BC hydro

FOR GENERATIONS

Report Title: *Peace River Fisheries Investigation - Peace River Tributary Spring Spawning Migration, Tributary Summer Juvenile Rearing and Radio Telemetry Studies 2006*
Project: Peace River Site C Hydro Project
Prepared By: Amec Earth & Environmental and LGL Limited
Prepared For: BC Hydro

NOTE TO READER:

This is a report on a study commissioned toward the development of engineering, environmental and technical work conducted to further define the potential Site C project.

For environmental studies, the focus is on the development of an environmental and socio-economic baseline around the area of the potential Site C Project. Baseline studies are generally a survey of existing conditions within a project study area.

This report and other information may be used for future planning work or an environmental assessment or regulatory applications related to the potential Site C Project.

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PEACE RIVER
FISHERIES INVESTIGATION

Peace River Tributary Spring Spawning Migration, Tributary Summer Juvenile Rearing and Radio Telemetry Studies 2006

FINAL REPORT

Conducted for

BC Hydro

by

AMEC Earth & Environmental

and

LGL Limited.

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FISHERIES INVESTIGATION
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EXECUTIVE SUMMARY

BC Hydro operates two hydroelectric facilities on the Peace River in northern British Columbia. To meet future power demands, BC Hydro is investigating the potential for further hydroelectric development on the Peace River at Site C in the vicinity of Fort St. John. As part of the investigation and to support ongoing operations, BC Hydro commissioned AMEC Earth & Environmental and LGL Limited, to undertake fisheries studies on the upper Peace River system to address specific data gaps.

The main objectives of this study were to:

1. Determine the species composition, timing, and relative magnitude of spring spawning runs in Peace River tributaries upstream of the proposed Site C dam (i.e., the Halfway and Moberly rivers and Cache, Farrell, Lynx, and Maurice creeks).
2. Determine the species composition, distribution, and relative abundance of rearing juveniles and the location and characterization of critical rearing habitats in Peace River tributaries upstream of the proposed Site C dam (i.e., the Moberly River, Cache, Red, Wilder, Farrell, Lynx, and Maurice creeks).
3. Determine the movements of Arctic grayling, rainbow trout, walleye, and mountain whitefish in the Peace River mainstem and into its major tributaries between the Peace Canyon Dam and the Beatton River.

The study approach involved three major field programs: 1) a spring spawning run enumerations; 2) a summer juvenile electrofishing surveys; and 3) a radio telemetry tracking study.

Spring spawning migrations

The spring spawning migrations of large-bodied fish species into tributaries upstream of the proposed Site C dam was monitored between May 10 and June 15, 2006 with hoop nets. Brief backpack electrofishing surveys were used to determine if any upstream migrations had occurred prior to hoop net installations and if any significant migrations were being missed by the hoop net. Larval drift nets were placed in Peace River tributaries to determine the effectiveness of this sampling technique in capturing larval fish in the spring.

A total of 19 fish species was captured during the 2006 fisheries investigations including the provincially blue-listed bull trout and the provincially red-listed spottail shiner.

A total of 1,853 fish, representing 17 species, was captured in Peace River tributaries during the spring hoop netting program. As a group, suckers comprised 59% of the total catch while minnows, sportfish, and sculpins comprised 33%, 8%, and <1% of the total catch. Longnose sucker were the most commonly captured fish species, comprising 47% of the total hoop net catch. Redside shiner (18% of total catch), northern pikeminnow (11%), and largescale sucker (9%) were also abundant. Rainbow trout were the most commonly captured sportfish species but only comprised 4% of the total catch. Other sportfish captured included mountain whitefish (2%), Arctic grayling (1%), bull trout (0.6%), burbot (0.6%) and kokanee (0.2%).

