Overview (1:50,000) Fish and Fish Habitat Inventory of the Fox River (239-350100) Watershed Group – Part II

Prepared for:

Ministry of Environment
Prince George

Prepared by:

Triton Environmental Consultants Ltd.
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Approved by:

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Project Biologist

March 2006

Project Reference Information

FDIS Project Number:	13802
MOE Region:	Omineca
FW Management Unit:	7-41
DFO Habitat Management Area:	Muskwa – Kechika
Forest Region:	Northern Interior Forest Region
Forest District:	Mackenzie Forest District
Forest Licensees:	N/A

Watershed Information

Watershed Group:	Fox River
Watershed Names:	Kwadacha River, Warneford River, Weissener Creek
Watershed Codes and Tributary Status:	Kwadacha River 239-333700 (tributary to the Finlay River); Warneford River 239-333700-26500 (tributary to the Kwadacha River); Weissener Creek 239-350100-340000-32600 (tributary to the Fox River).
1:50,000 NTS Maps:	94 E/16, 94 F/5, 94 F/9, 94 F/10, 94 F/11, 94 F/12, 94 F/13, 94 F/14, 94 F/15.
BEC Zone:	AT, ESSF, SWB, BWBS

Sampling Design Summary

Field sample dates:	August 24-26, 2005
Number of Proposed Stream Surveys:	54
Number of Proposed Fish-Only Sample Site:	6
Number of Proposed Lake Surveys:	1

Summary of Project Achievements

Number of Stream Sites Surveyed:	53
Number of Fish-Only Sample Sites:	9
Total Number of Stream Sites:	62
Number of Lakes Surveyed:	1
Fish Species Captured in Streams:	BB, BT, CCG, GR, LKC, LSU, MW, PW, RB
Fish Species Captured in Lakes:	BB, BT, LKC, LSU, LT, MW, RB, WSU

Contract Information

Project Type:	Overview (1:50,000) Fish and Fish Habitat Inventory
Inventory Contractor:	Triton Environmental Consultants Ltd.
Contact:	Ryan Liebe, B.Sc., R.P.Bio. Ph: (250) 562-9155 or e-mail: rliebe@triton-env.com

Contractor Information

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Field Crew:	*Names:*	Neal Foord, Mark LeRuez, Ryan Liebe, Dan Tisseur, Jim Trask, Rachel Manson
Field QA/QC:	*Names:*	Lynn Blouw (MOE)
Data Entry:	*Names:*	Rachel Manson
Report prepared by:	*Names:*	Rachel Manson, Ryan Liebe
Report Edited by:	*Name:*	Ryan Liebe, Jim Trask
Maps Prepared by:	*Name:*	Triton Environmental Consultants Ltd.
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Planning Information and Sampling Design Protocols

Relevant planning information is discussed in the following report, and can be found in its entirety in the planning report (Attachment 1). Specific project requirements, agreements with respect to the application of the standards, and other contractual obligations are recorded in the contract.

Disclaimer

This product has been accepted as being in accordance with approved standards within the limits of Ministry quality assurance procedures. Users are cautioned that interpreted information on this product developed for the purposes of the Forest and Range Practices Act/Forest Practices Code Act and Regulations, for example stream classifications, is subject to review by a statutory decision maker for the purposes of determining whether or not to approve an operational plan.

Acknowledgments

Funding for this inventory was provided by the Muskwa Kechika Trust Fund.

Triton would like to thank Lynn Blouw (Ministry of Environment – Prince George) for making this work possible. Additionally, Triton would like to thank Sean Rickards (Yellowhead Helicopters) for providing access to the study area.

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1. INTRODUCTION

This report, appendices (7), attachments (2) and mapping present the results of an Overview (1:50,000) Fish and Fish Habitat Inventory conducted within the Fox River Watershed Group (Part II). Field data was collected during August of 2005.

1.1 Project Scope/Objectives

The fish and fish habitat inventory information gathered during this project is used to report key sport fish habitat values, habitat capabilities, limiting factors, and management concerns within the project area. The baseline inventory information collected significantly exceeds the minimum requirements necessary to classify streams for the Forest Practices Code/Forest and Range Practices Act and is suitable for use in integrated forest management planning.

The overall project objective is to:

- collect fish habitat inventory information that will facilitate integrated resource and fisheries planning and decision making.

The specific objectives of this project are to:

- provide information on the fish species, distributions and relative abundance,
- to provide stream biophysical data.

Although some analysis of data is presented in this report, a thorough and detailed analysis is beyond the scope of the project.

1.2 Location

The Fox River Watershed Group is located within the Mackenzie Forest District, which is situated in the north central portion of the province within the centre of the Northern Interior Forest Region. As identified by the Ministry of Environment (MOE), the planning area for this project is described as the Weissener Creek watershed (tributary to the Fox River), the Warneford River watershed, and the upper portion of the Kwadacha River (upstream of the confluence of Warneford River). The Fox River and Kwadacha River flow south into the Finlay River, which then continues to drain southeast into the Williston Reservoir.

The study area is described by four biogeoclimatic zones, generally based on elevation. The Dry Cool 1 subzone of the Boreal White and Black Spruce zone (BWBSdk1) describes the portion of the study area below approximately 1100 m in elevation. This subzone describes the valley bottom of the Kwadacha River, the lower two-thirds of the Warneford River, Chesterfield Creek upstream to Chesterfield Lake, Haworth Creek upstream to Haworth Lake, the lower half of

Weissener Creek and the lower half of Joe Poole Creek (BECWeb 2005). The subzone is characterized by stands of white spruce (*Picea glauca*), lodgepole pine (*Pinus contorta*), and black spruce (*Picea mariana*) and contains important low-land habitat for moose (*Alces alces*), elk (*Cervus elaphus*), caribou (*Rangifer tarandus*), black bear (*Ursus americanus*), grizzly bear (*Ursus arctos*), gray wolf (*Canis lupus*), beaver (*Castor Canadensis*), and muskrat (*Ondatra zibethicus;* MacKinnon *et al*. 1990).

The Spruce Willow Birch zone (SWBmk) generally describes portions of the study area between 1100 and 1500 m in elevation, which includes the valley bottoms of the headwaters of Weissener, Joe Poole, Haworth, and Chesterfield creeks, the valley bottom of the headwaters of the Warneford River, and the valley bottom of the North Kwadacha River. This zone is sub-alpine, and is characterized by an open tree canopy consisting of white spruce, gray-leaved willow and scrub birch (*Betula glandulosa*). Valley bottom riparian forests and wetlands in this zone provide important moose and bear habitat while the arboreal lichens found in the forested portions are used by caribou in the winter. Steep, grass and shrub-dominated habitats are used by sheep (*Ovis canadensis*) while mountain goats (*Oreamnos americanus*) use the higher elevation, rugged slopes.

The Engelmann Spruce – Subalpine Fir zone (ESSFmv4) generally describes portions of the study area between 1100 and 1500 m in elevation (similar to the SWBmk), but is typically associated with the valley walls of larger valley bottoms and is limited to the southeaster portion of the study area. The ESSF describes the middle slopes around Weissener Lake, the Kwadacha River (downstream of the North Kwadacha River), and the lower Warneford River (BECWeb 2005). Mature coniferous stands with dense arboreal lichen can be used by caribou in the winter. Subalpine meadows are used by moose, caribou and willow ptarmigan (*Lagopus lagopus*) in summer (DeLong *et al.* 1994).

The last biogeoclimatic zone within the watershed is the Alpine Tundra zone (AT), which occurs above 1500 m in elevation. This zone is characteristically treeless with low-lying shrub, bryophytes and lichen. Trees that do occur sporadically within the zone are usually in a krummholz form (MacKinnon *et al*. 1990).

The climate in the region is generally dry and cool and characterized by moderate summer flows and cool summer water temperatures. Winters are cold (average temperature of –18°C between November and February) and relatively dry at low elevations (annual average precipitation of BWBSdk1 is 417 mm), and moist to wet at higher elevations (annual average precipitation of the SWBmk is 579 mm; DeLong 2004).

1.2.1 Access

Development in the vicinity of the study area is limited to the Kwadacha Nation (Fort Ware), located 20 km to the southwest and an abandoned mine near the headwaters of the Paul River. Forestry roads and cutblocks are abundant south of the study area (*e.g.* the Buffalo Head operating area to the northeast of the Williston Reservoir). However, there is no road development within the planning area. The nearest road access was obtained by the Paul River FSR, which branches off the Finlay FSR. A helicopter was necessary to access the majority of stream survey sites within the planning area. The remainder of the sites (mainstem Warneford and Kwadacha rivers) were access by a river raft that was initially positioned with a helicopter.

1.3 Summary of Previous Sampling

1.3.1 Kwadacha River Watershed

Existing fish records for waterbodies in the upper Kwadacha River watershed (upstream of the Warneford River confluence), include Chesterfield Lake, Quentin Lake, and the Warneford River. Quentin Lake is known to contain pygmy whitefish and mountain whitefish, but also has records for bull trout (*Salvelinus confluentus*) and longnose sucker (*Catostomus catostomus*). The Warneford River, which drains into the Kwadacha River is also known to contain bull trout. Chesterfield Lake is known to contain rainbow trout (*Oncorhynchus mykiss*), bull trout and mountain whitefish (*Prosopium williamsoni*). All other watercourses in the upper Kwadacha watershed, including Haworth Lake, Chesterfield Creek, Ipec Lake, the Aramis Lakes, and the North Kwadacha River have no existing fish records available on web-based search tools (*e.g.* Fish Wizard and the Fisheries Information Summary System (FISS)).

The majority of existing information for the upper Kwadacha River watershed comes from Ministry of Environment (1982) lake surveys completed on four of the largest lakes within the project area. Lake surveys and habitat assessments of tributaries to the lakes were completed for Haworth, Chesterfield and Quentin lakes. The results of these surveys were as follows:

- No fish were captured in Haworth Lake, or observed at two of its tributaries and its outlet.
- Chesterfield Lake was found to contain rainbow trout, Dolly Varden[1] (bull trout), and mountain whitefish. No fish were observed in two tributaries to the lake (including Chesterfield Creek), or at the outlet of the lake.
- Quentin Lake was found to contain Dolly Varden (bull trout), mountain whitefish, pygmy whitefish (*Prosopium coulteri*), and longnose sucker. No fish were observed at the inlet or outlet to the lake (Warneford River) or at a third order tributary to the Warneford River immediately downstream of the Quentin Lake.

Quentin Lake was more recently sampled by staff of the Peace/Williston Fish and Wildlife Compensation Program (PWFWCP). Fish species captured included bull trout, mountain whitefish, pygmy whitefish, longnose sucker, rainbow trout, lake trout (*Salvelinus namaycush*), and lake whitefish (*Coregonus clupeaformis;* PWFWCP 2003).

A limited amount of information exists for the lower Kwadacha River. The lower Kwadacha River mainstem is known to contain mountain whitefish, rainbow trout, slimy sculpin (*Cottus cognatus*) and pygmy whitefish, which were captured by Triton crews

[1] Although some existing records indicate the presence of Dolly Varden (*Salvelinus malma*) in the project area, a regional analysis (Haas 1996) has resulted in the determination that the fish in this area are most likely all bull trout.

during the Fox River Watershed 1:50,000 overview FFHI in 2004. In 1996 Timberwest, more recently known as Slocan Mackenzie (and now Canfor), completed four 1:20,000 inventory sites in tributaries to the lower Kwadacha River watershed. Of the sites surveyed fish were not captured at three of the sites and the final site was not sampled (Timberwest 1996).

1.3.2 Fox River Watershed

Existing fish records for waterbodies in the Weissener Creek watershed (part of the Fox River watershed) include Weissener Lake, which is known to contain longnose sucker, rainbow trout, lake trout, lake whitefish, pygmy whitefish and mountain whitefish. A lake survey of Weissener Lake completed by the Ministry of Environment in 1982 also included the assessment of several tributaries and the lake outlet. Mountain whitefish were observed in Weissener Creek downstream of the lake, but fish were not observed at three tributaries that were assessed (including Weissener Creek and Joe Poole Creek).

Weissener Lake was more recently sampled by staff of the PWFWCP. Fish species captured included rainbow trout, lake trout, lake whitefish, pygmy whitefish, mountain whitefish and one kokanee (PWFWCP 2003).

Although downstream of the study area, the Fox River is known to contain slimy sculpin, Arctic grayling, mountain whitefish, white sucker (*Casostomus commersoni*), burbot (*Lota lota*) and bull trout (Triton 2005). The McCook River mainstem, of which Weissener Creek is a tributary, was found to contain slimy sculpin (Triton 2005). Furthermore, FISS records indicate that Fox Lake contains lake trout, rainbow trout and lake whitefish.

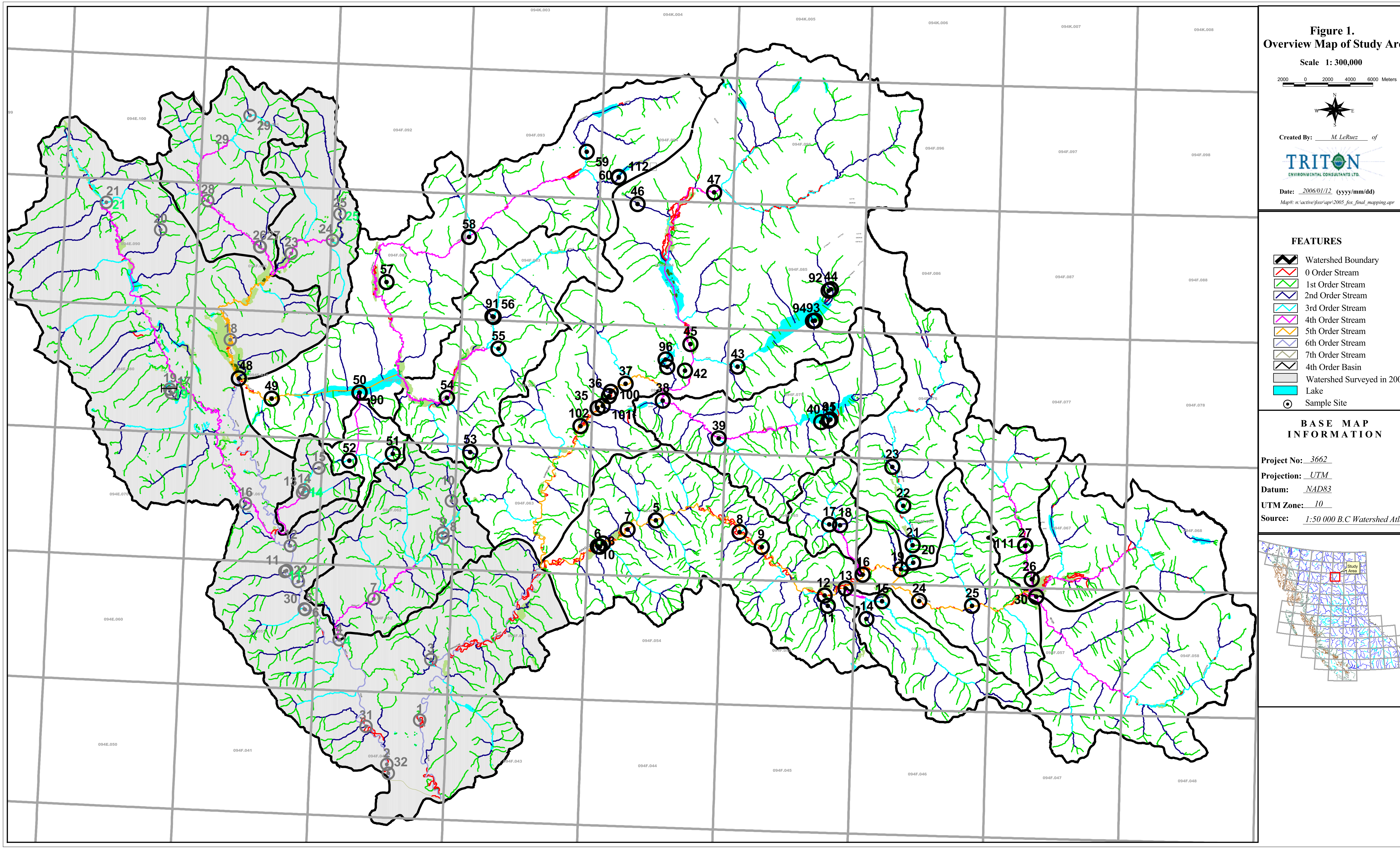

Figure 1.
Overview Map of Study Area
Scale 1: 300,000
2000 0 2000 4000 6000 Meters
N S W E
Created By: M. LeRuez of
TRITON ENVIRONMENTAL CONSULTANTS LTD.
Date: 2006/01/12 (yyyy/mm/dd)
Map#: n:\active\foxr\apr\2005_fox_final_mapping.apr
FEATURES
Watershed Boundary
0 Order Stream
1st Order Stream
2nd Order Stream
3rd Order Stream
4th Order Stream
5th Order Stream
6th Order Stream
7th Order Stream
4th Order Basin
Watershed Surveyed in 2004
Lake
Sample Site
BASE MAP INFORMATION
Project No: 3662
Projection: UTM
Datum: NAD83
UTM Zone: 10
Source: 1:50 000 B.C Watershed Atlas
Study Area

2. RESOURCE/DEVELOPMENT INFORMATION

Fisheries

Recreational fishing opportunities within the study area are limited due to difficult access. Arctic grayling, bull trout, burbot, lake trout, mountain whitefish, pygmy whitefish, and rainbow trout were the species of sport fish encountered within the planning area. The larger lakes (with the exception of Haworth Lake which does not appear to support fish) such as Weissener, Chesterfield, and Quentin lakes, are the most suitable for fishing within the study area, although there are a couple of smaller lakes along the mainstem of the Warneford River (including the lake surveyed during this study) that provide open water suitable for angling (although access is difficult). There are several lakes in the headwaters of Weissener Creek and the Warneford River, but their fish-bearing status is not known. Fishing opportunities in streams and rivers are limited to the mainstem of the Kwadacha, North Kwadacha, and Warneford rivers, Weissener, Chesterfield, and Joe Poole creeks and the larger 3rd and 4th order tributaries. No commercial fishery exists in the region and no information could be found in regards to aboriginal fisheries (although it is assumed fishing for both food and ceremonial purposes occurs throughout the region).

