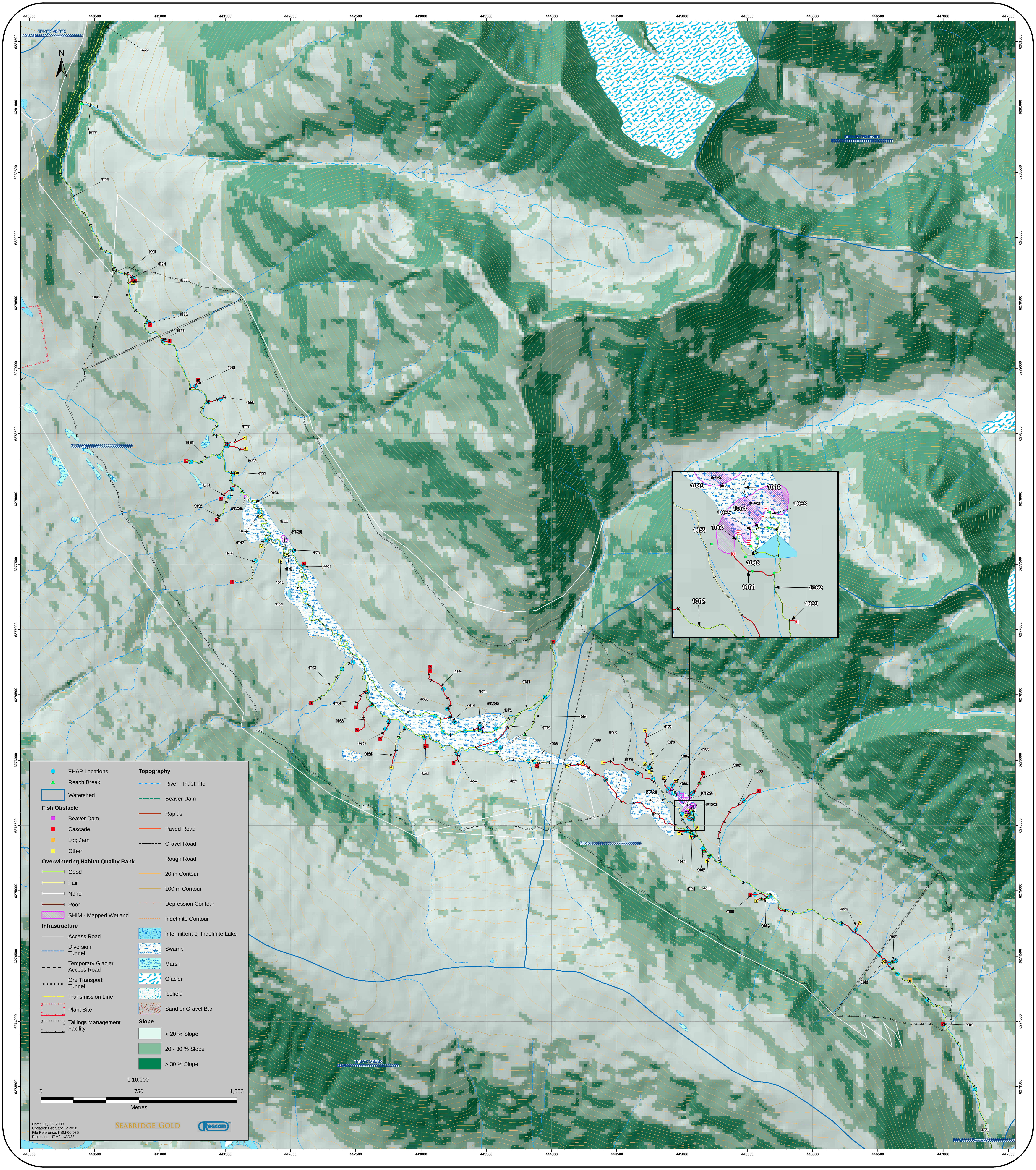

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Overwintering Habitat Quality Rank
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SHIM - Mapped Wetland
Infrastructure
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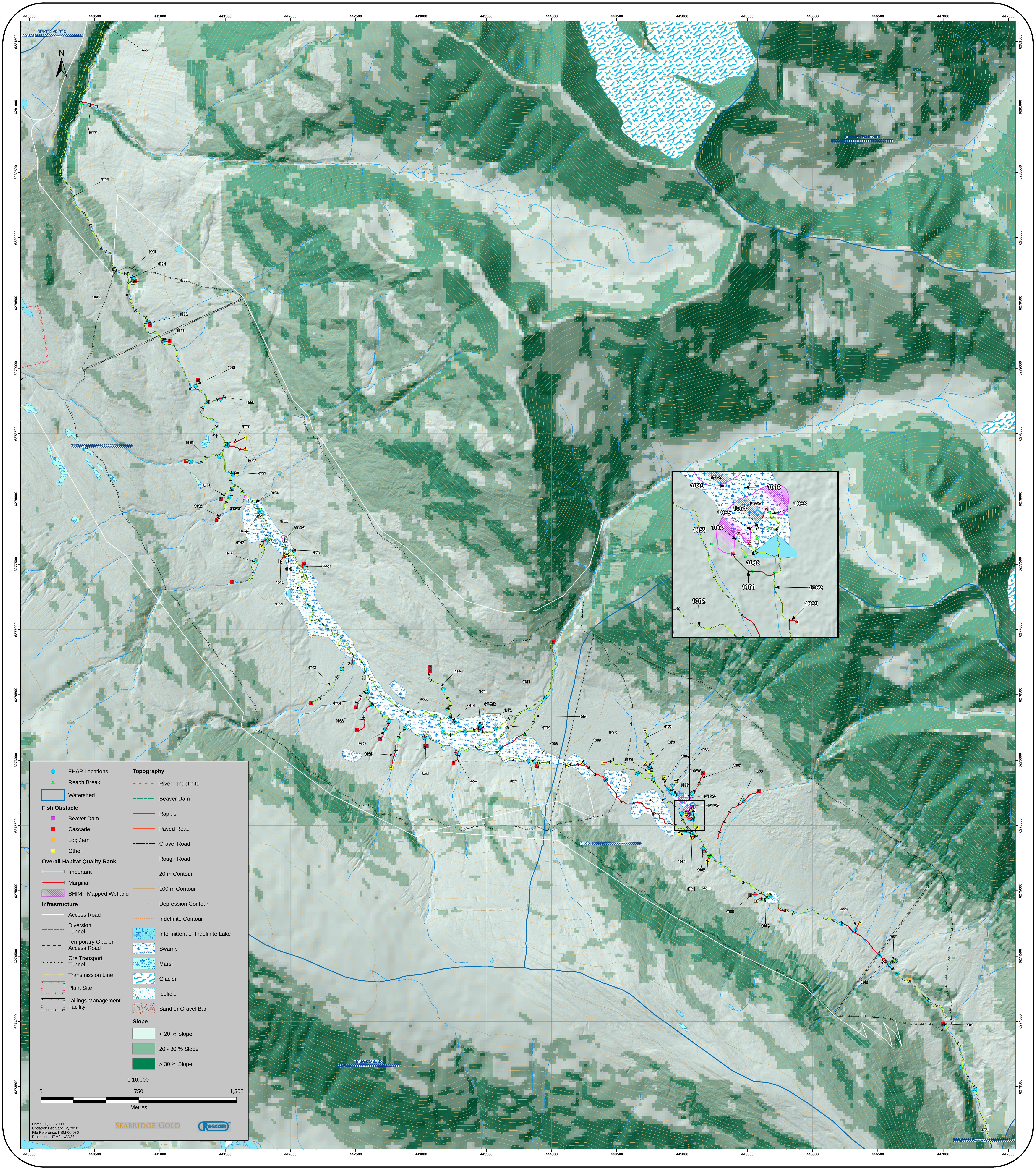

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Infrastructure
Access Road
Diversion Tunnel
Temporary Glacier Access Road
Ore Transport Tunnel
Transmission Line
Plant Site
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Topography
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Glacier
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Sand or Gravel Bar
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> 30 % Slope
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