A total of 772 fish, representing 15 species, was captured in spring electrofishing surveys. Sportfish comprised 9% of the catch and included rainbow trout, mountain whitefish and bull trout. Suckers, minnows and sculpin comprised 28%, 47% and 16% of the total catch, respectively. Longnose suckers (27%) and longnose dace (25%) were the most common species captured.

Arctic grayling spawn and rear in the Moberly River and the Moberly River likely contributes more to the annual recruitment of the Peace River Arctic grayling population than any other tributary upstream of the proposed Site C dam.

Young-of-the-year mountain whitefish were captured in the Moberly River, and in Cache, Farrell, Lynx, and Maurice creeks in summer 2006 indicating that mountain whitefish successfully spawned in each of these tributaries in fall 2005.

Longnose sucker spawn in all major tributaries upstream of the Pine River. Northern pikeminnow move into the Moberly River, Halfway River, and Farrell Creek in spring to spawn. Upstream migrations of redside shiner in Cache, Lynx, and Farrell creeks and in the Halfway River were also observed in spring 2006.

Larval fish were collected in half of the drift samples. However, most (71%) of the samples with fish were collected in Maurice Creek. These included larval suckers, sculpins, and minnow species. Larval minnows were also captured in Farrell Creek. Larval fish were not captured in Lynx Creek, Cache Creek or the Halfway River. Larval salmonids were not captured in any of the tributaries sampled.

The larval drift pilot study indicated that drift nets are effective at catching larval fish and that debris loads in the Peace River tributaries in spring do not limit the effectiveness of the nets to catch fish or to process samples.

Summer juvenile rearing

Electrofishing surveys were conducted in tributaries upstream of the proposed Site C dam site between July 25 and August 2 in 2006.

An estimated total of 23,253 fish, representing 13 species, was captured in Peace River tributaries during summer electrofishing surveys. Sportfish only accounted for 0.3% of the total catch and included mountain whitefish, rainbow trout, Arctic grayling and burbot. Minnows (81% of total catch) and suckers (18%) were the most abundant groups of fish captured. The two most abundant species were longnose dace (29%) and redside shiner (22%).

There were very few significant differences among habitat types (pool, run, riffle) in the abundance of fish captured in summer electrofishing surveys. However, fish were often most abundant in runs and least abundant in riffles.

In most tributaries, there was no significant difference in the abundance of fish captured in the summer electrofishing surveys between upper and lower reaches (i.e. above and below the potential inundation zone for Site C).

Fish Movement in the Peace River Mainstem

A total of 49 Arctic grayling, 58 walleye, 32 rainbow trout and 116 mountain whitefish were radio-tagged in fall 2005 and early summer 2006. These tagged fish were tracked with aerial tracking flights beginning in February 2006 and continuing in most months until October. Aerial flights typically included the entire Peace River mainstem from the Peace Canyon Dam downstream to the Dunvegan, Alberta as well as the lower reaches of major tributaries. Fixed station receivers with directional antennae were installed at eight locations along the Peace River mainstem from the Peace Canyon Dam to the mouth of the Beatton River and in one headwater tributary of the Halfway River in April 2006.

Radio-tagged rainbow trout moved relatively little overall in the Peace River and were generally found upstream of the Halfway River. Radio-tagged Arctic grayling moved very little in the Peace River mainstem and movements were generally concentrated between the Halfway and Pine rivers. Radio-tagged mountain whitefish appear to make only localized movements within the Peace River mainstem with most fish located between Farrell Creek and Beatton River. However, seven mountain whitefish moved up the Halfway River, with five detected in the headwaters in the fall. Most of the radio-tagged walleye remained in the vicinity of the Beatton River or moved downstream to Alberta. However, three walleye were detected at the mouth of the Moberly River in May 2006. The most significant movement detected into the tributaries in spring was walleye moving into the Beatton River in early May, and possibly earlier.

Portions of the tagged population moving past the proposed Site C location were 67%, 34%, 13% and 5% for Arctic grayling, mountain whitefish, rainbow trout and walleye, respectively.