Timber

The Northern Interior Forest Region is the largest in the province, covering more than 9.8 million hectares. The study area is located in the northern portion of the Mackenzie District, which is administered from the District office in Mackenzie, BC.

At the time of the study, there was no logging within the planning area. Abitibi Consolidated is studying the economic feasibility of harvesting to the southwest of the study are within the lower Kwadacha River and Fox River watersheds. Their Forest Development Plan (FDP) map for the area (FLA15385) dated January 7, 2004 shows approximately 20 blocks and associated roads along the western side of the Fox River valley bottom. Additionally, the FDP map shows 11 blocks adjacent to the lower Kwadacha River that are to be harvested by the Kwadacha First Nation (Fort Ware).

Residential

The nearest community to the planning area is Fort Ware (Kwadacha First Nation), located at the confluence of the Kwadacha and Finlay rivers (approximately 25 km southwest of the study area). The Tsay–Keh Dene First Nation is located further downstream on the Finlay River at its confluence with the Williston Reservoir (approximately 80 km south of the study area). Mackenzie is the only major residential community in the region, and is located at the southern end of the Williston Reservoir, approximately 260 km south-southeast of the study area. The downstream point of the planning area is located approximately 420 km north-northwest of Prince George.

Recreation

At present there is no significant development within the study area, with only the occasional guide/outfitter cabin on some of the larger lakes. The remainder of the study area is undeveloped, with a large portion being found within the Kwadacha Wilderness Park. There are no roads into the park, and the area can only be accessed by foot or air. Two trails exist into the park the first starting at Trutch on the Alaska Highway, then running north along the Prophet River to the Muskaw Valley where it follows the Muskwa River down to Fern Lake. The second access trail starts just west of Sikanni Chief on the Alaska Highway heading north until it meets with the first trail. The park itself also contains a few undeveloped trails and primitive camp sites, which are only suggested for experienced backpackers and horseback riders (Province of British Columbia 2003).

Due to poor access to the majority of the planning area, recreational opportunities in the region are limited although may include hiking, hunting, fishing and camping during the summer months and snowmobiling and cross-country skiing in the winter months. Several cabins (assumed to be for hunting or trapping) were observed within the planning area from the helicopter during the completion of the field sampling. Cabins were located at the confluence of the Kwadacha and Warneford rivers, and also on the majority of larger lakes within the planning area (*i.e.* Chesterfield, Quentin and Weissener lakes).

Agriculture

There was no observed agriculture use, and there is little to no potential for agricultural land use within the Fox River planning area.

Wildlife

The Fox River watershed provides important habitats for a variety of wildlife species. In particular, the lowland areas provide habitat for woodland caribou, moose, deer and elk. In addition, there are healthy populations of large carnivores including wolves, grizzly bear and black bear as well as abundant furbearers such as marten, lynx, beaver and muskrat. Small mammals, raptors, owls, cavity nesters, and waterfowl are commonly found throughout the area. The numerous wetlands and small ponds provide important nesting and staging sites for waterfowl such as Mallards, Northern Pintail, Blue-Winged Teal and Northern Shoveler.

Mining/Oil and Gas

Although mining occurs within the Mackenzie Forest District (*e.g.* Kemess), there was no evidence of gas exploration (seismic lines) or mining within the planning area. An abandoned mine (the Cirque Mine), is located in the headwaters of the Paul River, less than 10 km to the south of the planning area.

First Nations

The nearest First Nations settlement to the planning area is the Kwadacha First Nation (Fort Ware), located just upstream of the confluence of the Kwadacha and Finlay rivers. Fort Ware is a 388 ha reserve with approximately 50 dwellings, a store, school and airstrip (Province of British Columbia 2000).

The Tsay–Keh Dene First Nation is located further downstream on the Finlay River at its confluence with the Williston Reservoir (approximately 80 km south of the study area).

3. METHODS

The methods employed for each phase of this project are consistent with the *Overview Fish and Fish Habitat Inventory Methodology* (Province of British Columbia 1999), which are described in the following steps:

- Pre-field activities: data review, map analysis, project plan;
- Field data collection;
- Data compilation and reporting.

Milestone achievements, Triton's approach to meeting the project objectives, deviations or modifications from standard procedures, special considerations, and relevant details are documented for each of the identified project phases in the following sub-sections.

3.1 Data review

The collection and review of existing information was conducted in order to:

- determine the known fisheries values of the system;
- locate potential obstructions to fish migration;
- determine areas of potentially sensitive habitat;
- determine areas for priority assessment; and
- select locations of suitable access points.

The review included, but was not limited to the following information sources:

- FISS database;
- 1:50,000 scale NTS maps; and
- aerial photographs.

An annotated bibliography and contact list (see Appendix 7) were generated from the sources obtained and consulted for the overview.

3.2 Map analysis

The watershed atlas base map (including classification of streams by order and 4th order watershed polygons) and aerial photographs were obtained for the entire planning area. Interim maps displaying stream order were produced, so that sampling sites could be selected which generally met the requirements of the standards (*i.e.* two mainstem sites; one site in each major tributary; one 3rd, 2nd, and 1st order tributary in each 4th order basin).

The final component of the map analysis was to identify stream sections selected for sampling on the interim maps and aerial photographs. Stream sample locations were based on the following criteria:

- stream order (to meet Overview standard requirements),

- access (sites on smaller streams needed to be at some visible opening so that the helicopter could land),
- likelihood of obtaining relevant fisheries information (*e.g.* sites were not selected at the terminal ends of short tributaries, above numerous beaver dams as it is unlikely to capture fish in such locations).

3.3 Project Plan

The final pre-field task was to develop the logistics of completing the work, develop the detailed budget, and produce the planning report. Other tasks associated with this phase included refining the specific requirements of the inventory project, including water quality sampling and testing, collecting aging structures, and collecting voucher specimens. In addition, a preliminary prioritization and scheduling of sampling effort was conducted in order to maximize the value of fish information collected with respect to fish distributions and timing.

3.4 Field Data Collection

The following provides an outline of the approach used in conducting the field work, as well as clarification of specific sampling methodologies.

3.4.1 Field Mobilization

Pre-field preparations involved both office activities and logistics planning in coordination with members of the project team. Copies of the planning maps (with aerial photographs) and field-office supplies were mobilized. The required fish collection permits were obtained from the Ministry of Environment.

Pre-field preparations included a crew talk and pre-field training. During the crew talk, safety issues and procedures were reviewed. Irrespective of the experience of crew members, all staff were required to complete pre-field training to review the standards and procedures. Crew members who were not involved in the planning phases were informed about project specific logistics and requirements. The crew talk and pre-field training provided a means to ensure that inventory cards were completed in a standardized manner by all crews and that crews were aware of QA/QC requirements.

3.4.2 Stream Inventory

Field work was conducted by experienced two person field crews that generally consisted of a biologist and a fisheries technician. The field crews were equipped with Smith-Root backpack electrofishers and other standard field gear (Table 1).

Table 1. Field sampling equipment and specifications used during the stream inventory.

Equipment	Make/model
Backpack electrofisher	Smith-Root Model 12-B
Camera	Olympus Stylus 300 (digital)
pH meter	Oakton pHTestr
Conductivity meter	Oakton TDSTestr
Clinometer	Suunto
Compass	Silva Ranger
Eslon tape	30 m
Meter stick	folding plastic (2 m)
Alcohol thermometer	standard Celsius
Hip chain	standard
GPS	Garmin 12xl
Minnow traps	Gee
Fishing rod with tackle	Collapsible

Additional gear supplied to the raft crew included a Bushnell Yardage Pro laser range finder and a beach seine.

Field crews were supplied with 1:50,000 planning maps to assist in locating and accessing streams of interest. Streams were accessed using a combination of maps, aerial photographs and GPS units.

Site Data Collection

Due to the relatively small number of sites to be sampled (n = 60), site locations were identified, numbered, and added to the field maps during the planning phase prior to completion of the field work. These site numbers were then used on the site cards during the field phase as well as in the database during the post-field phase.

Whenever possible, site data were collected according to inventory standards (Province of British Columbia 2001). At times however, field crews were not always able to meet the standards due to site-specific conditions. A common example was the collection of residual pool depths. The standards require six measurements to be taken, but there were instances where this was not possible due to a lack of residual pools to measure. This often occurs where there are no well-defined pools such as in ponded reaches, river mainstems, and very small streams with poor channel and pool development.

Field GPS coordinates were required to be recorded at the downstream end of each of the sites visited during the field phase of the inventory. To ensure field UTM's line up with mapped streams a proximity test was completed during the mapping QA process, ensuring that all sample points fall within 10 m of the stream line. This in turn results in occasional differences between field and final UTM's within the map attribute table.

Fish Sampling

Fish sampling was conducted to determine fish presence, relative abundance and distribution. Fish sampling within streams was conducted in all representative habitats using five primary sampling techniques: electrofishing, minnow trapping, angling, beach seining and pole seining.

Electrofishing is the most efficient method of sampling in shallow stream habitats and was the preferred sampling method for all habitat types encountered in small streams and shallow water habitats. Electrofishing was the only fish sampling technique employed where the use of an additional sampling method would not have provided any additional information or where conditions were unsuitable (*e.g.* the pools were too shallow for minnow traps or the channel was too narrow to angle).

A combination of techniques was employed where the use of only one method would not have effectively sampled all habitats and in areas that were not suited to electrofishing (*e.g.* deep pools and wetlands). Angling was conducted at sites with sufficient channel depth and width and where instream vegetation could be avoided so as not to snag the hook. Minnow traps were only used from the raft during the stream sampling program, due to the short timeline (3 field days) and the helicopter requirement for access (the helicopter time required for return trips to sites would have reduced the overall number of sites that could be sampled). Minnow traps were also used during the lake survey (Triton 2006). Pole and beach seining was employed at several sites where habitat conditions were appropriate (*e.g.* shallow water, slower water velocities, minimal woody debris and boulders to tangle the net).

Where electrofishing was conducted in streams, the minimum effort was typically the greater of: 1) a lineal distance of 100 m, or 2) 10 channel widths. Greater sampling effort was expended in mainstem reaches, and in reaches where suitable fish habitat was present but no fish were captured. At certain sites however, a distance of less than 10 channel widths was sampled. Such instances usually occurred on big systems where 10 channel widths would require a sample length of 500 m or greater. In these cases it was put to the discretion of the biologist at the site to determine when all habitats available within the stream were adequately sampled.

Fish Identification, Data Collection and Voucher Specimen Collection

All fish sampling data were recorded on waterproof Fish Collection Forms. Fish species were identified in the field using the *Field key to freshwater fishes of British Columbia* (McPhail and Carveth 1994). Fork lengths (or total lengths where applicable) were measured to the nearest millimeter, and recorded for all fish species captured.

There was a total of eleven species of fish captured in the planning area, and voucher specimens were collected for nine of the species (the one lake trout captured was not vouchered due to the size and the fact that it could easily be confirmed by photograph, and bull trout were not vouchered as they are a blue-listed species and it was specified in the contract that they not be vouchered). The identification of each of the voucher specimens was confirmed by Triton fisheries biologists and were also compared to independently identified specimens collected in watersheds in the Northern Interior Forest Region that were inventoried by Triton in 2004, and by addition vouchers collected in the Quesnel Forest District during previous inventories. Details pertaining to the vouchers are summarized in Appendix 1.

In addition to the collection of voucher specimens, genetic samples were collected from sport fish captured during the inventory. The number of samples collected was in accordance with the contract and the pre-field planning report which stated that aging structures (analyzed by Birkenhead Scale Analysis) and tissue samples (analyzed by SR Bioloigcal) were to be collected as follows:

- Bull trout – maximum 50 fin rays for aging and 50 fin clips for genetic analysis.
- Arctic grayling – maximum 50 scale samples for aging and 50 fin clips for genetic analysis.
- Lake trout – maximum 50 fin rays for aging and 50 fin clips for genetic analysis.
- Pygmy whitefish – maximum 50 scale samples for aging and 50 fin clips for genetic analysis.
- All other salmonids/sport fish – maximum 50 aging structures (scale samples for rainbow trout and mountain whitefish).

Destructive samples (*i.e.* otoliths) were only collected from specimens that were accidental mortalities (*e.g.* fish captured in gill nets as part of the lake survey). In total 192 aging structures (17 finrays, 143 scales and 32 otoliths) and 119 genetic structures (including 86 adipose fins and 33 caudal fins) were collected.

Collected aging structures included:

- Otoliths from 28 rainbow trout (lake survey).
- Otoliths from 4 bull trout (lake survey).
- Scales from 29 rainbow trout (lake survey).
- Scales from 19 rainbow trout (stream survey).
- Scales from 37 mountain whitefish (lake survey).
- Scales from 40 mountain whitefish (stream survey).
- Scales from 18 pygmy whitefish (stream survey).
- Fin rays from 1 lake trout (stream survey).
- Fin rays from 4 bull trout (lake survey).
- Fin rays from 12 bull trout (stream survey).

Collected genetic structures included:

- Adipose fins from 25 bull trout (stream survey).
- Adipose fins from 4 bull trout (lake survey).
- Adipose fins from 4 rainbow trout (lake survey).
- Adipose fins from 14 rainbow trout (stream survey).
- Adipose fin from 1 lake trout (stream survey).
- Adipose fins from 38 mountain whitefish (stream survey).
- Caudal fins from 33 pygmy whitefish (stream survey).

Fish Habitat Description

Habitat parameters were recorded on Site Cards and fish capture data were documented using the Fish Collection Cards. The sample site locations were marked on field copies of maps. Features relevant to fish and fish habitat were documented, geo-referenced, and photographed where encountered. The photographs taken at each site include representative upstream and downstream views. Where appropriate, photographs were taken of riparian conditions, barriers to fish migration (*e.g.* falls and gradient barriers), critical habitats (*e.g.* spawning habitat, off-channel habitat), unmapped fish habitat features (*e.g.* fisheries sensitive zones), and upslope features that may affect the aquatic environment (*e.g.* eroding banks, clay deposits).

The assessment of fish habitat values was based on criteria developed by Triton, which include physical habitat parameters, flow parameters and fish abundance. Habitat assessment is based on key sport fish species encountered in the watershed. For this project, habitat assessments were generally based on bull trout requirements for smaller tributary streams and mountain whitefish and Arctic grayling requirements in larger mainstems where they were more likely to occur.

The following was provided to field crews to aid in the determination of fish habitat values. It is important to note that the following is only a guide and that not all criteria identified with each bullet must be met. It is also important to note that any given reach may sustain high rearing habitat values but not contain any suitable spawning habitat.

High value fish habitat is typically characterized by:

- the presence of significant (at least 5% of the total habitat area) suitable spawning habitat (must be adequate water depths and velocities during spawning and incubation periods)
- abundant cover, perennial flows, coarse substrates, moderate gradient (1-5% for grayling or whitefish)
- significant representation (>10% of the total habitat area) of both pool (>25 cm deep) and riffle habitats for grayling (cascade or riffle habitats for bull trout)
- an abundance of fish (at least 5 bull trout per site).

Medium or Moderate value fish habitat is typically characterized by:

- moderate to abundant cover, predominantly coarse substrates, moderate gradient
- perennial or occasionally ephemeral flows
- some representation of riffle and pool habitats (5-10% riffle and >10% pool) and moderately abundant boulder and/or LWD
- low to moderate numbers of fish (note that fewer or perhaps no fish would likely be captured at low flows).

Low value fish habitat is typically characterized by:

- low cover, low habitat complexity (homogenous shallow glide-pool or riffle habitat), low discharge volume, shallow (<10 cm) average water depth, infrequent pools >15 cm deep, ephemeral flows, predominantly fine substrates

- wetland reaches with seasonal rearing habitat (usually means there is visible flow and occasionally gravels)
- none, few or moderate numbers of fish at optimal flows.

Poor value fish habitat is characterized by:
- ephemeral flows, poor channel definition, vascular plant growth within the channel, low proportion (or no) of coarse substrates, low (0-1%) or high (>15% in small and >20% in larger streams) gradient, infrequent or no pools >15 cm deep, shallow (<5 cm deep) average water depth
- no fish captured or observed, low likelihood of use.

No suitable fish habitat is typically characterized by:
- high average gradients (>15-20% in streams <1.5 m wide, >20% in streams >1.5 m wide[2]), strongly ephemeral flows (may only flow during snow melt and/or prolonged heavy rains), shallow average water depth (<5 cm) with infrequent or no pools >10 cm deep
- intermittent or poorly defined channels
- no fish captured or observed, insignificant possibility of use by sport fish (including burbot).

Water Quality Sampling

Water samples for laboratory analysis were not required from stream surveys, however water quality measurements including temperature, pH and conductivity were taken from all stream reaches to indicate the general conditions in the planning area.

3.4.3 Helicopter Overflight

Helicopter overflights were completed opportunistically in conjunction with the field sampling so as to limit costs. The primary goals of the overflight video were to record general habitat conditions in the watersheds and to document significant features such as logjams or major obstructions to fish movement. Overflight video was generally further limited to 4^{th} and 5^{th} order mainstems where the channel could be clearly observed through the forest canopy.

A helicopter overflight video of the North Kwadacha River, the Kwadacha River mainstem as well as three fourth order tributaries to the upper Kwadacha River had already been produced (Terra Pro 1998), and additional footage of these mainstems was not considered necessary as part of this project.

[2] It should be noted that this may not always be appropriate where bull trout are present as they can utilize stream reaches with >20% gradient if the channel morphology is suitable.

Video recording was completed using a Digital-8 Sony Handycam, and edited post-field using Adobe Premiere. Additionally, representative overview photographs were taken and geo-referenced using a Garmin 12XLS GPS unit. These overflight photos with captions are located in Appendix 2.

3.5 Data Compilation

Following the field program, data were entered into the FDIS inventory database. All data entered into FDIS were audited by the project manager prior to inclusion in the report. Photographs were developed, and captions were created for inclusion in the report. Photograph logs were generated using the database and all photographs were arranged by roll number.

Fish stage and fish maturity were determined for individual species based on the size classes of fork length shown in Table 2. These size classes were determined based on a review of literature (*e.g.* Scott and Crossman 1973) and data from local inventory work.

Table 2. Fish stage of individual fish species, based on fork length (mm).

		Fish Stage				**Fish Maturity**		
Common Name	**Code**	**Fry**	**Parr**	**Juvenile**	**Adult**	**Immature**	**Maturing**	**Mature**
Arctic grayling	GR	<35	35-100	101-250	>250	<150	150-250	>250
bull trout	BT	<35	35-100	101-250	>250	<150	150-250	>250
burbot	BB	N/A	N/A	<250	>250	<175	175-250	>250
lake chub	LKC	<30	N/A	30-80	>80	<65	65-80	>80
longnose sucker	LSU	<40	N/A	40-140	>140	<100	100-134	>134
mountain whitefish	MW	<40	N/A	40-200	>200	<120	120-200	>200
pygmy whitefish	PW	<30	N/A	30-80	>80	<60	60-80	>80
rainbow trout	RB	<35	36-100	100-200	>200	<150	150-250	>250
slimy sculpin	CCG	<25	N/A	25-60	>60	<45	45-60	>60
white sucker	WSU	<35	N/A	35-180	>180	<100	100-180	>180

3.6 Reporting and Mapping

3.6.1 Data Organization

The data are organized by site, and are presented in the following order:

1. Site Card.
2. Fish collection card(s), if the site was sampled for fish.
3. Representative site photographs (including features).
4. Non-Fish Bearing Status Reports (where applicable).

Both the data (Appendix 3) and project map (Appendix 4) are included in the same binder as the overview report. Electronic copies of the data, report, and appendices are attached to each of the deliverable copies.

3.6.2 Report

This report follows the outline provided in the inventory standards (Province of British Columbia 1999), and includes some data analyses not otherwise required by the standards. Fisheries values are featured in the report.

For all reaches where fish absence is suspected, a written explanation is provided in the Non-Fish Bearing Status Report. The discussion sections of the non-fish bearing reports focus on sampling methods and effort, habitat conditions, barriers to fish passage, and water quality parameters (*i.e.* discharge volume, water temperature, pH, conductivity, turbidity).

3.6.3 Mapping

The project map is based on the 1:50,000 watershed atlas stream network. The project map includes: watershed codes, stream names, stream order, stream network, fish sampling and site card locations, fish species, and features.

All feature symbols, and the site summary symbols are explained in the map legend. On the site summary symbols it should be noted that 'NFC' stands for No Fish Captured, and 'NS' stands for Not Sampled. For stream sites classified as having no visible channel (NVC), there is no sampling summary information presented (the numerator of the reach summary symbol is left blank). There is no sampling summary information presented because where no visible channel exists, sampling is generally not an option.

4. RESULTS AND DISCUSSION

4.1 Achievement of Project Objectives

A total of 60 stream sites were selected for sampling, as identified in the planning report. During the field work completed on August 24-26th, 2005 a total of 62 sites were surveyed. Table 3 provides a breakdown of the sites sampled within the planning area.

Table 3. Number of sample sites identified within the Fox River Watershed Group (Part II) planning area, and the total number of sites (including fish only sites) actually completed during the field program (in brackets).

Basin #	Description	Total # of Sites	Stream Order
I	Weissener Creek	6 (9)	1st to 5th
II	Tributary to Weissener Lake WSC: 239-350100-3400-32600-1730	3 (3)	2nd to 4th
III	Joe Poole Creek	4 (4)	1st to 4th
IV	Warneford River	12 (15)	1st to 5th
V	Chesterfield Creek	4 (4)	1st to 4th
VI	upper Kwadacha River	17 (13)	1st to 5th
VII	Tributary to the Kwadacha River WSC: 239-333700-59700	3 (3)	2nd to 4th
VIII	Tributary to the Kwadacha River WSC: 239-333700-57800	3 (3)	2nd to 4th
IX	Tributary to the Kwadacha River WSC: 239-333700-75400-02200	2 (3)	1st, 4th
X	Headwaters of the Kwadacha River	2 (1)	3rd, 4th
XI	North Kwadacha River	4 (4)	1st to 3rd

4.2 Logistics

4.2.1 Problems Encountered

Problems encountered during the overview inventory included:

- Difficulty finding helicopter landing sites in certain portions of the study area (usually the result of snags and a thick shrub layer due to previous forest fires). It was very rare that a landing site could not be found at the primary site, but in a couple of instances sites had to be relocated within the same basin.
- Large channel spanning log jams on the Kwadacha River near the confluence with the Warneford River, and the lower end of the Warneford River prevented raft access to several planned sites. The distribution of sites sampled by the raft had to be modified in the field, which resulted in a couple of less sites being completed in the lower sections of the Warneford and the Kwadacha Rivers.
- Three planned sites were dropped above the falls on the Kwadacha River (one was subsequently replaced with a fish-only sample site). The presence of bull trout above the falls on the Kwadacha River had been confirmed at two separate sites, and sites

further up the watershed were dropped and reassigned to other areas (*e.g.* Haworth Lake basin to confirm the absence of fish).

- Although budgeted helicopter hours were thought to be more than adequate at the planning stage, it became apparent during the field program that very efficient use of the helicopter would be necessary to stay within the 25 budgeted hours. Overflight video was completed on an opportunistic basis, with no real opportunity to investigate portions of the study area where stream sites were not located.
- The raft crew encountered problems with their electrofisher at Site 36 (a small tributary to the Warneford River), due to a broken anode. The site was completed without conducting electrofishing, while the anode was being repaired. The repaired anode was sufficient to complete the remainder of scheduled sites.

4.2.2 Weather

Weather conditions encountered during the field phase were ideal for completion of the work. Water temperatures were moderate and ranged between 4° and 15°C. Skies were clear for two of the three field days, and cloud cover on the third day did not limit helicopter access to any of the sites.

4.3 Fish Above 20%

None of the surveyed streams were found to have reach gradients that exceeded 20% and therefore no fish were captured above that gradient. In two instances, isolated populations of fish were documented upstream of features (*i.e.* falls) that had gradients in excess of 20%. These sites included:

- Rainbow trout captured in the headwaters of Weissener Creek (Site 59), upstream of a 10 m high falls.
- Bull trout captured in the headwaters of the Kwadacha River (Site 26), upstream of the falls on the mainstem Kwadacha River.

4.4 Key sport fish species

Based on existing information, key or target fish species within the watershed included bull trout, mountain whitefish, pygmy whitefish, and rainbow trout. Although records of Arctic grayling did not exist for the study area, the distribution and abundance of the species in the study area was a key objective identified by the Ministry of Environment.

It should be noted that although lake whitefish and lake trout have been documented in the study area, their life history is such that they are likely limited to lakes (and therefore not a target species for stream surveys). Each of the key species were captured during the field portion of the project, along with burbot, slimy sculpin, lake chub, longnose sucker, and white sucker. Following is a brief summary of Arctic grayling, bull trout, and pygmy whitefish habitat requirements, knowledge of which is important for understanding the observed fish distributions and habitat limitations reported in the results.

4.4.1 Arctic grayling

Ideal Arctic grayling rearing habitat can be characterized by cold, clear water with abundant pools and riffles and small boulder and gravel substrates with little silt (Ford *et al.* 1995). Arctic grayling fry show a preference to boulder and cobble substrates located in areas that have adequate cover for concealment. Juveniles prefer current velocities of <0.5 m/s and water depths of <50 cm, while adults prefer current velocities of 0.2-0.8 m/s and depths of <10 m (Ford *et al.* 1995).

Gravel is the preferred spawning substrate although a proportion of sand (<15-20%) is found in many spawning grounds (Scott and Crossman 1973). No nest is built, but mating is accompanied by vigorous vibrating that can disturb bottom substrates and bury the eggs under 1-3 cm of gravel. Preferred spawning current velocities are in the range of 0.3 – 1.5 m/s (Ford *et al.* 1995).

Overwintering for adults generally occurs in large rivers and lakes. Water temperature is the driving force for the timing of overwintering migration, with fish moving downstream to larger, deeper mainstem sites as freeze-up or dewatering occurs (Ford *et al.* 1995). Alternatively, juvenile usage of smaller systems and impounded areas for overwintering is becoming increasingly evident in the Region (Pers. Comm. – Brendan Anderson, MOE). Additional information pertaining to Arctic grayling can be found in Ford *et al.* (1995) and Scott and Crossman (1973).

4.4.2 Bull Trout

Cover has been identified as the most important variable affecting bull trout juvenile densities during their stream resident years. It has been found that juvenile bull trout usually associate with complex forms of cover and high stream channel complexity (Baxter and McPhail 1996). Fry and juveniles have also been found to prefer large diameter substrate, probably due to its ability to provide cover and refuge from predators and fast currents (Baxter and McPhail 1996).

Bull trout populations spawn in flowing water and apparently avoid spawning in large rivers, instead preferring sites in smaller streams (Baxter and McPhail 1996). Bull trout tend to occupy headwater reaches of mountainous watersheds where they are typically the only species present. Cover associated with instream velocity breaks has been found to be an important attribute in spawning tributaries (Baxter and McPhail 1996).

Some populations of bull trout are known to make long distance migrations to and from spawning areas. One study in the Peace River region found the largest range in seasonal movement to be 275 km (Burrows, Euchner and Baccante 2001).

The typically low densities of bull trout, low reproductive capacity, susceptibility to angling pressure and sensitivity to changes in water quality support the provincial listing bull trout as a vulnerable (blue-listed) species. The increased awareness of declining populations of bull trout has led to increased levels of inventory, research and management considerations, which are an indication that increased protection (where possible) may be forthcoming.

4.4.3 Pygmy whitefish

Pygmy whitefish are small (typical size of 65 – 260 mm), slim whitefish with a cylindrical body and blunt snout. Pygmy whitefish have a discontinuous distribution within British Columbia, occurring in portions of the Fraser, Skeena, Peace and Liard River systems.

Pygmy whitefish appear to occur in two distinct habitats: the bottom of deep cold lakes, and in fast cold rivers (Mackay 2000). Spawning occurs in fall (October - December). The misidentification of pygmy whitefish can easily occur, as they resemble juvenile mountain or round whitefish. Their known distribution is still being revised as 1) they are easily misidentified, and 2) often not appropriately sampled for in lakes (a small mesh sinking gill net set at the bottom a lake has been the most successful method of capturing the species (Mackay 2000)).

4.5 Summary of Biophysical Information

Fish habitat values are influenced by several primary physical characteristics of watercourses including gradient, channel confinement, side slope length and angle, streambed substrates, and channel morphology. In addition to physical characteristic, biological parameters such as riparian and instream vegetation, large woody debris and aquatic invertebrate production have been shown to influence fish habitat.

The physical characteristics of watercourses within the watershed are strongly influenced by the terrain, which is representative of the Northern Rocky Mountain ecoregion. This ecoregion consists of steep mountain ranges separated by broad lowland sections with meandering rivers and streams and abundant wetlands. The longitudinal profile of tributary streams in this region typically start with low to moderate gradients and a lack of confinement in the alpine-plateau headwater portion followed by a section of steep, confined channel on the valley wall of the mainstem before once again exhibiting a decrease in gradient and confinement on the valley floor. This trend was consistent with the gradients encountered in the study area where the majority of sites on smaller tributaries were located either on the valley floor of the larger rivers (*e.g.* Weissener Creek, or the Warneford River) or on the alpine plateaus. Access to the steeper, valley-wall region between these two areas was limited due to lack of landing sites. The average gradient of all sites surveyed in the watershed was 3.7% with a range of 0% to 18% recorded at individual sites.

Riffle-pool morphology was the dominant channel morphology encountered within the planning area, and was assigned to 69% (37/54) of stream sites. The remaining stream sites were either assessed as cascade-pool (n=12) or as having a large channel morphology (n=1). As a result of the low to moderate gradient reaches found throughout the majority of the watershed, step-pool morphologies were not applied to any of the stream sites. This category is often applied to small channels with moderate to steep gradients where functional large woody debris or boulders results in a stepped or uneven longitudinal profile.

Cobble was the most common substrate within the watershed, assessed as the dominant substrate at 44% of the stream sites. Gravel substrates were the dominant substrate in 40% of the stream sites, fines were assessed as being dominant at 14% of the stream sites, and boulders were the dominant substrate at one site (2%). Bedrock was not assessed as being the dominant substrate at any of the sites surveyed.

Approximately 37% of the stream sites were occasionally confined, with the remainder unconfined (35%) or frequently confined (27%). Only one site (Site 37) was assessed as being confined, as bedrock walls were prevalent along this section of the Warneford River. There were no sites assessed as being entrenched. The majority (63%) of stream sites were considered decoupled from the hillslopes, with the remaining sites considered partially coupled (31%) or coupled (6%).

A wide range of riparian vegetation types was encountered in the planning area. Coniferous species were the most common riparian vegetation type, prevalent along 61% of the surveyed stream banks. Shrub vegetation was dominant along 29% of the surveyed stream banks. Remaining vegetation types included mixed coniferous/deciduous tree species (10%) and a lack of riparian vegetation was noted along the left bank of a side-channel site (Site 3) on the mainstem of the Kwadacha River.

Conductivity measurements in the study area averaged 332 µS/cm (range 140 - 700 µS/cm), and were suitable for electrofishing. The average pH for the area was 8.4 (range 7.8 – 8.9), and all measurements were found to be within the range of 6.5 - 9.0, which is considered to have no fisheries impacts (Province of British Columbia 1998).

Beaver activity was low throughout the majority of the study area, with no beaver dams featured, and no beaver dams indicated as disturbance indicators on any of the site cards. Beaver dams may be more prevalent in some of the wetlands not targeted by the stream sampling program.

4.6 Distribution of Fish and Fish Habitat

A total of 416 fish of 10 different species (including one lake trout angled from a lake) were captured during stream surveys in the study area by the use of electrofishing, angling, minnow trapping and pole seining. Arctic grayling, bull trout, burbot, lake trout, pygmy whitefish, mountain whitefish and rainbow trout were the species of sport fish captured within the planning area. Table 4 provides a breakdown of the total catch by species within the planning area captured during stream surveys (lake survey results can be found in Triton 2006).

Table 4. Fish species captured during stream surveys in the study area.

Species (Scientific name)	**# captured (% of total catch)**	**# of sites (% of fish-bearing sites, n=36)**
Arctic grayling (*Thymallus arcticus*)	1 (0.2%)	1 (3%)
bull trout (*Salvelinus confluentus*)	57 (13.7%)	22 (61%)
burbot (*Lota lota*)	8 (1.9%)	3 (8%)
lake chub (*Couesius plumbeus*)	4 (1.0%)	3 (8%)
lake trout (*Salvelinus namaycush*)	1 (0.2%)	1 (3%)
longnose sucker (*Catostomus catostomus*)	6 (1.4%)	2 (6%)
mountain whitefish (*Prosopium williamsoni*)	153 (36.8%)	17 (47%)
pygmy whitefish (*Prosopium coulteri*)	46 (11.1%)	5 (14%)
rainbow trout (*Oncorhynchus mykiss*)	40 (9.6%)	11 (31%)
slimy sculpin (*Cottus cognatus*)	100 (24.0%)	21 (58%)
Total	416 (100%)	NA

The primary sampling method was electrofishing, which was conducted at a total of 57 stream sites with a total cumulative effort of 27,305 seconds, and an average effort of 479 seconds per site. This was the most effective method of sampling the majority of the stream sites, particularly those with narrow channels and low discharge volume. However, due to the frequency of sites with large channel widths and deep pool habitat, alternative sampling methods were relied upon as well. Angling was conducted at 21 sites for a cumulative effort of 10.9 hours and an average effort of 0.5 hours per site. Seining (either pole or beach) was conducted at 7 sites for a total of 10 passes with an average pass length of 14 m. Minnow traps were employed by the raft crew at two sites (Site 37, Site 6), and left to soak overnight. Four minnow traps were set per night for a total minnow trapping sample effort of 87.9 hours, and an average of 44 minnow trap hours per site.

Although numerous beach seining locations were suggested during the pre-field planning stage based on orthophoto and TRIM interpretation, only one site was found to have suitable conditions in the field. Typical limitations that made beach seining unpractical included: uneven channel bed conditions (*e.g.* due to excessive woody debris accumulations and/or excessively coarse channel bed substrates), steep channel drop-offs and excessive water velocities.

It is thought that the fish species captured with the employed capture techniques accurately reflects the species composition of the study area. Specifically, the mix of low and moderate gradient streams and the abundance of sites with good habitat complexity would favour sport-fish. Therefore, it is reasonable to accept the results of the fish sampling in which sport fish make up the larger proportion (73%) of the total fish captured within the watershed. Wetland and ponded portion of the watershed (generally not targeted by sampling) likely would have a larger proportion of coarse fish.