Flow conditions in the Peace River tributaries in 2006 were aberrant in two respects: there was an initial spring freshet in March, a month earlier than those seen in the last 10 years; and flows after spring were at the 10 year minimum flow level. These abnormal flows have the potential to influence the abundance, distribution and species composition of fish utilizing the Peace River tributaries to spawn and rear. Therefore, 2006 results should be seen as indicative of a low flow year and these studies should be repeated. In addition, the upstream extent of spawning migrations and critical spawning locations within the Peace River tributaries remain unknown and should also be investigated in the future.

Radio telemetry results only represent the initial year of tracking and tags will remain active for at least another year. All conclusions regarding the movement of Arctic grayling, walleye, rainbow trout, and particularly mountain whitefish, in the Peace River will not be finalized until data from the second year of tracking has been gathered and analyzed.

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1.0 INTRODUCTION

BC Hydro operates two hydroelectric facilities on the Peace River in northern British Columbia. To meet future power demands, BC Hydro is investigating the potential for further hydroelectric development on the Peace River at Site C in the vicinity of Fort St. John.

1.1 Objectives

BC Hydro commissioned AMEC and LGL Ltd., to provide baseline fisheries information to help assess both new and ongoing operations. The specific objectives of the 2006 Peace River investigation, were as follows:

1. to determine the species composition, timing, and magnitude of spring spawning runs of large-bodied fish species in Peace River tributaries upstream of the proposed Site C dam;
2. to determine the species composition, abundance, and distribution of juveniles rearing in Peace River tributaries upstream of the proposed Site C dam;
3. to determine the feasibility, level of effort required, and effectiveness of larval drift surveys to identify spawning locations in Peace River tributaries;
4. to determine the effectiveness of hoop netting as a means of enumerating spring spawning migrations in the Halfway and Moberly Rivers; and
5. to determine the spatial extent, timing, and magnitude of movements of Arctic grayling, rainbow trout, mountain whitefish, and walleye in the Peace River mainstem and between the Peace River and its tributaries.

1.2 Background

BC Hydro has conducted fisheries baseline studies and investigated the potential environmental impacts of Site C dam at various intervals over the last 30 years. In recent years, BC Hydro has initiated literature reviews and gap analyses to identify what information exists regarding the Peace River fish community and to identify what information is still needed for on-going Water Use Planning (WUP) and to develop a defensible database upon which to base a future environmental impact assessment of Site C dam (Valenius, 2001, Pottinger Gaherty, 2001). Based on these reviews and gap analyses, AMEC identified fisheries studies that BC Hydro required to assess the potential impacts of the proposed Site C Dam. In 2005, AMEC initiated two of these recommended studies and research focused on determining the utilization of upstream tributaries by Peace River fish and assessing fish migrations past the proposed Site C dam location (AMEC and LGL 2006a).

Inundation of the Peace River and the lower reaches of upstream tributaries by Site C dam would change fish habitat from riverine to more lacustrine and alter the upstream fish community as it adapts to the new environment. Previous studies in the Peace River tributaries upstream of Site C (ARL, 1991a, 1991b, R.L.&L., 1991a, b) suggested that a number of large-bodied fish species in the Peace River, including bull trout, Arctic grayling, rainbow trout, mountain whitefish, and longnose sucker, use tributaries upstream of Site C for spawning and rearing. More recent examination of available data has suggested that Peace River tributaries provide most of the annual recruitment for many large-bodied fish species in the river (P & E, 2002). Inundation of the lower reaches of these tributaries has the potential to impact fish species using these tributaries by changing the hydraulic habitat and increasing sedimentation, factors that may have an effect on the species composition, abundance and distribution. Despite these past studies, data gaps exist and additional information regarding the species composition, timing, and relative magnitude of spawning runs, the location of critical spawning areas, and the extent of juvenile rearing in Peace River tributaries is needed.

Site C dam also has the potential to alter upstream and downstream migrations of fish through the Site C area of the Peace River. Bull trout are known to move from the Halfway River to the Peace River and although most fish remain in the vicinity of the Halfway River confluence, a portion of Halfway River bull trout make extensive upstream and downstream migrations in the Peace River including downstream movements past the proposed Site C dam site (AMEC and LGL, 2006b). A population of bull trout is also known to exist in the Pine River system but the movement of this population between the Pine River, the Peace River, and the Halfway River is unknown. An upstream movement of walleye from the Beatton River to the Moberly River was observed in 1989 and 1990 (R.L.&L., 1991a, b) but the number of migrants was small and the magnitude and importance of this migration past Site C dam remains unclear. Mountain whitefish are found throughout the Peace River and are known to use the Halfway River for spawning (R.L. & L., 1991a, b, 2001, P & E. 2002). Arctic grayling are found principally in the reach between the Halfway and Pine rivers which includes the proposed Site C dam site. An upstream movement of mountain whitefish in the Peace River has been observed during the Large River Fish Indexing Program (P & E, 2002; Mainstream Aquatics 2004, 2005, 2006) but the movement of these fish in relation to Site C dam is unclear. Movements of Arctic grayling and rainbow trout, two important sportfish species in the river, past Site C dam have not been confirmed. Additional study is required to confirm the movement of walleye, mountain whitefish, Arctic grayling, and rainbow trout in the Peace River and to determine the movement of Pine River bull trout.

1.3 Study Area

Because this report includes results of both fish utilization of Peace River tributaries and radio telemetry tracking in the Peace River mainstem, the overall study area includes the Peace River mainstem and its tributaries, extending from Peace Canyon Dam downstream to Peace River, Alberta (Figure 1).