Arctic grayling, bull trout, burbot, lake trout, mountain whitefish, pygmy whitefish, and rainbow trout were the species of sport fish captured in the study area, representing 73% of the total number of fish captured during stream surveys. Only three species of non-sport fish were captured within the planning area. Of these, slimy sculpin were both the most abundant (representing 24% of the captured fish) and the most common (being present at 58% of the sites where fish were captured). Longnose sucker were the next most abundant non-sport species (representing 1.4% of the captured fish), and lake chub were the least abundant non-sport species (representing 1.0% of the captured fish).

4.7 Fish Age, Size and Life History

Bull trout captured at stream sites in the watershed (n = 57) ranged in size from 41 – 264 mm in fork length, with an average fork length of 110 ± 41 mm (Figure 2). From the results of the data collected it is apparent that both adult and juvenile size classes are present and make use of the abundant cobble dominated stream habitats found throughout the watershed.

Age analysis of fin rays indicates that the bull trout captured in streams ranged from 1 - 3 years of age, while bull trout captured during the lake survey ranged from 4 – 5 years of age. Figure 4 provides length-at-age data for bull trout captured in the study area, as well as several other systems for comparison. Age 1 and 2 bull trout captured in streams seem to have similar growth characteristics to the Fox River watershed group (Part I), and the Gataga population (northern systems). Age 3 bull trout appear to be intermediate in length between the Gataga stream and lake fish. The age 4 bull trout (n=1, captured during the lake survey) appears significantly longer at age compared to age 4 bull trout (n=2) captured in streams as part of the Fox River watershed group (Part I) study. This seems reasonable as lakes are typically warmer, have a higher productivity, which generally results in larger fish at a specific age compared to cooler, less productive streams. As would be expected, the bull trout captured in the study area are slower growing than southern lake/reservoir populations shown on the figure (*e.g.* Arrow Lake).

A total of 153 mountain whitefish were captured in the watershed ranging in size from 41 – 357 mm with an average size of 132 ± 64 mm. Age analysis of scales indicates that the mountain whitefish captured in streams were up to nine years of age, while mountain whitefish captured during the lake survey were up to ten years of age (Figure 5). The majority of individuals captured by electrofishing during the stream surveys are considered juveniles, with the observation of adults generally limited to the mainstems of Weissener Creek, and the Warneford and Kwadacha rivers. It is therefore assumed that smaller stream habitats and larger river margins in the watershed are used predominantly as rearing habitat for juveniles with adults showing a preference for lake habitats or the mid-channels of larger rivers/streams that were not easily or effectively sampled.

A total of 40 rainbow trout were captured in the watershed ranging in size from 23 – 242 mm with an average size of 95 ± 56 mm. Age analysis of scales indicates that the rainbow trout captured in streams ranged from 0 - 4 years of age, while rainbow trout captured during the lake survey ranged from 3 – 5 years of age (Figure 5). From the results of the data collected it is apparent that both adult and juvenile size classes are present and make use of the stream habitats in the Weissener Creek and Warneford River watersheds, but appear to be absent (or at low densities) in the Kwadacha River watershed upstream of the Warneford River. It is likely that larger adult fish are limited to the larger mainstems and the occasional lake in the watershed. For a discussion of rainbow trout captured during the secondary lake survey, please refer to that lake report (Triton 2006).

A total of 46 pygmy whitefish ranging in size from 30 – 147 mm, with an average size of 58 ± 33 mm, were captured at five locations in the watershed. Age analysis of scales indicates that the pygmy whitefish captured in the study ranged from 0 - 4 years of age. Pygmy whitefish were only captured in the mainstem of the Kwadacha River downstream of the mainstem falls (located near the confluence of the North Kwadacha River). Within this section of the Kwadacha River, pygmy whitefish were captured in deep back-eddies and larger side channels that were directly linked to the mainstem. These habitats were characterized by moderately turbid to highly turbid water, with very slow water velocities and predominantly fine substrates (at least 90%). The water depths where pygmy whitefish were captured were at least 0.5 m, but more commonly were one meter in depth or more. The primary cover at these sites was limited to the deep, turbid water and structural complexity was often minimal or completely absent (large woody debris was sometimes present but did not appear to be a driving factor for pygmy whitefish presence).

Based on the habitats at pygmy whitefish capture sites and the relative abundance of fish at each site, it is likely that the total abundance of fluvial pygmy whitefish is limited by the availability of suitable habitat. Large, deep, slow-flowing backchannel habitats were uncommon in the surveyed section of the river and while more frequent, deep backeddy habitats with slow water velocity were often small in area and often did not produce pygmy whitefish. It is also notable that young-of-year were only captured at one side channel site that provided a relatively large area of water with greater depth and very little velocity, therefore it is possible that juvenile survivorship is limited by the availability of suitable rearing habitat, which would appear to be a subset of the habitats utilized by adults. Pygmy whitefish have previously been described to inhabit cold deep lakes, and cold fast rivers (see section 4.4.3), although they were never captured in fast water during this study. They were also never found in water that was less than 0.5 m in depth. Their known distribution within the study area includes Weissener and Quentin lakes, and the mainstem of the Kwadacha River downstream of the falls (near the confluence with the North Kwadacha River).

Other sport fish species captured during stream surveys in the planning area included burbot (n = 8), which ranged in total length from 147 to 227 mm, one 52 mm Arctic grayling captured in the Warneford River and one 520 mm lake trout captured in Weissener Lake at the mouth of a sampled stream (Figure 2).

Slimy sculpin were the most abundant non-sport fish in the planning area (n = 100), ranging in total length from 29 - 101 mm with an average total length of 62 ± 17 mm. No fry (< 25 mm) were captured, and juveniles (25 - 60 mm) and adults (> 60 mm) were equally common. Additional non-sport species captured during stream surveys in the planning area included longnose sucker (n = 6) and lake chub (n = 4). A size frequency histogram for each of the species of non-sport fish is shown in Figure 3.

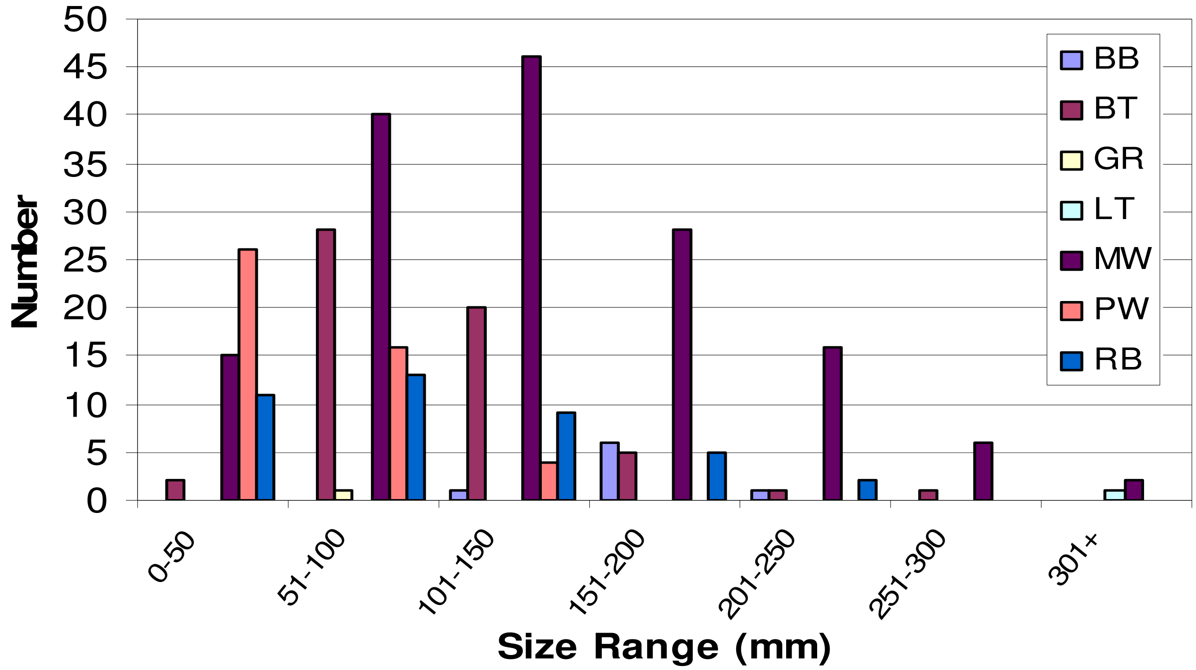

Figure 2. Size frequency histogram for burbot (BB), bull trout (BT), Arctic grayling (GR), lake trout (LT[3]), mountain whitefish (MW), pygmy whitefish (PW) and rainbow trout (RB) captured during stream surveys in the Fox River planning area.

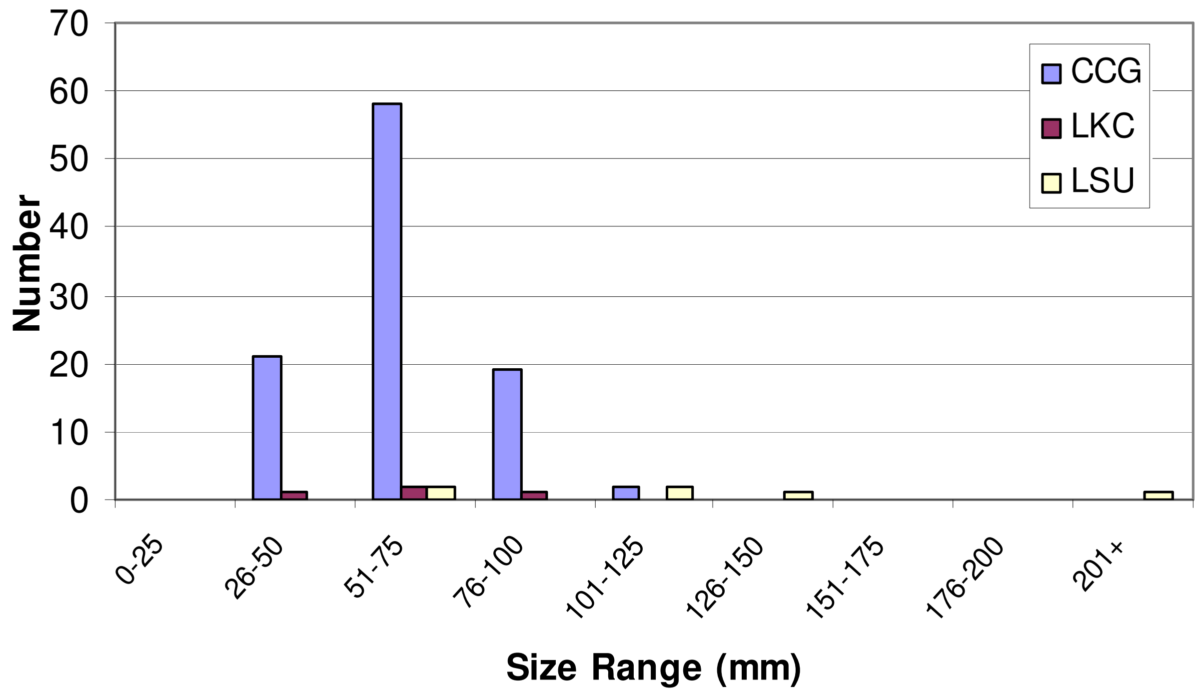

Figure 3. Size frequency histogram for slimy sculpin (CCG), lake chub (LKC), and longnose sucker (LSU), captured in streams in the study area.

[3] Note the lake trout was captured in Weissener Lake at the mouth of a stream sampled during the stream sampling program.

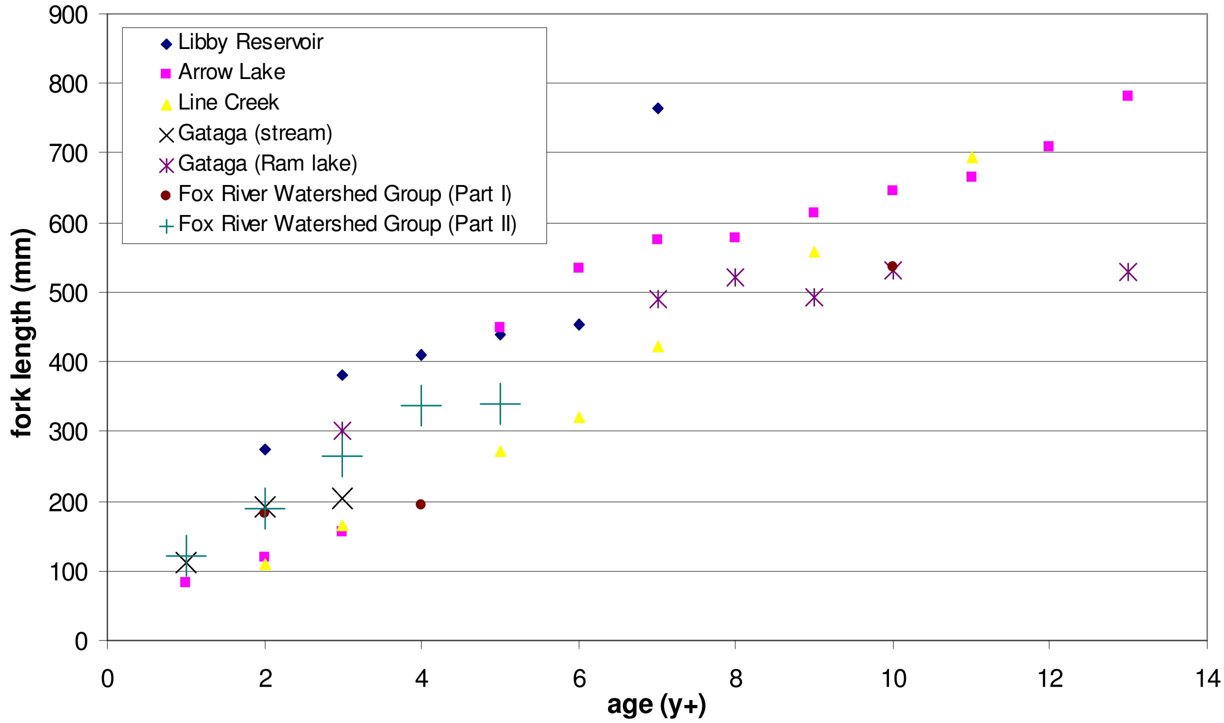

Figure 4. Mean length-at-age for bull trout from various locations, including the Fox River watershed group (Part II; n=15). Data from the Fox River watershed group (Part I) are taken from Triton 2005. Data from the Gataga River watershed are taken from Triton 2004. Data from the Libby Reservoir (Montana), Arrow Lake (southeast BC) and Line Creek (upper Clearwater River, Alberta) are taken from Table 9 in Ford *et al.* (1995).

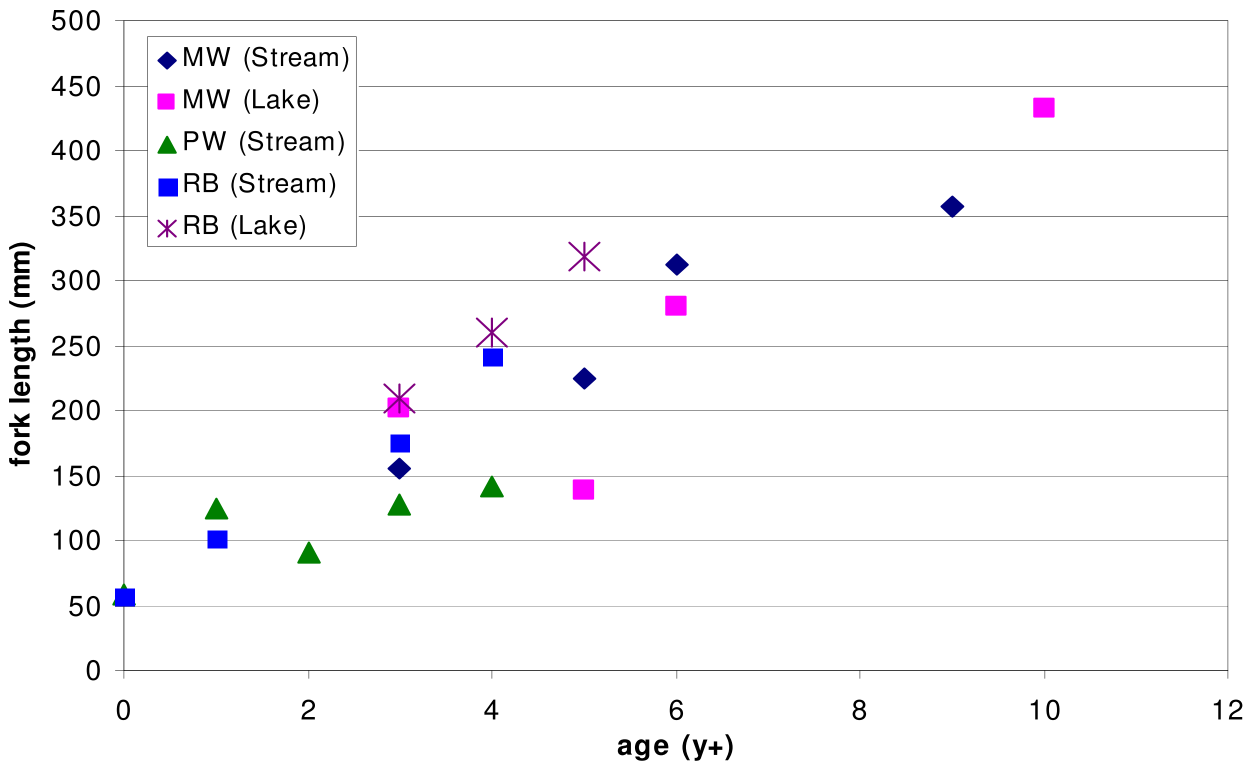

Figure 5. Mean length-at-age for mountain whitefish, pygmy whitefish and rainbow trout captured in streams and during the lake survey.