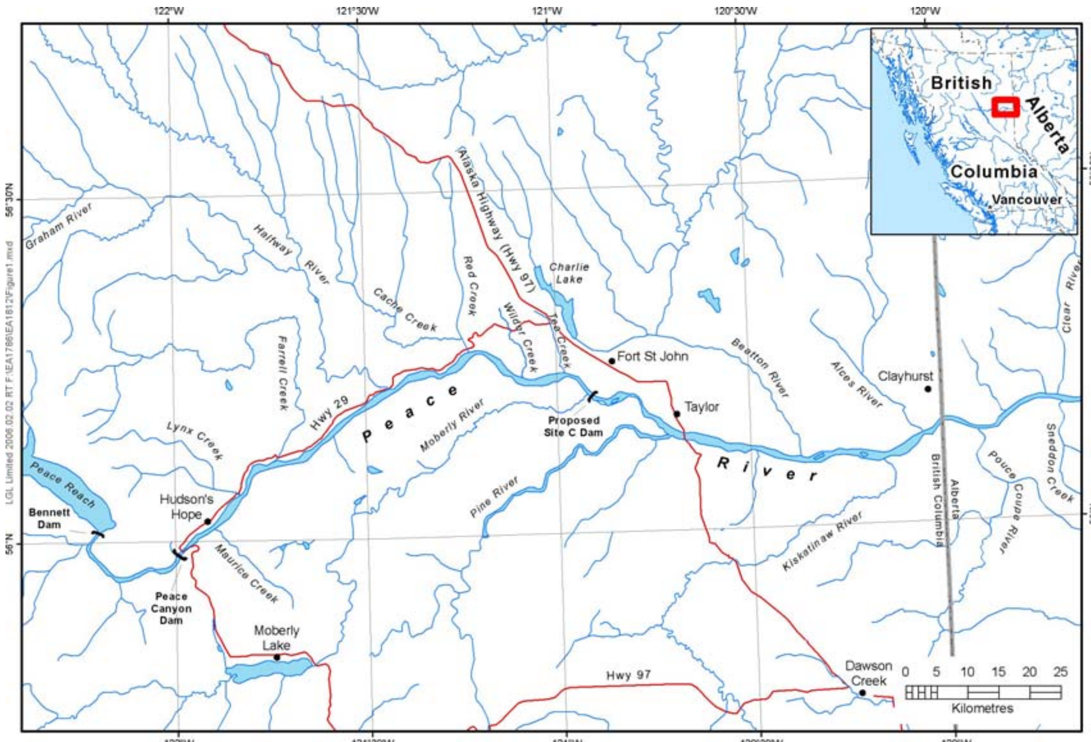


Figure 1: Peace River and its tributaries in northeast British Columbia

The study area for the fish utilization component was focused on Peace River tributaries upstream of the proposed Site C dam site and included reaches extending twice the full reservoir operating level of the Site C reservoir. These tributaries included:

- Halfway River;
- Moberly River;
- Cache Creek;

- Farrell Creek;
- Wilder Creek;
- Red Creek (a tributary of Cache Creek);
- Lynx Creek; and
- Maurice Creek.

The distance upstream from the proposed Site C dam site, the length potentially inundated and the total watershed area of each tributary sampled is presented in Table 1.

Table 1: Location and length of upstream tributaries potentially inundated by Site C dam

Tributary	Watershed Area (km^2)	Distance Upstream from Site C Dam (km)	Length of Tributary Inundated by Site C Reservoir (km)
Moberly River	1833	2.5	10.0
Wilder Creek	100	14.0	2.5
Cache Creek	899	25.0	8.0
Red Creek	238	28.5[1]	1.5
Halfway River	9402	41.0	14.0
Farrell Creek	620	63.0	2.5
Lynx Creek	307	73.0	0.8
Maurice Creek	266	79.0	0.3

Note: [1] Red Creek is a tributary of Cache Creek with its confluence 3.5 km upstream from the mouth of Cache Creek.

2.0 METHODS

2.1 Overview of Study Approach

The approach of this study involves four major field programs: a radio telemetry tracking study, spring spawning run enumerations, an early summer radio-tagging program, and summer juvenile surveys. The major tasks of these programs were as follows:

Radio Telemetry Study (February – October 2006)

- conduct monthly or bi-monthly aerial tracks throughout the year;
- establish fixed telemetry stations in key locations throughout the study area;
- download data from the fixed stations twice a month;
- remove electrical components of the fixed station for winter; and

- analyze and document movements of fish within the Peace River and into major tributaries with particular attention on movements through the proposed Site C dam site.

Spring Migration (May – June 2006)

- install hoop nets at the mouth of all the major tributaries of the Peace River upstream of Site C and check them daily to determine the magnitude, duration, and timing of upstream spawning migrations by spring spawning fish species;
- electrofish near the mouth of each tributary to ensure that hoop-nets catches were not biased;
- electrofish in each tributary to determine if spawning migration started prior to net installations;
- conduct a preliminary investigation of the use of drift nets to collect larval fish in the tributaries;
- establish staff gauges to develop stage-discharge relationships in each ungauged tributary (i.e., all except the Moberly and Halfway rivers); and
- download and replace previously installed temperature loggers.

Early Summer Tagging (June 2006)

- collect, radio-tag and release additional mountain whitefish, Arctic grayling and rainbow trout for the 2007 telemetry tracking program.

Summer Juvenile Surveys (July 2006)

- conduct electrofishing surveys in discrete habitat units to compare abundance of juvenile fish in the areas above and below the Site C inundation zone; and
- determine the location and type (e.g., pools, riffles, runs) of critical rearing habitat in each tributary sampled.

2.2 Flows and Water Temperatures

Information on flow of the Peace (near Taylor, BC; station 07EF001), Pine (station 07FB001), Moberly (station 07FB008) and Halfway (station 07FA006) rivers was obtained from Water Survey of Canada (WSC, EC 2006a, b). For each day in the year, average flows for the last 10 years (1996-2005) were calculated and the maximum and minimum flows were determined for each day during the same 10 year period. The previous decade average, maximum, and minimum are put in context of the 2006 flows, especially during the sampling period.

In Cache, Farrell, Lynx and Maurice creeks, discharge was determined during the spring hoop-net sampling from mid-May to mid-June. A staff gauge was used to document changes in water depth and these heights were recorded daily. Discharge measurements were taken at least three times during the spring sampling period in each tributary and were regressed against corresponding staff gauge heights to develop stage/discharge relationships for each creek. These relationships were used to estimate the daily stream discharge in each creek during the spring and summer sampling periods.

Tidbit® temperature loggers were placed in the Peace River mainstem at Site C and in all of the major tributaries of the Peace River from Peace Canyon dam to the Beatton River. Most of the loggers were located within 1 km of the confluence with Peace River. The timing of deployment varied among sites and some loggers were lost or needed to be moved over the course of 2006. All temperature loggers were downloaded for the last time in 2006 during mid-October. The timing of deployment and downloads of each temperature logger in the Peace River and its tributaries is provided in Table 2.

Table 2: Dates of deployment and downloads for temperature loggers in Peace River and its tributaries

Tributary	Deployment	1st Download	Final Download
Beatton River	3-Jun-06		22-Oct-06
Pine River	9-May-06		21-Oct-06
Peace River, Site C	27-May-06		21-Oct-06
Moberly River	23-May-06		21-Oct-06
Wilder Creek	5-Sep-05	10-May-06	22-Oct-06
Cache Creek	5-Sep-05	9-May-06	23-Oct-06
Halfway River	31-Aug-05		22-Oct-06
Farrell Creek	30-Aug-05	8-May-06	23-Oct-06
Lynx Creek	30-Aug-05		23-Oct-06
Maurice Creek	1-Sep-05	8-May-06	23-Oct-06

2.3 Spring Spawning Run Enumerations

2.3.1 Hoop Netting

Hoop nets were installed near the mouths of the Halfway and Moberly rivers and Maurice, Lynx, Farrell and Cache creeks on May 10 or 11, 2006 (Figure

2). Specific details about the fishing effort of the hoop net program in each tributary are presented in Table 3. All hoop nets were set to capture upstream migrants and no downstream hoop nets were installed. Hoop nets were shifted and adjusted throughout the sampling period to maximize catches and to ensure net stability and personnel safety during retrieval. An attempt was made in the creeks to completely block upstream migrations by setting extra nets from the mouth of the hoop net out on an angle to the edge of the shore. Hoop nets in the Halfway and Moberly rivers were set as close to the thalweg as safely possible. Hoop nets were checked once or twice daily until mid-June when upstream migrations tapered to numbers consistently below five fish per day. All nets were removed by the end of June.