4.8 Significant Features and Fisheries Observations

A total of 11 features associated with sites were identified during field surveys within the planning area including 2 cascades, 7 falls, and 2 debris jams (Table 5).

Table 5. Identified features within the Fox River planning area.

Watershed Code	Site	Type	Field UTM Zone	Field UTM Easting	Field UTM Northing	Description
239-333700-59700-41000	18	C	10	379016	6391013	1.2 m high by 5 m long cascade located at the confluence.
239-333700-26500	47	C	10	368041	6420650	25 m high by 50 m long impassable velocity barrier.
239-333700-63500-10900	21	F	10	385598	6389329	0.4 m high bed drop located 37 m upstream from confluence. Semi-permanent, likely only a barrier to smaller juveniles.
239-333700-59700-37500	17	F	10	377882	6391173	6 m high falls that is a barrier to upstream fish migration. Dimensions estimated from helicopter.
239-333700-63500	22	F	10	384481	6392281	15 m high falls (dimensions estimated from the helicopter).
239-333700	24	F	10	383840	6386069	10 m + high, two-step falls. Barrier to upstream fish migration, although BT captured upstream.
239-333700-26500	47	F	10	367905	6420660	10 m high falls observed 600 m upstream of site from helicopter.
239-333700-26500-44200	43	F	10	370561	6405716	Haworth Falls. Approximately 30 m in height. Dimensions estimated from the helicopter.
239-350100-34000-32600	59	F	10	356507	6423128	10 m high falls. Barrier to upstream fish migration.
239-333700-26500-44200	43	X	10	369851	6405185	20 m long log jam along right margin. Typical of reach.
239-333700	8	X	10	370133	6390469	80 m long log jam along left margin of river.

C = cascade F = falls X = debris jam

4.8.1 Fish and Fish Habitat

There were 54 sites surveyed (*i.e.* excluding fish-only sites), 52 of which were recognized as streams (*i.e.* excluding 2 sites with no visible channel). The data collected demonstrates the occurrence, relative abundance and distribution of fish species that are common to the study area. Definitive limits of sport fish are unknown for most streams within the watershed. Limits of fish distribution on tributary streams are likely associated with permanent gradient related barriers (*e.g.* long cascades or bedrock falls) as the tributaries extend down the valley walls of the larger watercourses. The confirmation of fish distribution within all streams is limited by the fact that many streams are not selected for sampling as intensive sampling is outside the scope of an overview inventory, and would be prohibitively expensive.

Fish habitat assessment for sport fish in general were completed at the surveyed stream sites. The majority of reaches within the planning area were assessed as having moderate rearing habitat values, low spawning habitat values and limited overwintering (Table 6).

Table 6. Assessed sport fish (general) habitat values at stream sites within the study area.

	Number of Reaches		
Habitat Quality	**Rearing**	**Spawning**	**Overwintering**
High (abundant for overwintering)	5	0	2
Moderate – High	3	1	0
Moderate	30	9	9
Low – Moderate	4	5	0
Poor – Low (limited for overwintering)	10	21	19
None	0	16	22

Bull trout habitats were found throughout the study area, and bull trout were the most widely distributed species. High-value bull trout rearing habitat is typically associated with abundant cover, good channel complexity, riffle-pool or cascade-pool morphology and gravel, cobble or boulder substrates. Such habitat values were typical of intermediate reaches of major tributaries within the watershed. Where captured, bull trout occurred at low densities (usually only a couple per site). The highest densities of bull trout occurred on the North Kwadacha River downstream of the falls (Site 20), and a third order tributary to the Kwadacha River (WSC 239-333700-57800, Site 15, Sub-basin VIII). At Site 15, eight bull trout were captured during 556 seconds of electrofishing, and at Site 20, eight bull trout were captured during 646 seconds of electrofishing.

Similar to bull trout, rainbow trout were found within both mainstem and tributary streams. However, the distribution of rainbow trout appears to be limited to the Weissener Creek watershed and the Warneford River watershed. Rainbow trout were noticeably absent at sites completed in the Kwadacha River, including larger tributaries to the Kwadacha River (*e.g.* North Kwadacha River, Sub-basin VII, Sub-basin VIII, Sub-basin IX). The highest density of rainbow trout occurred in the mainstem of Weissener Creek (Site 49) where 8 fry/parr were captured using electrofishing and pole seining and one larger (170 mm) individual was visually observed.

Contrary to both rainbow trout and bull trout, Arctic grayling habitats within the watershed appear to be limited to the mainstem Warneford River in the vicinity of Quentin Lake (Site 45, the only location where Artic grayling were captured within the study area). High-value Arctic grayling rearing habitat is typically associated with abundant cover, good channel complexity, riffle-pool morphology and gravel substrates. The value of the Arctic grayling rearing habitat tends to degrade towards the headwaters of tributaries in a watershed such as the Warneford River as gradient increased and morphology changed from riffle-pool to cascade-pool.

Spawning habitat for sport fish within the watershed area followed the same general trend as that of rearing habitat discussed previously. Appropriate spawning habitat for Arctic grayling and mountain whitefish is likely limited to the mainstems of the larger systems. Bull trout and rainbow trout spawning habitat is characterized by riffle-pool morphology and gravel substrate, conditions that are widely distributed throughout the planning area. Typically, poor or low quality spawning habitat was the result of inappropriate substrates (*e.g.* cobbles or fines) or if gravels were present they were compacted with fines or angular in shape (therefore lacking interstitial spaces). Another common reason of for a site being assessed as having poor or low quality spawning habitat occurred in smaller streams where there was insufficient discharge volume to provide access or cover for adult fish.

A range in overwintering habitat availability was observed within the planning area. Abundant overwintering habitat was assessed as being present at two sites (Site 24 – Kwadacha River, and Site 37 – Warneford River) within the watershed. Moderate overwintering habitat was assessed to be present at nine sites, typically associated with deep pools or glides in the larger mainstems. Additional abundant amounts of overwintering habitat is present in the numerous lakes within the study area. Overwintering habitat was most often assessed poor or limited, resulting from the shallow average water depth and lack of significant pools observed in most of the smaller tributaries. A total of 22 sites were found to have no potential overwintering habitat due to a lack of deep pools and generally low discharge volume.

4.8.1.1 Water Quality and fish distribution

As access for fish between major systems in the Kwadacha River downstream of the falls is not an issue, another factor must be the cause of the observed fish distributions. In general, the available habitats and stream flows are comparable between watersheds, however the influence of glacial runoff on water quality differs between the Warneford River and Kwadacha River above their confluence. In particular, the effects on water temperature and turbidity are notably different between the Warneford River, North Kwadacha River, and Kwadacha River mainstem between the two confluences. The North Kwadacha River was the coldest and most turbid, followed by the Kwadacha and Warneford rivers, respectively.

There are several notable observations with respect to fish species distribution and relative abundance that may be in part, related to water temperature and turbidity. In particular, Arctic grayling and rainbow trout were not captured in the Kwadacha River watershed above the confluence with the Warneford River, yet both species were captured in the Warneford River watershed.

Optimal temperatures for growth range between 10-14^{0}C for rainbow trout and Arctic grayling, and are reported to be less than 12^{0}C for bull trout, the latter are also known to be more tolerant of colder temperatures (Ford *et al*. 1995). Based on feeding habits, rainbow trout and Arctic grayling tend to be more surface feeders and could therefore be affected more by reduced water clarity than bull trout, where juveniles are more benthic feeders and adults are piscivorous.

4.8.2 Rare/Sensitive Species

Sensitive species identified within the planning area included the Williston Reservoir population of Arctic grayling and bull trout.

Bull trout are identified on the provincial species tracking lists (BC Ecosystem Explorer 2003). Bull trout are blue-listed[4] within the Mackenzie Forest District, and within the Province of British Columbia in general, as they are sensitive to development pressures.

Arctic grayling are identified on the provincial species tracking lists (BC Ecosystem Explorer 2003). The Williston Reservoir population are red-listed[5] within the Mackenzie Forest District, as they are sensitive to development pressures and their habitat has become effectively fragmented due to the reservoir.

4.8.3 Habitat Protection Concerns

In general, low terrain sensitivity and limited development reduces the level of concern with respect to protecting sensitive fish habitats within the watershed.

4.8.3.1 Fisheries Sensitive Zones

There were no specific Fisheries Sensitive Zones identified within the study area. However, abandoned side-channels and ox-bows are present along the length of the Kwadacha and Warneford rivers, as well as Weissener and Joe Poole creeks, and are likely seasonally accessible to fish, providing refuge habitat during high flows.

4.8.3.2 Important Habitats

Important Arctic graying habitats were not specifically identified as only one grayling was captured. Until Arctic grayling use of the study area is better understood, the Warneford River downstream of Site 47 (where a falls barrier was identified) should be considered potentially important habitat for Arctic grayling.

Important lacustrine pygmy whitefish habitat within the study area includes Weissener and Quentin lakes. There are numerous smaller lakes in the study area that have not been surveyed that may support populations of pygmy whitefish. Important fluvial pygmy whitefish habitat appears to be limited to the portion of the Kwadacha River downstream of the mainstem falls (just upstream from the confluence with the North Kwadacha River). Within this section of the Kwadacha River, pygmy whitefish were typically captured in back-eddies with slow water velocities and fine substrates.

[4] Species considered to be of Special Concern (formerly Vulnerable) in British Columbia. Blue-listed taxa are at risk, but are not Extirpated, Endangered or Threatened.

[5] Species that have or are candidates for Extirpated, Endangered, or Threatened status in British Columbia.

Bull trout are widespread throughout the study area, and no specific habitat important to the species (*i.e.* spawning grounds) was identified.

4.8.3.3 Restoration and Rehabilitation Opportunities

No restoration and rehabilitation opportunities within the watershed were identified, largely the result of the very limited development (*i.e.* the occasional hunting/trapping cabin) and lack of road network within the watershed.

4.9 Fish Bearing Status

The fish bearing status of a stream may be directly supported by sampling data or indirectly inferred based on fish captured in associated reaches, or habitat quality and the occurrence or lack of barriers to fish passage. For example, if the habitats within a given reach are suitable for rearing and/or spawning but no fish were captured and no barriers were observed, the reach would be classed as fish bearing. If the habitats were inadequate to provide suitable rearing habitat, or where barriers prevent fish from accessing and utilizing the reach, it would be considered non-fish bearing. Where supporting evidence is inconclusive, the reach would have an inferred interpretation pending additional sampling. A complete list of fish-bearing and inferred fish-bearing sites are provided in Table 7. A list of non-fish bearing sites is provided in Table 8.

4.9.1 Follow-up Sampling

As definitive stream classification for all stream sites is not an objective of the Overview program, no follow-up is required.

Should additional sampling be conducted, the timing is critical to ensure optimal conditions and maximize the potential for fish to occur. Specifically, sampling should occur immediately following peak runoff. The exact timing should be determined based on observations of conditions in the spring of the season in which sampling is scheduled to occur.

4.10 Recommendations for Future Inventory

The data collected allows an adequate overview of fish species present and abundance in the Fox River Watershed Group (Part II) study area, and the likely distribution of sport fish within the watershed. As such, additional work at the overview level is not recommended.

Due to the large size of the study area, and limited field budget, there are a couple of specific areas where general fish presence and species distribution is not known. Theses areas include:

- The headwaters of the Kwadacha River (Sub-basin X), upstream of the numerous cascades identified during the overflight completed by Terra Pro (1998).

- The headwaters of the Warneford River upstream of the falls identified at Site 47, including the numerous headwater lakes associated with the third order tributary to this section of river.

Additional future work could focus on the distribution and abundance of Artic grayling in the Warneford River downstream of the falls barrier identified at Site 47. Lake sampling to target Arctic grayling could be conducted in Quentin Lake (even though two surveys of the lake have already been completed), as an Arctic grayling was captured a couple of kilometers downstream of the lake. Mainstem sampling should focus on looking for juveniles in side-channel habitat during the day, and electrofishing at night could be employed along the river margins to capture juveniles (a technique that was successful in the Fox River watershed; Triton Environmental Consultants Ltd. 2005). Angling larger pools would likely be the most effective way of sampling for adults in the mainstem, as the glacially turbid water would severely limit the effectiveness of snorkel surveys.

Table 7. Fish-bearing and inferred fish-bearing sites within the Fox River Watershed Group (Part II) study area.

Watershed Code	Site	Average Site Gradient	Site Length (m)	Average Channel Width (m)	Fish Species	Comments
239-333700-	3	1.0	100	23.0	BT, CCG, LSU, PW	High value rearing. Excellent pygmy whitefish habitat located in calm turbid side-channel. No spawning habitat for salmonids due to dominant fine substrates. Gravels present are mixed with a high proportion of fines. Moderate overwintering habitat associated with a slow, moderately deep channel but limited by no obvious deep pools.
239-333700-	5	3.0	350	30.0	CCG, PW	Low value rearing associated with abundant discharge volume but limited by a lack of velocity refugia. No spawning habitat observed as all observed substrate are too coarse. No accumulations of appropriate spawning gravels were observed. Limited overwintering habitat. High discharge volume likely prevents freezing but limited holding areas available due to high water velocity.
239-333700-	6	N/A	N/A	N/A	CCG, MW	Fish-only site completed on the Kwadacha River.
239-333700-35300-	7	5.2	140	1.9	BT	Moderate rearing habitat associated with moderate cover provided by undercut banks, and LWD. Low spawning habitat values - limited by infrequent accumulations of appropriate gravels. No overwintering habitat as pools are too shallow.
239-333700-	8	1.8	250	56.1	BT, CCG, MW, PW	Moderate rearing associated with moderate cover and abundant functional LWD. Side channels have high rearing habitat values for juvenile MW. Moderate overwintering associated with the mainstem Kwadacha River. No distinct pools were noted, but channel depth is adequate for overwintering. Moderate spawning values, mainly associated with side channels (mainstem substrates are typically too large) and gravel accumulations at log jams.
239-333700-	9	N/A	N/A	N/A	BT, CCG, MW, PW	Fish-only site completed on the Kwadacha River.
239-333700-32300-	10	7.7	210	1.3	NFC	Low rearing habitat values due to almost no cover other than some overhanging vegetation and almost entirely riffle habitat (no holding pools). No spawning habitat due to all gravels being angular and compact and extensive riffle habitat which provides no holding areas for adults. No overwintering habitat as no significant pools are present and stream has shallow average water depth overall.
239-333700-	12	N/A	N/A	N/A	BT, CCG, MW, PW	Fish-only site completed on the Kwadacha River.
239-333700-57800-	13	2.5	145	8.0	BT, CCG	Low - moderate rearing habitat for bull trout - limited by trace cover and generally low channel complexity. Low spawning habitat limited by a lack of significant holding pools. Gravels that are present are mixed with large cobbles. Additionally, the channel bed is compacted with fines. No overwintering habitat as all pools are too shallow. It is likely limited overwintering habitat is available elsewhere in the reach. Abundant overwintering habitat is available downstream in the Kwadacha River.

Watershed Code	Site	Average Site Gradient	Site Length (m)	Average Channel Width (m)	Fish Species	Comments
239-333700-57800-13600-2410-	14	3.5	150	1.7	NFC	Moderate rearing habitat associated with moderate cover, good flow and moderate habitat diversity. Low spawning habitat due to lack of adequate accumulations of gravels without abundant fines. Limited overwintering as pools of adequate depth are rare.
239-333700-57800-	15	3.5	140	7.9	BT	Moderate rearing habitat associated with moderate cover and good channel complexity. Low spawning habitat values as gravel present are angular and channel substrates are compacted with fines. Limited overwintering habitat associated with the occasional pool with sufficient depth.
239-333700-59700-	16	4.3	200	5.7	BT, CCG, MW	High rearing habitat values associated with abundant cover from LWD, pools and boulders. No spawning habitat as all available substrates are too coarse. No appropriate accumulations of gravels were observed. Limited overwintering associated with occasional pool that may have sufficient depth.
239-333700-59700-37500-	17	7.5	140	3.6	NFC	Moderate rearing associated with abundant cover but limited by a lack of significant pools. Low spawning habitat associated with lack of significant holding pools for adults. Gravels present are very angular and steam channel substrates are compacted. No overwintering habitat as all pools were too shallow.
239-333700-59700-41000-	18	15.0	150	1.6	NFC	Low - moderate rearing habitat values associated with moderate cover, but limited by steep gradient and high water velocities with no significant holding pools. Low spawning habitat values - limited by a lack of appropriate accumulations of gravels, high water velocities, and a lack of significant holding pools for adults. No overwintering habitat- pools too shallow.
239-333700-	19	2.3	350	30.3	BT, CCG, MW	Moderate rearing habitat associated with abundant discharge, good holding in occasional eddies but limited by low LWD and lack of complex cover. Low spawning habitat values - most substrates are coarse, however some suitable gravel pockets may exist within reach. Moderate overwintering habitat as high discharge likely maintains quality, unfrozen habitat but no good deep overwintering pools in section surveyed.
239-333700-63500-	20	2.5	150	15.1	BT	Low-moderate rearing limited by high velocity and lack of cover. Low spawning due to lack of gravel accumulations and compaction of most gravels present. Limited overwintering habitat as most pools are too shallow.
239-333700-63500-10900-	21	11.0	104	1.1	BT	Low rearing habitat values - limited by narrow channel width, and lack of significant pools. Available rearing habitat is associated with moderate cover. Low spawning due to lack of appropriate accumulations of gravels and a lack of significant holding pools for adults. No overwintering habitat observed as all pools are too shallow.
239-333700-	24	2.7	475	42.7	NFC	High rearing habitat associated with abundant cover from boulders and deep pools. Low spawning habitat due to large size of substrates but a few small appropriate patches of gravels are present. Abundant overwintering habitat associated with abundant suitable pools and sufficient discharge.