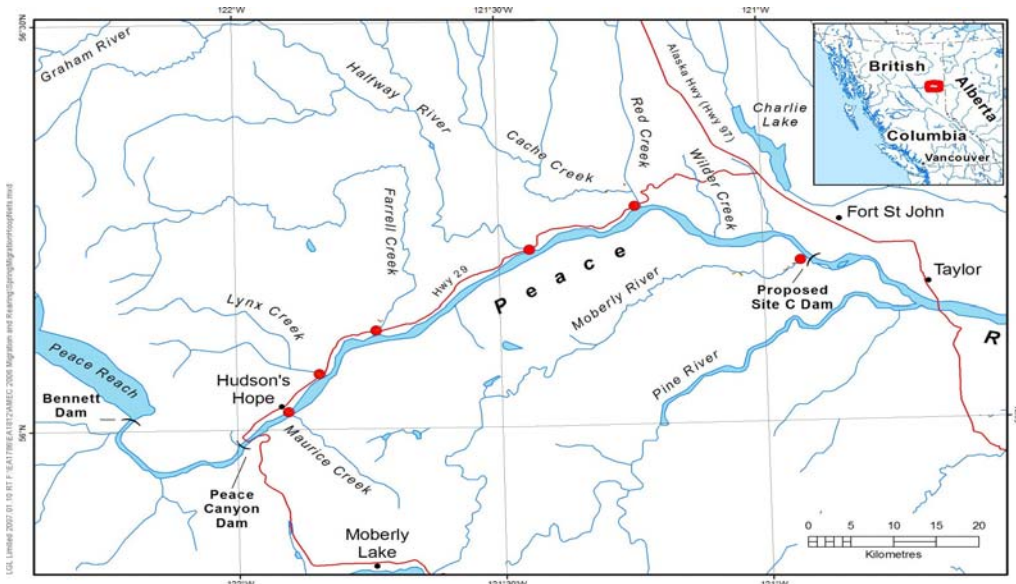


Figure 2: ***Map of hoop net location in Peace River tributaries***

***Table 3:* Hoop net sampling dates, locations and % of channel sampled by tributary**

	Tributary					
	Moberly River	**Cache Creek**	**Halfway River**	**Farrell Creek**	**Lynx Creek**	**Maurice Creek**
Date of net installation	May 11	May 10	May 10	May 10	May 10	May 10
Date of net removal	June 10	June 15	June 21	June 15	June 21	June 15
Dates net not checked	May 13, 17, June 1, 2		May 22-28	May 25-27	May 24	May 23-25, June 1
Distance upstream from Peace River (m)	500	1000	500	100	250	25
% of channel sampled in low flows	20	95	10	90	95	95
% of channel sampled at highest flow	10	60	0	40	75	70
Hoop net mesh dimension (mm)	7.5, 20	20	7.5, 20	20	20	20

2.3.1.1 Moberly River

At the start of sampling in the Moberly River, the hoop net was installed close to the center of the channel but it was gradually shifted closer to the river left as water levels rose during the spring (Plate 1 and 2).

Plate 1: Moberly River hoop net during low flows, May 12, 2006

Plate 2: Moberly River hoop net during high flows, May 22, 2006

The original hoop net with stretched mesh of 7.5 mm had to be replaced on May 24th with a hoop net of a larger mesh (20 mm) to reduce water resistance in high river flows. Often boulders set at the bottom of the net were shifted by water flow between net checks reducing the effectiveness of the wings to direct fish into the hoop net. There were four days when the hoop net in the Moberly River could not be checked because of logistical problems with the jet boat necessary to access the Moberly River from Fort St John (Table 3).

2.3.1.2 Cache Creek

In Cache Creek, the hoop net reached both banks under most spring flow conditions observed however, at the highest flows the net was only fishing approximately 60% of the channel (Plate 3 and 4). Beavers in the area often chewed holes in the net between net checks and it is unclear how many fish many have passed through the net as a result of this net damage. It is likely that very few fish were missed over the spring period given high catch rates on most days except for on May 21 when no fish were captured and it is assumed all fish passed through a hole in the net.

Plate 3: Cache Creek hoop net during low flows, May 12, 2006

Plate 4: Cache Creek hoop net during high flows, May 21, 2006

2.3.1.3 Halfway River

A single hoop net was installed near the right bank (looking downstream), approximately 500 m upstream from the confluence with Peace River (Plate 5). High water in the Halfway River limited the width of river that could be effectively and safely fished while also limiting the number of days when the hoop net could be checked. When water levels receded sufficiently a second hoop net was installed approximately 150 m upstream from the original location (Plate 6). This new hoop net had a larger mesh dimension (20 mm) to reduce water resistance in the high flows.

Plate 5: Halfway River hoop net during low flows, May 18, 2006

Plate 6: Halfway River hoop net during high flows, May 28, 2006

2.3.1.4 Farrell Creek

In Farrell Creek, the original hoop net was located approximately 100 m upstream from the confluence with Peace River (Plate 7). The net was washed out May 26 by high flows and was reinstalled approximately 50 m upstream three days later when river flows had receded (Plate 8).