Watershed Code	Site	Average Site Gradient	Site Length (m)	Average Channel Width (m)	Fish Species	Comments
239-333700-71300-	25	4.0	113	8.4	NFC	Moderate rearing habitat associated with boulder cover and pools but limited by high water velocity. No spawning habitat as substrates are dominated by cobbles and boulders. No appropriate accumulations of gravels observed. Limited overwintering due to high velocity and shallow pools.
239-333700-75400-02200-	26	3.0	400	41.7	BT	Moderate rearing habitat associated with moderate cover and gradient. Moderate spawning habitat associated with moderate gradient and the occasional patch of appropriate gravel. Limited overwintering as only occasional pools may have sufficient depth.
239-333700-75400-02200-2730-	27	5.0	120	4.0	NFC	Low rearing habitat as site lacks functional woody debris, cover and habitat complexity. No spawning habitat due to dominant cobble/boulder substrates. No overwintering habitat as all pools are too shallow. Additionally, high water velocities further limits the potential for overwintering.
239-333700-	30	3.0	400	31.8	NFC	Moderate rearing habitat associated with moderate gradient and cover. Moderate spawning associated with several appropriate accumulations of gravels. Limited overwintering associated with the occasional pool with sufficient depth.
239-333700-26500-	35	N/A	N/A	N/A	BT, CCG, MW, RB	Fish-only site on the Warneford River.
239-333700-26500-29600-	36	3.0	100	1.6	NS	Moderate rearing associated with good cover from LWD and pools. Site is overgrown with shrubs. Low - moderate spawning associated with small gravels that are generally mixed with fines. Limited overwintering habitat as only one pool with a depth greater than 0.50 m was observed in site. Low discharge volume is also limiting.
239-333700-26500-	37	1.8	430	37.2	CCG, LKC, MW, RB	High rearing value associated with good discharge, good habitat complexity and some good side-channel habitat. Moderate spawning habitat associated with many appropriate patches of useable substrate but generally limited by high water velocity. Abundant overwintering habitat associated with good discharge and occasional large pools greater than 1.0 m in depth.
239-333700-26500-38300-	38	2.0	250	16.4	MW, RB	Moderate rearing habitat associated with moderate cover and gradient. Moderate spawning habitat associated with several accumulations of appropriate gravels. However, most gravels present are compacted with fines. Limited overwintering associated with the occasional pool that may have sufficient depth.
239-333700-26500-38300-2860-	39	3.0	200	5.0	BT	Moderate rearing habitat associated with moderate gradient and abundant cover. Low spawning habitat as gravels present are flat and angular and mixed with a high proportion of fines. Limited overwintering habitat associated with the occasional pool that may have sufficient depth.
239-333700-26500-38300-6430-	40	6.0	110	1.4	NFC	Low rearing habitat values - limited by a lack of significant pools and low discharge volume. No spawning habitat due to insufficient discharge and no accumulations of appropriate gravels. No overwintering habitat observed - pools are too shallow.
239-333700-26500-38300-6630-	41	12.0	275	10.0	RB	Low rearing habitat values - limited by trace cover, high gradient and lack of sufficient pools. No spawning habitat due to no accumulations of appropriate gravels. Gravels present are angular and mixed in with large cobbles. No overwintering habitat as pools are too shallow.

Watershed Code	Site	Average Site Gradient	Site Length (m)	Average Channel Width (m)	Fish Species	Comments
239-333700-26500-41100-	42	1.8	100	0.8	NFC	Moderate rearing habitat associated with abundant quality cover but limited by small stream size and low discharge volume. No spawning habitat as substrates are 100% fines. No overwintering habitat observed as all pools are too shallow.
239-333700-26500-44200-	43	4.0	300	26.8	BT, CCG, MW	Moderate - high rearing habitat associated with moderate gradient and cover and numerous scour pools associated with LWD piles. Moderate overwintering habitat as site is a deep glide with numerous LWD scour pools. Low - moderate spawning habitat associated with the occasional patch of appropriate gravels but limited by long sections with very turbulent flows. Most gravels mixed with cobbles and boulders.
239-333700-26500-	45	1.5	170	85.5	BT, CCG, GR, LKC, MW	Moderate rearing - associated with low gradient and large discharge volume (mainstem). Rearing limited by lack of cover and low habitat complexity and diversity. Low - moderate spawning associated with good accumulations of gravels and deep runs but limited by gravel compaction and interstitial fines. Moderate overwintering habitat as deep run will provide some overwintering.
239-333700-26500-61300-	46	3.5	110	1.6	NFC	Moderate rearing associated with good flows and defined pools but limited by trace cover and low channel complexity. No spawning habitat due to dominant coarse substrates. No appropriate accumulations of gravels observed. No overwintering as all pools are too shallow.
239-350100-34000-32600-	48	2.5	300	28.8	CCG, MW	Moderate rearing habitat associated with moderate cover and gradient. Moderate - high spawning associated with abundant clean gravels or appropriate size and numerous holding pools for adults. Moderate overwintering associated with several pool and glides with sufficient depth.
239-350100-34000-32600-	49	1.5	160	20.8	RB	Moderate rearing habitat associated with good flows but low habitat diversity and trace cover are limiting factors. Moderate spawning habitat associated with good accumulations of gravels but limited by compaction and interstitial fines. Moderate overwintering as most pools are too shallow and < 0.8 m, but water is greater than 1.0 m deep therefore overwintering is possible.
239-350100-34000-32600-1730-	50	4.5	150	6.9	NFC	Moderate rearing associated with moderate cover and gradient. Low spawning due to all gravels present being flat and angular. Limited overwintering associated with the occasional pool that may have sufficient depth. Abundant overwintering available downstream in Weissener Lake.
239-350100-34000-32600-1730-5770-	51	2.5	110	1.0	NFC	Moderate rearing associated with abundant cover, good flow and good habitat complexity. No spawning habitat observed. No overwintering habitat as all pools too shallow.
239-350100-34000-32600-1730-	52	3.0	125	1.2	RB	Moderate rearing habitat associated with moderate cover and gradient. Low - moderate spawning associated with frequent accumulations of appropriate gravels. Limited by lack of significant pools and narrow channel widths. No overwintering habitat as all pools are too shallow. Overwintering habitat available in upstream lake.
239-350100-34000-32600-2150-1770-	53	3.5	200	2.0	NFC	Moderate rearing associated with moderate cover and flow but limited by low habitat diversity and lack of riffle-pool interchanges (low channel complexity). No spawning habitat as no appropriate gravels were present. Limited overwintering habitat as stream has very few defined pools but a deep channel that will provide limited overwintering.

Watershed Code	Site	Average Site Gradient	Site Length (m)	Average Channel Width (m)	Fish Species	Comments
239-350100-34000-32600-2150-	54	2.5	150	9.6	BB, CCG	Moderate value rearing associated with moderate cover and gradient and good channel complexity. Limited by long sections with minimal cover. Low spawning habitat values associated with abundant gravels but most are compacted with fines and are flat and angular. Limited overwintering habitat associated with several pools and glides with sufficient depth.
239-350100-34000-32600-2150-4550-161-	55	4.5	140	2.0	NFC	Moderate rearing habitat associated with moderate cover and good flows but limited by lack of habitat diversity and high water velocities. Low spawning habitat as site lacks appropriate accumulations of gravels, has high water velocity and abundant cobble substrates. Moderate rearing habitat associated with moderate cover and good flows but limited by lack of habitat diversity and high water velocities.
239-350100-34000-32600-2150-	56	4.0	150	7.1	BT, MW	Moderate rearing habitat associated with moderate cover and gradient. Low spawning habitat with no appropriate accumulations of gravels a most gravels present are mixed with large cobbles and boulders. Limited overwintering habitat associated with the occasional pool that may have sufficient depth.
239-350100-34000-32600-	58	1.5	210	18.0	BT, CCG, MW	Moderate value rearing associated with good flows and pools but limited by moderate cover and lack of habitat complexity. Low - moderate spawning associated with appropriate gravels and pools but limited by abundance of cobbles and larger substrates. Limited overwintering habitat associated with the deep channel and occasional deep pools.
239-350100-34000-32600-	59	1.5	300	8.5	RB	Low-moderate rearing limited by trace cover. Moderate spawning associated with several accumulations of appropriate gravels. However, most gravels are angular, flat and compacted with fines. Limited overwintering associated with the occasional pool with sufficient depth.
239-350100-34000-32600-7890-	60	2.5	170	10.5	NFC	Moderate rearing habitat associated with the low gradient and wide channel but limited by the lack of cover and habitat diversity. Low spawning habitat limited by cobble substrates with interstitial spaces filled with glacial fines. Moderate overwintering habitat associated with the occasional deep pool greater than 1.0 m in depth. However, such pools are infrequent.
239-350100-34000-32600-	90	N/A	N/A	N/A	LT	Fish-only site completed at Weissener Lake.
239-350100-34000-32600-2150-5520-	91	7.0	110	1.9	BT	Moderate rearing associated with moderate gradient and cover. No spawning habitat as there are no appropriate accumulations of gravels and no significant holding pools for adults. No overwintering habitat as all pools are too shallow.
239-333700-26500-38300-	95	N/A	N/A	N/A	NFC	Fish-only site completed at Chesterfield Lake.
239-333700-26500-38700-	96	4.0	110	8.2	BB, CCG, RB	Moderate-high rearing habitat associated with abundant cover and moderate gradient. Somewhat limited by lack of significant pools. Low spawning habitat with occasional patches of useable gravels. Most gravels are very angular. No overwintering habitat as all pools are too shallow. Abundant overwintering habitat is available in upstream and downstream lakes.

Watershed Code	Site	Average Site Gradient	Site Length (m)	Average Channel Width (m)	Fish Species	Comments
239-333700-26500-30500-	100	2.0	100	1.9	BT, RB	Moderate rearing associated with some nice pools and functional woody debris. Moderate spawning habitat due to several patches of suitable substrates. No overwintering habitat due too all pools being too shallow.
239-333700-26500-28500-	101	1.5	100	1.8	CCG, MW, RB	High rearing habitat associated with abundant LWD, pools and good channel depth. Moderate spawning habitat associated with numerous appropriate accumulations of gravels. Limited overwintering as some deep channel sections present despite residual pools being shallow. System is lake fed which likely maintains perennial flow.
239-333700-26500-	102	N/A	N/A	N/A	BT, CCG, MW, RB	Fish-only site completed on the Warneford River.
239-333700-75400-22000-	111	N/A	N/A	N/A	BT	Fish-only site.
239-350100-34000-32600-7890-	112	N/A	N/A	N/A	NFC	Fish-only site completed on lake upstream of Site 60.

BB – burbot
BT – bull trout
CCG – slimy sculpin
GR – Arctic grayling
LKC – lake chub
LSU – longnose sucker
MW – mountain whitefish
NFC – No fish captured
NS – Not sampled
NVC – No visible channel
PW – pygmy whitefish
RB – rainbow trout

Table 8. Potential non-fish bearing sites within the Fox River Watershed Group (Part II) study area.

Watershed Code	Site	Average Site Gradient	Site Length (m)	Average Channel Width (m)	Fish Species	Comments
239-333700-55500-	11	1.5	100	N/A	NVC	No potential fish habitat. Sampling conducted in 50 m channelized section (NFC), but remainder of site is NVC.
239-333700-63500-	22	2.0	400	30.6	NFC	A 15 m falls d/s of site prevents fish access. Insufficient sampling to confirm the absence of an isolated population of fish in the system. Moderate rearing habitat associated with moderate cover and good channel complexity. Low spawning habitat as all gravels present are mixed with high proportions of fines and large cobbles and boulders. Limited overwintering associated with occasional pools of sufficient depth. Long glide section may provide overwintering habitat.
239-333700-63500-34800-	23	4.5	125	2.7	NFC	A 15 m falls d/s of site prevents fish access. Insufficient sampling to confirm the absence of an isolated population of fish in the system. Low rearing habitat associated with abundant cover but limited by a lack of significant pools. No spawning habitat due to no accumulations of appropriate gravels and no significant holding pools for adults. No overwintering habitat as all pools are too shallow. Abundant overwintering habitat available in the lake at the upstream end of site.
239-333700-26500-44200-	44	3.0	200	13.3	NFC	Haworth Falls, located at outlet of Haworth Lake, prevents fish access upstream. Low rearing habitat - limited by trace cover, lack of significant pools and cold (unproductive) glacial water. Low spawning habitat as gravels present are mixed with large cobbles, boulders and covered with glacial silt. Most gravels are angular and flat. No overwinteirng habitat as all pools are too shallow.
239-350100-34000-32600-4680-	57	0.5	160	N/A	NVC	No potential fish habitat.
239-333700-26500-44200-7360-	92	3.5	100	0.5	NFC	Haworth Falls, located at outlet of Haworth Lake, prevents fish access upstream. Low rearing habitat due to limited discharge, narrow channel, and lack of significant pools. No spawning habitat due to insufficient discharge volume to provide habitat for adults. Also gravels present are small and mixed with fines. No overwintering habitat as all pools are too shallow.
100	93	2.0	100	2.0	NFC	Haworth Falls, located at outlet of Haworth Lake, prevents fish access upstream. Unmapped tributary to Haworth Lake. Barrier identified downstream. Low rearing associated with low discharge volume, low channel complexity and lack of significant pools. No spawning habitat values observed - no accumulations of appropriate gravels. Gravels that are present are very small and mixed with a high proportion of fines. No overwintering habitat as all pools are too shallow
239-333700-26500-44200-6080-	94	3.0	150	4.8	NFC	Haworth Falls, located at outlet of Haworth Lake, prevents fish access upstream. Moderate rearing associated with moderate gradient, abundant cover and good channel complexity. Limited by lack of significant pools. Low spawning habitat as gravels that are present are flat and angular. No overwintering habitat as all pools are too shallow.

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Appendix 1.

Voucher, genetic and aging samples data.

Appendix 1a. Voucher specimens collected within the For River Watershed Group (Part II) planning area.

Voucher #	Site	Name/WSC	Date	Crew	Species	Length (mm)	Collection Method	Comment
1	3	Kwadacha River	25-Aug	ML/JT/LB	PW	66	SN	
2	3	Kwadacha River	25-Aug	ML/JT/LB	LSU	51	SN	
3	3	Kwadacha River	25-Aug	ML/JT/LB	LSU	51	SN	
4	12	Kwadacha River	24-Aug	ML/JT	CCG	88	EF	2 operculo-madibular pores on tip of chin, no conspicuous dark spot at back of first dorsal, anal fin base not distinctly longer than head length, less than 14 anal fin rays.
5	37	Warneford River	26-Aug	ML/JT	MW	139	EF	
6	37	Warneford River	26-Aug	ML/JT	LKC	73	EF	
7	43	Haworth Creek	26-Aug	RL/NF	CCG	101	EF	2 operculo-madibular pores on tip of chin, no conspicuous dark spot at back of first dorsal, anal fin base not distinctly longer than head length, less than 14 anal fin rays.
8	45	Warneford River	25-Aug	RM/DT	MW	50	EF	
9	45	Warneford River	25-Aug	RM/DT	CCG	46	EF	2 operculo-madibular pores on tip of chin, no conspicuous dark spot at back of first dorsal, anal fin base not distinctly longer than head length, less than 14 anal fin rays.
10	45	Warneford River	25-Aug	RM/DT	CCG	80	EF	2 operculo-madibular pores on tip of chin, no conspicuous dark spot at back of first dorsal, anal fin base not distinctly longer than head length, less than 14 anal fin rays.
11	45	Warneford River	25-Aug	RM/DT	GR	52	EF	
12	45	Warneford River	25-Aug	RM/DT	LKC	54	EF	
13	47	Warneford River	25-Aug	RL/NF	LSU	116	EF	
14	47	Warneford River	25-Aug	RL/NF	LSU	130	EF	
15	47	Warneford River	25-Aug	RL/NF	LKC	88	EF	
16	48	Weissener Creek	25-Aug	RL/NF	MW	201	EF	
17	49	Weissener Creek	25-Aug	RM/DT	RB	43	EF	
18	52	239-350100-34000-32600-1730-	25-Aug	RL/NF	RB	145	EF	

Voucher #	Site	Name/WSC	Date	Crew	Species	Length (mm)	Collection Method	Comment
19	52	239-350100-34000-32600-1730-	25-Aug	NF/RL	RB	101	EF	
20	54	239-350100-34000-32600-2150-	25-Aug	NF/RL	BB	227	EF	
21	101	239-333700-26500-28500-	26-Aug	JT/ML	RB	64	EF	
22	101	239-333700-26500-28500-	26-Aug	JT/ML	RB	83	EF	
23	101	239-333700-26500-28500-	26-Aug	JT/ML	MW	50	EF	
24	101	239-333700-26500-28500-	26-Aug	JT/ML	CCG	49	EF	2 operculo-madibular pores on tip of chin, no conspicuous dark spot at back of first dorsal, anal fin base not distinctly longer than head length, less than 14 anal fin rays.
25	113	Lake Survey	26-Aug	DT/RM/LB/TL	BB	221	GN	
26	113	Lake Survey	26-Aug	DT/RM/LB/TL	WSU	121	MT	
27	3	Kwadacha River	25-Aug	JT/ML	PW	62	SN	

Appendix 1b. Genetic samples collected within the For River Watershed Group (Part II) planning area.

Sample #	Site #	Species	Fish Length	Comments
507	3	PW	32	Vouchered whole fish
508	3	PW	39	Vouchered whole fish
509	3	PW	35	Vouchered whole fish
510	3	BT	178	Adipose Fin
511	3	PW	36	Vouchered whole fish
512	3	PW	38	Vouchered whole fish
513	3	PW	32	Vouchered whole fish
514	3	PW	136	Adipose Fin.
515	3	PW	66	Caudal Fin.
516	3	PW	96	Caudal Fin.
517	3	PW	35	Vouchered whole fish
518	3	PW	38	Vouchered whole fish
519	3	PW	97	Caudal Fin.
520	3	PW	32	Vouchered whole fish
521	3	PW	35	Vouchered whole fish
522	3	PW	40	Vouchered whole fish
523	3	PW	33	Vouchered whole fish
524	3	PW	58	Pelvic Fin
525	3	PW	33	Vouchered whole fish
526	3	PW	39	Vouchered whole fish
527	3	PW	38	Vouchered whole fish
528	3	PW	32	Vouchered whole fish
529	3	PW	35	Vouchered whole fish
530	3	PW	34	Vouchered whole fish
540	3	PW	33	Vouchered whole fish
541	3	PW	32	Vouchered whole fish
543	3	PW	30	Vouchered whole fish
544	3	PW	40	Vouchered whole fish

Sample #	Site #	Species	Fish Length	Comments
546	3	PW	32	Vouchered whole fish
56	5	PW	67	Caudal Fin
31	7	BT	143	Adipose Fin
38	7	BT	145	Adipose Fin
50	7	BT	147	Adipose Fin
506	7	BT	129	Adipose Fin
40	8	BT	150	Adipose Fin
42	8	BT	207	Adipose Fin
39	9	PW	128	Adipose Fin.
46	9	PW	147	Adipose Fin.
52	9	MW	171	Adipose Fin.
53	9	MW	209	Adipose Fin.
57	9	MW	145	Adipose Fin.
58	9	MW	150	Adipose Fin.
32	12	MW	122	Adipose Fin.
33	12	MW	240	Adipose Fin.
34	12	MW	120	Adipose Fin.
35	12	BT	118	Adipose Fin.
43	12	MW	212	Adipose Fin.
44	12	MW	165	Adipose Fin.
45	12	MW	124	Adipose Fin.
47	12	MW	123	Adipose Fin.
55	12	MW	227	Adipose Fin.
60	12	MW	135	Adipose Fin.
500	12	PW	124	Adipose Fin.
559	13	BT	264	Adipose Fin.
100	15	BT	91	Adipose Fin.
101	15	BT	101	Adipose Fin.

Sample #	Site #	Species	Fish Length	Comments
36	16	MW	247	Adipose Fin
41	16	MW	229	Adipose Fin
48	16	MW	157	Adipose Fin
51	16	BT	137	Adipose Fin
54	16	MW	239	Adipose Fin
37	19	MW	153	Adipose Fin
59	19	BT	185	Adipose Fin
102	26	BT	184	Adipose Fin.
103	26	BT	97	Adipose Fin.
104	26	BT	119	Adipose Fin.
556	35	RB	147	Adipose Fin.
560	35	MW	198	Adipose Fin.
565	35	RB	215	Adipose Fin.
547	37	MW	357	Adipose Fin.
548	37	RB	242	Adipose Fin.
549	37	MW	237	Adipose Fin.
550	37	MW	190	Adipose Fin.
552	37	MW	220	Adipose Fin.
553	37	MW	272	Adipose Fin.
554	37	MW	247	Adipose Fin.
561	37	MW	215	Adipose Fin.
564	37	MW	174	Adipose Fin.
122	38	MW	262	Adipose Fin.
124	38	RB	152	Adipose Fin.
125	38	RB	96	Adipose Fin.
126	38	RB	164	Adipose Fin.
129	39	BT	81	Adipose Fin.
127	43	MW	196	Adipose Fin.
128	43	BT	119	Adipose Fin.
117	47	MW	239	Adipose Fin.
118	47	MW	238	Adipose Fin.

Sample #	Site #	Species	Fish Length	Comments
119	47	MW	192	Adipose Fin.
120	47	MW	198	Adipose Fin.
121	47	MW	169	Adipose Fin.
105	48	MW	105	Adipose Fin.
107	52	RB	145	Adipose Fin.
108	52	RB	101	Adipose Fin.
109	56	MW	189	Adipose Fin.
110	56	MW	196	Adipose Fin.
201	58	BT	178	Adipose Fin.
202	58	MW	313	Adipose Fin.
114	59	RB	152	Adipose Fin.
115	59	RB	130	Adipose Fin.
116	59	RB	109	Adipose Fin.
106	90	LT	520	Adipose Fin.
551	90	BT	107	Adipose Fin.
555	90	BT	112	Adipose Fin
111	91	BT	104	Adipose Fin.
112	91	BT	136	Adipose Fin.
113	91	BT	110	Adipose Fin.
130	96	RB	150	Adipose Fin.
131	96	RB	119	Adipose Fin.
132	96	RB	148	Adipose Fin.
200	D1	BT	149	Adipose Fin.
300	Lake	RB	298	Adipose Fin.
301	Lake	RB	224	Adipose Fin.
302	Lake	RB	266	Adipose Fin.
303	Lake	RB	284	Adipose Fin.
327	Lake	BT	311	Adipose Fin.
328	Lake	BT	351	Adipose Fin.
329	Lake	BT	366	Adipose Fin.
330	Lake	BT	338	Adipose Fin.

Appendix 1c. Aging samples collected within the For River Watershed Group (Part II) planning area.

Sample #	Site #	Species	Fish Length	Sample Type
510	3	BT	178	FR
514	3	PW	136	FR
514	3	PW	136	SC
516	3	PW	96	SC
519	3	PW	97	SC
600	3	PW	65	SC
604	3	PW	100	SC
605	3	PW	65	SC
606	3	PW	68	SC
607	3	PW	62	SC
601	3	PW	69	SC
608	3	PW	59	SC
56	5	PW	67	SC
506	5	PW	91	SC
504	6	MW	270	SC
505	6	MW	263	SC
31	7	BT	143	FR
38	7	BT	145	FR
50	7	BT	147	FR
506	7	BT	129	FR
40	8	BT	150	FR
42	8	BT	207	FR
503	8	PW	94	SC
502	8	PW	93	SC
501	8	PW	96	SC
52	9	MW	171	SC
53	9	MW	209	SC

Sample #	Site #	Species	Fish Length	Sample Type
57	9	MW	145	SC
58	9	MW	150	SC
39	9	PW	128	FR
39	9	PW	128	SC
46	9	PW	147	SC
35	12	BT	118	FR
45	12	MW	124	FR
34	12	MW	120	FR
32	12	MW	122	SC
33	12	MW	240	SC
34	12	MW	120	SC
43	12	MW	212	SC
44	12	MW	165	SC
45	12	MW	124	SC
47	12	MW	123	SC
55	12	MW	227	SC
60	12	MW	135	SC
500	12	PW	124	FR
500	12	PW	124	SC
100	15	BT	91	FR
101	15	BT	101	FR
101	15	BT	101	FR
100	15	BT	91	FR
51	16	BT	137	FR
36	16	MW	247	SC
41	16	MW	229	SC
48	16	MW	157	SC

Sample #	Site #	Species	Fish Length	Sample Type
54	16	MW	239	SC
59	19	BT	185	FR
37	19	MW	153	SC
102	26	BT	184	FR
103	26	BT	97	FR
104	26	BT	119	FR
103	26	BT	97	FR
104	26	BT	119	FR
102	26	BT	184	FR
560	35	MW	198	SC
556	35	RB	147	SC
565	35	RB	215	SC
547	37	MW	357	SC
549	37	MW	237	SC
550	37	MW	190	SC
552	37	MW	220	SC
553	37	MW	272	SC
554	37	MW	247	SC
561	37	MW	215	SC
564	37	MW	174	SC
607	37	MW	253	SC
548	37	RB	242	SC
122	38	MW	262	SC
123	38	RB	84	SC
124	38	RB	152	SC
125	38	RB	96	SC
126	38	RB	164	SC
129	39	BT	81	FR
128	43	BT	119	FR

Sample #	Site #	Species	Fish Length	Sample Type
127	43	MW	196	SC
117	47	MW	239	SC
119	47	MW	192	SC
118	47	MW	238	SC
120	47	MW	198	SC
121	47	MW	169	SC
108	52	RB	101	FR
107	52	RB	145	FR
107	52	RB	145	SC
108	52	RB	101	SC
109	56	MW	189	SC
110	56	MW	196	SC
201	58	BT	178	FR
201	58	BT	178	SC
202	58	MW	313	SC
114	59	RB	152	SC
116	59	RB	109	SC
106	90	LT	520	FR
111	91	BT	104	FR
112	91	BT	136	FR
113	91	BT	110	FR
113	91	BT	110	FR
112	91	BT	136	FR
111	91	BT	104	FR
130	96	RB	150	SC
131	96	RB	119	SC
132	96	RB	148	SC
133	96	RB	164	SC
134	96	RB	52	SC
135	96	RB	57	SC

Sample #	Site #	Species	Fish Length	Sample Type
551	100	BT	107	FR
555	100	BT	112	FR
650	100	RB	83	SC
559	102	BT	264	FR
200	111	BT	149	FR
200	111	BT	149	SC
327	113	BT	311	FR
328	113	BT	351	FR
329	113	BT	366	FR
330	113	BT	338	FR
327	113	BT	311	SC/OT
328	113	BT	351	SC/OT
329	113	BT	366	SC/OT
330	113	BT	338	SC/OT
331	113	MW	432	SC
332	113	MW	230	SC
333	113	MW	204	SC
334	113	MW	248	SC
335	113	MW	242	SC
336	113	MW	192	SC
337	113	MW	251	SC
338	113	MW	205	SC
339	113	MW	212	SC
340	113	MW	308	SC
341	113	MW	298	SC
342	113	MW	242	SC
343	113	MW	186	SC
344	113	MW	284	SC
345	113	MW	244	SC

Sample #	Site #	Species	Fish Length	Sample Type
346	113	MW	255	SC
347	113	MW	200	SC
348	113	MW	139	SC
349	113	MW	227	SC
350	113	MW	198	SC
351	113	MW	258	SC
352	113	MW	209	SC
353	113	MW	200	SC
354	113	MW	237	SC
355	113	MW	253	SC
356	113	MW	245	SC
357	113	MW	250	SC
358	113	MW	180	SC
359	113	MW	177	SC
360	113	MW	196	SC
361	113	MW	261	SC
362	113	MW	195	SC
364	113	MW	245	SC
365	113	MW	226	SC
366	113	MW	208	SC
367	113	MW	204	SC
368	113	MW	190	SC
300	113	RB	298	SC/OT
301	113	RB	224	SC/OT
302	113	RB	266	SC/OT
303	113	RB	284	SC/OT
304	113	RB	293	SC/OT
305	113	RB	281	SC/OT
306	113	RB	273	SC/OT
307	113	RB	289	SC/OT

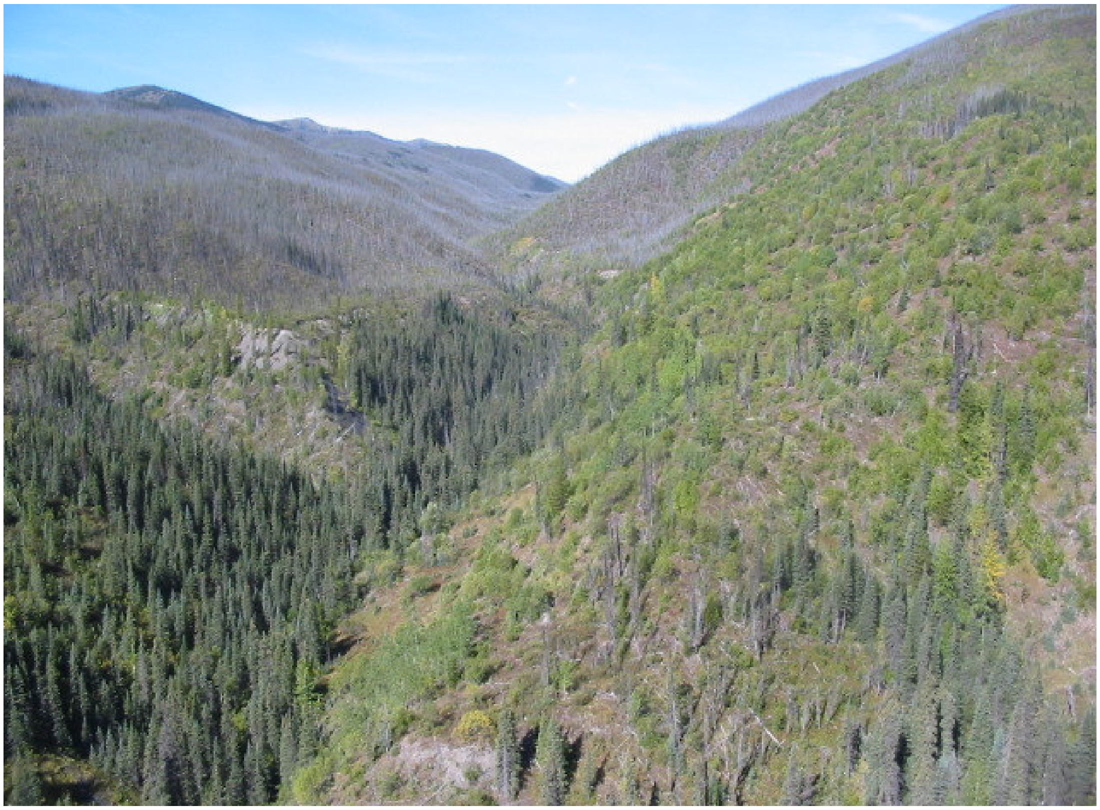
Sample #	Site #	Species	Fish Length	Sample Type
308	113	RB	343	SC/OT
309	113	RB	251	SC/OT
310	113	RB	323	SC/OT
311	113	RB	271	SC/OT
312	113	RB	298	SC/OT
313	113	RB	244	SC/OT
314	113	RB	242	SC/OT
315	113	RB	233	SC/OT
316	113	RB	253	SC/OT
317	113	RB	250	SC/OT
318	113	RB	238	SC/OT
319	113	RB	255	SC/OT
320	113	RB	260	SC/OT
321	113	RB	173	SC/OT
322	113	RB	166	SC/OT
323	113	RB	221	SC/OT
324	113	RB	263	SC/OT
325	113	RB	238	SC/OT
326	113	RB	254	SC/OT
369	113	RB	294	SC/OT
370	113	RB	188	SC/OT

Appendix 2.

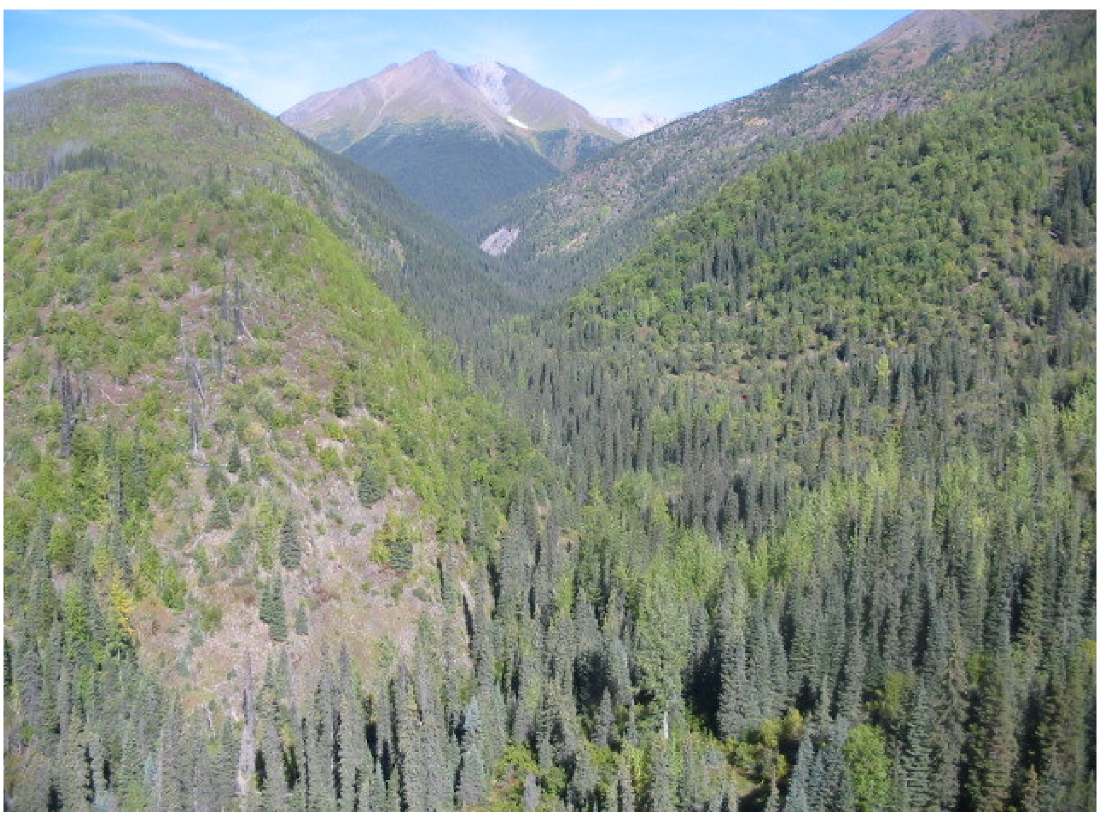
Overflight photographs.

Roll: 20 **Frame:** 1 **WSC:** 239-333700-57800 **UTM:** 10V 381644E 6384563N
Comment: Looking east along the unnamed 3rd order tributary to the Kwadacha River. One site (site 15) was located within the sub-basin of this tributary.

Roll: 20 **Frame:** 2 **WSC:** 239-333700-57800-13600 **UTM:** 10V 381306E 6384376N
Comment: Looking south along the unnamed 3rd order tributary to the Kwadacha River. One site (site 14) was located within the sub-basin of this tributary.

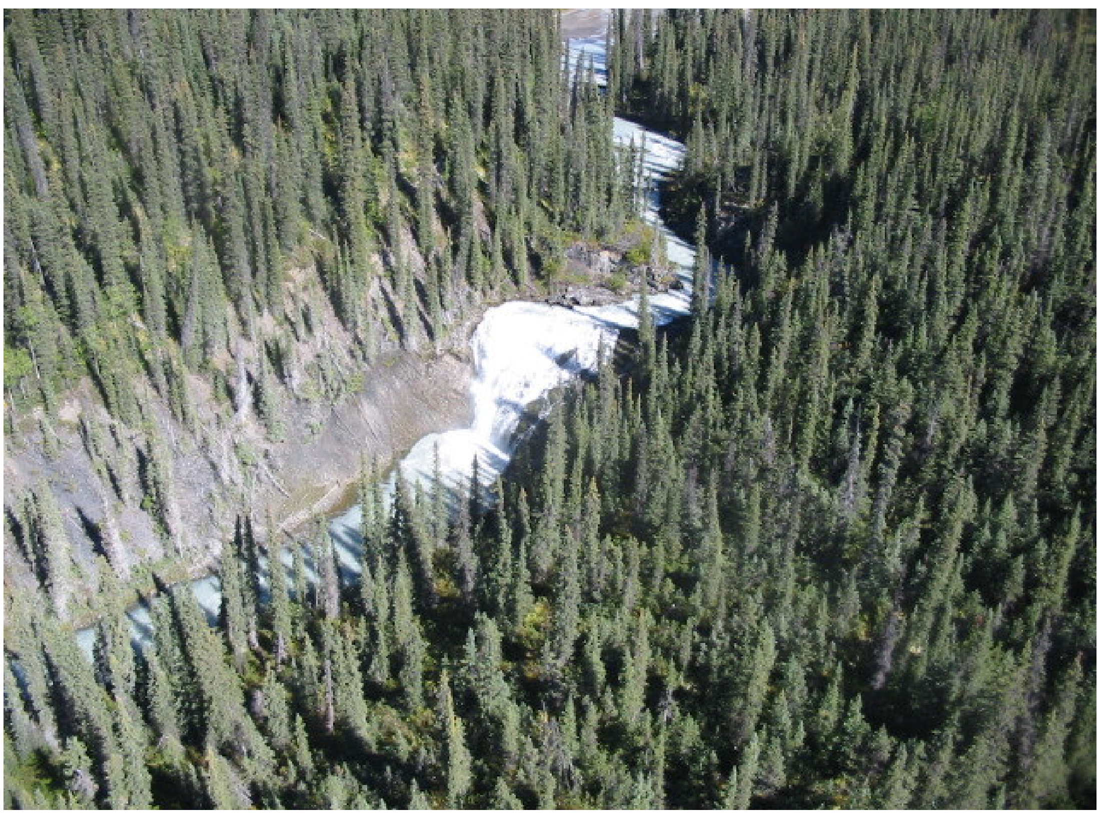


Roll: 20 **Frame:** 3 **WSC:** 239-333700-59700-37500 **UTM:** 10V 378529E 6390829N
Comment: Looking northwest along the unnamed 3rd order tributary to the Kwadacha River. One site (site 17) was located within the sub-basin of this tributary.



Roll: 20 **Frame:** 4 **WSC:** 239-333700-59700 **UTM:** 10V 379054E 6391296N
Comment: Looking north along the unnamed 3rd order tributary to the Kwadacha River. One site (site 18) was located within the sub-basin of this tributary.

Roll: 20 **Frame:** 5 **WSC:** 239-333700-59700-37500 **UTM:** 10V 377882E 6391173N
Comment: Falls located upstream of site 17.



Roll: 20 **Frame:** 6 **WSC:** 239-333700-63500 **UTM:** 10V 384481E 6392281N
Comment: Falls on North Kwadacha River.

Roll: 20 **Frame:** 7 **WSC:** 239-333700 **UTM:** 10V 383840E 6386069N
Comment: Falls on Kwadacha River.

Roll: 20 **Frame:** 8 **WSC:** 239-333700-71300 **UTM:** 391002E 6384038N
Comment: Looking north along the unnamed 3rd order tributary to the Kwadacha River. One site (site 25) was located within the sub-basin of this tributary.

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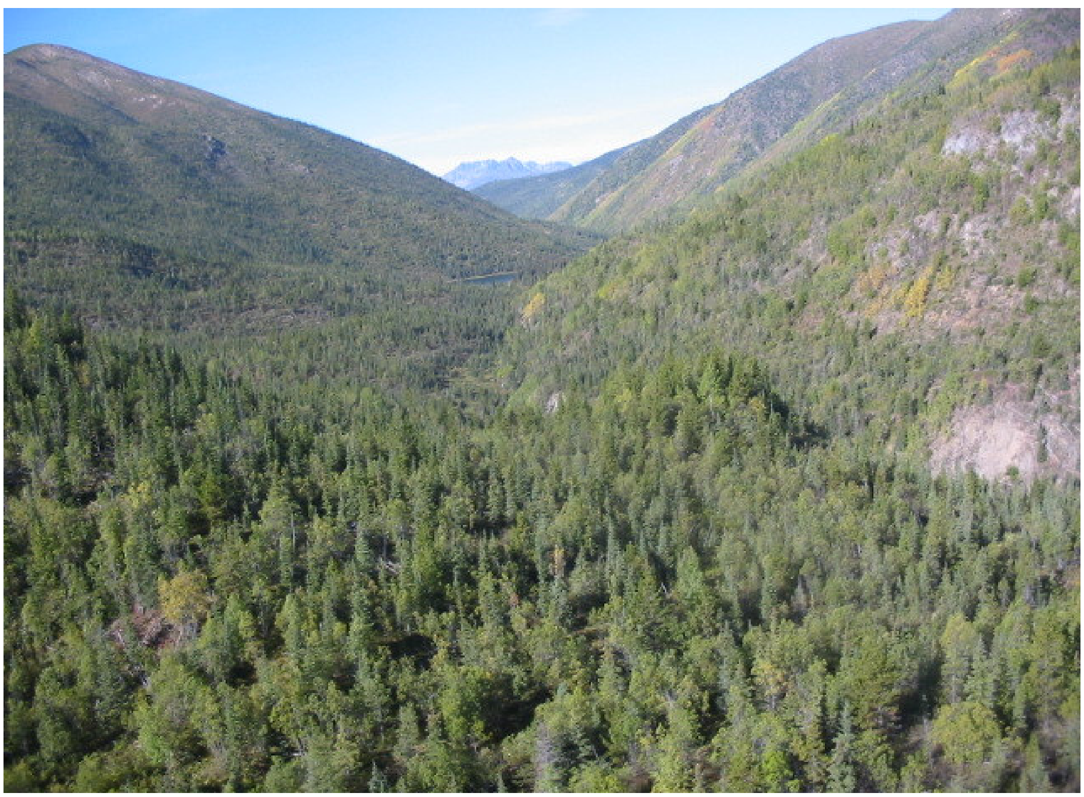
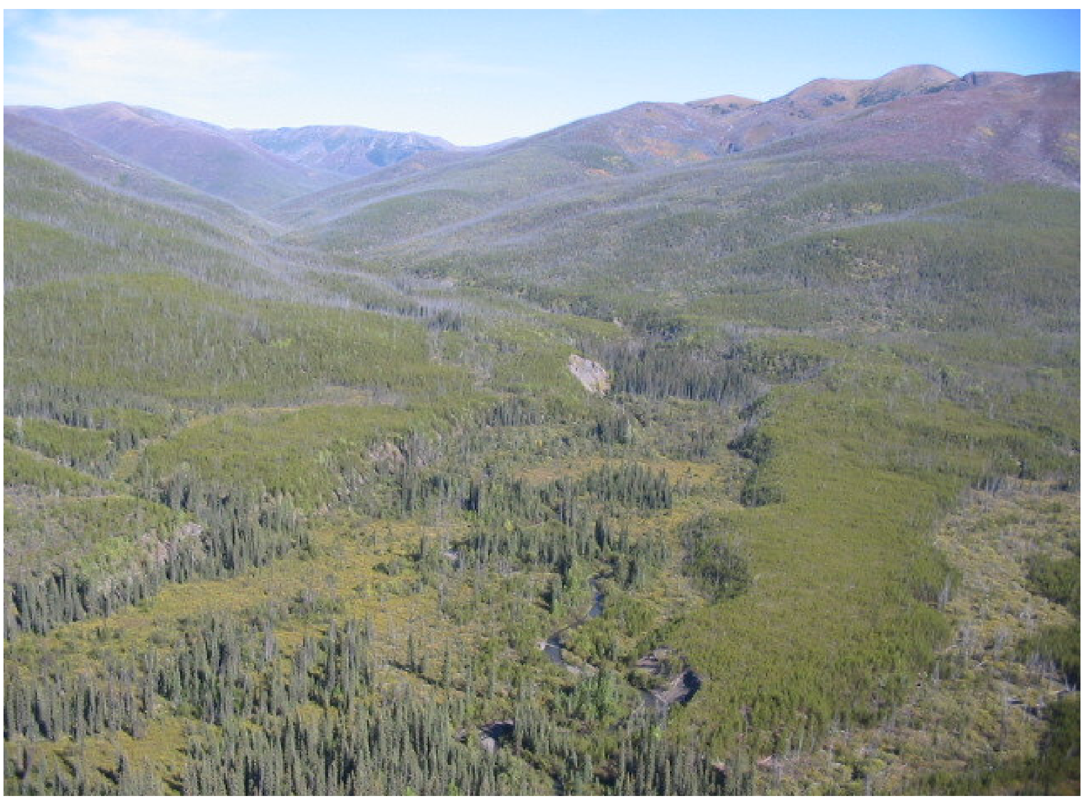
Roll: 20 **Frame:** 9 **WSC:** 239-350100-34000-32600-1730-5770 **UTM:** 10V 336230E 6397426N
Comment: Looking east along the unnamed 3rd order tributary to Weissener Lake. One site (site 51) was located within the sub-basin of this tributary.



Roll: 20 **Frame:** 10 **WSC:** 239-350100-34000-32600-1730 **UTM:** 10V 336039E 6397420N
Comment: Looking west along the unnamed 3rd order tributary to Weissener Lake. One site (site 52) was located within the sub-basin of this tributary.

Roll: 20 **Frame:** 11 **WSC:** 239-350100-34000-32600-2150-1770 **UTM:** 10V 342431E 6401633N
Comment: Looking southeast along the unnamed 3rd order tributary to Joe Poole Creek. One site (site 53) was located within the sub-basin of this tributary.



Roll: 20 **Frame:** 12 **WSC:** 239-350100-34000-32600-2150 **UTM:** 10V 347656E 6407117N
Comment: Looking north along the 3rd order portion of Joe Poole Creek. One site (site 56) was located within the sub-basin of this tributary.

Roll: 20 **Frame:** 13 **WSC:** 239-350100-34000-32600-2150-4550 **UTM:** 10V 348216E 6406802N
Comment: Looking southeast along the unnamed 3rd order tributary to Joe Poole Creek. One site (site 55) was located within the sub-basin of this tributary.

Roll: 20 **Frame:** 14 **WSC:** 239-350100-34000-32600 **UTM:** 10V 356337E 6423184N
Comment: Looking north along the 3rd order portion of Weissener Creek. One site (site 59) was located within the sub-basin of this tributary.

Roll: 20 **Frame:** 15 **WSC:** 239-350100-34000-32600-7890 **UTM:** 10V 356255E 6422484N
Comment: Looking southeast along the unnamed 3rd order tributary to Weissener Creek. One site (site 60) was located within the sub-basin of this tributary.

Roll: 20 **Frame:** 16 **WSC:** 239-350100-34000-32600 **UTM:** 10V 356507E 6423128N
Comment: Falls on the mainstem of Weissener Creek, downstream of site 59.

Roll: 20 **Frame:** 17 **WSC:** 239-350100-34000-32600-6260 **UTM:** 10V 346465E 6417234N
Comment: Looking north along the unnamed 3rd order tributary to Weissener Creek. No sites were located within the sub-basin of this tributary.

Roll: 20 **Frame:** 18 **WSC:** 239-333700-26500-70000 **UTM:** 10V 368495E 6421422N
Comment: Looking northeast along the 3rd tributary to the Warneford River. No sites were located within the sub-basin of this tributary.

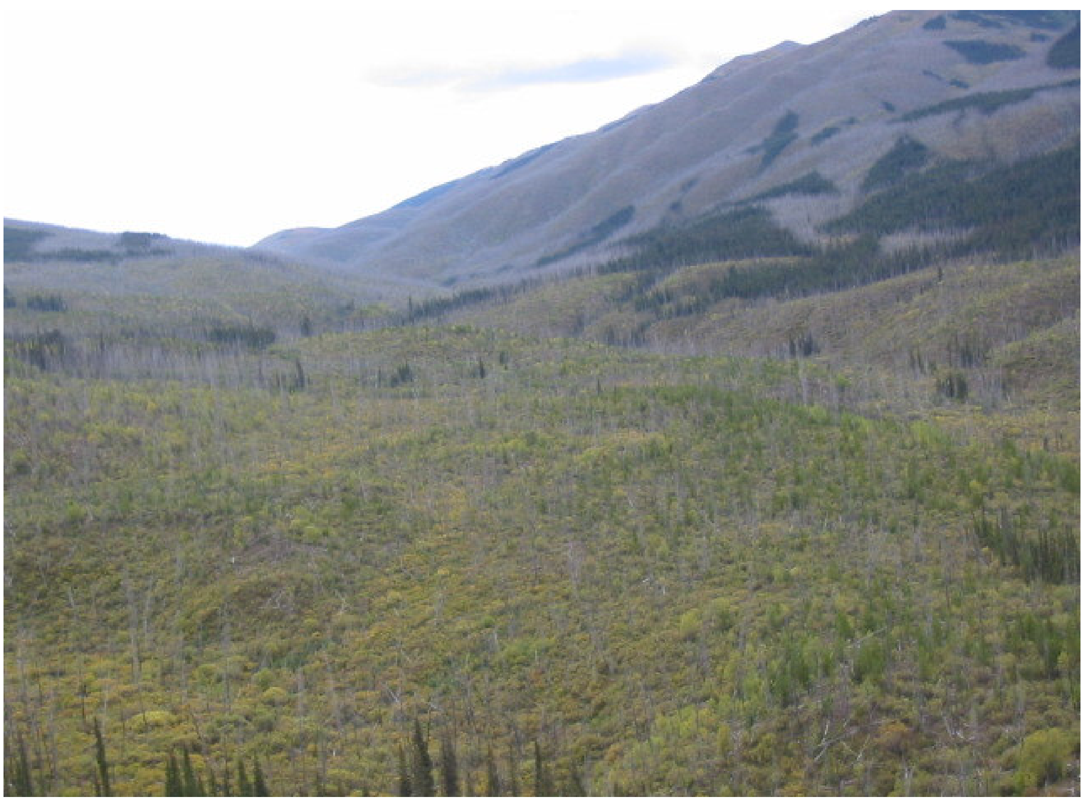
Roll: 20 **Frame:** 19 **WSC:** 239-333700-26500 **UTM:** 10V 368775E 6420664N
Comment: Looking southeast along the 3rd order portion of the Warneford River. No sites were located within the sub-basin of this tributary.

Roll: 20 **Frame:** 20 **WSC:** 239-333700-26500-38300-0440 **UTM:** 10V 363162E 6402158N
Comment: Looking east towards the Aramis Lakes, along the 3rd tributary to Chesterfield Creek. No sites were located within the sub-basin of this tributary.

Roll: 20 **Frame:** 21 **WSC:** 239-333700-26500-44200 **UTM:** 10V 366161E 6405682N
Comment: Looking east along Haworth Creek. Several sites were located within the sub-basin. The river in the foreground of the photograph is the Warneford River.

Roll: 20 **Frame:** 22 **WSC:** 239-333700-26500-44200 **UTM:** 10V 370561E 6405746N
Comment: Haworth Falls. No fish were captured upstream of the falls.

Roll: 20 **Frame:** 23 **WSC:** 239-333700-26500-38300-5790 **UTM:** 10V 375355E 6400303N
Comment: Looking northwest along a 3rd order tributary to the west end of Chesterfield Lake. No sites were located within the sub-basin of this tributary.



Roll: 20 **Frame:** 24 **WSC:** 239-333700-26500-38300-2860 **UTM:** 10V 368716E 6398682N
Comment: Looking southeast along a 3rd order tributary to Chesterfield Creek. No sites were located within the sub-basin of this tributary.

Appendix 3.

FDIS summary reports.

Appendix 4.

Project Map

Appendix 5.

Photodocumentation

Appendix 6.

Original Field Cards

Appendix 7.

Planning Report