Plate 7: Farrell Creek hoop net during low flows, May 20, 2006

Plate 8: Farrell Creek hoop net during high flows, May 27, 2006

2.3.1.5 Lynx Creek

During most flow conditions in Lynx Creek, the wings of the hoop net were able to reach the banks of the narrow channel without the assistance of barrier nets (Plates 9 and 10). The net was washed out by high water flows on May 25 but was replaced within a few hours in the same location.

Plate 9: Lynx Creek hoop net during low flows, May 20, 2006

Plate 10: Lynx Creek hoop net during high flows, May 24, 2006

2.3.1.6 Maurice Creek

The hoop net in Maurice Creek was located approximately 25 m upstream from the confluence with Peace River within a reach of the creek influenced by the fluctuating water levels of the Peace River. The net reached from one bank to the other under most flows (Plates 11 and 12). Muddy conditions on the access road limited access to Maurice Creek following a rain event on May 22, 2006. The hoop net was washed out on May 25 when it was checked after the access road was passable and it was assumed that the net was not fishing May 23 and 24. The hoop net was reinstalled in the same location on May 25. The net was also not checked on June 1 because of muddy conditions on the access road.

Plate 11: Maurice Creek hoop net during low flows, May 20, 2006

Plate 12: Maurice Creek hoop net during flooding from the Peace River, May 15, 2006

2.3.1.7 Fish Sampling

Fish collected in each hoop net were identified to species, enumerated, measured for length and weight, and externally examined for sex and state of maturity. Non-lethal aging structures (scales from salmonids and pectoral fin clips from suckers) were taken from large-bodied fish and length-stratified random sub-samples from each species from each tributary were sent to North/South Consultants Inc. in Winnipeg, Manitoba for aging analysis. In addition, an attempt was made to collect 10 genetic samples per species per tributary for each large-bodied fish species encountered by collecting and archiving fin clips.

All fish captured were checked for existing tags (PIT tags, floy tags or fin clips) and all unmarked large-bodied fish were given a unique fin clip to indicate the tributary of capture. Unique fin clips were right pectoral (Moberly River), left pectoral (Cache Creek), right pelvic (Halfway River), left pelvic (Farrell Creek), upper caudal (Lynx Creek) and lower caudal (Maurice Creek). All fish were released upstream of the hoop net at the end of each net check.

2.3.2 Spring Electrofishing

Backpack electrofishing was conducted in all tributaries, except the Moberly River, in spring 2006. This was done for two reasons: 1) to test the assumption that the hoop nets were catching a representative sample of the fish population moving upstream; and 2) to determine if fish had moved upstream prior to installation of the hoop nets.

Fish were collected with a Smith-Root D15 backpack electrofisher and sampling involved a single-pass progressing in an upstream direction. The sampling crew consisted of two people; one operating the electrofishing unit and another operating a single-person lip seine or, less frequently, a dip net. All wadeable habitats in each tributary were sampled for a distance of approximately 1 km upstream from the tributary confluence. Block nets were not employed as the goal was determining fish presence, species composition, and relative abundance rather than absolute density.

Electrofishing was not conducted on the Moberly River during spring 2006 because water flows were too high to wade and operate backpack electrofishing equipment safely. In all other tributaries, electrofishing was conducted between May 18 and June 12 (Table 4). It was not possible to electrofish the entire channel in the Halfway River but wadeable sections on the river right, above the hoop net were covered thoroughly.

Table 4: Dates of electrofish sampling on Peace River tributaries

Tributary	Sampling Dates
Cache Creek	June 5, 6
Halfway River	June 7, 8, 11, 12
Farrell Creek	May 22
Lynx Creek	June 2, 4
Maurice Creek	May 18, 20, 21

Fish captured at each site were processed in similar fashion to those captured in hoop nets. Fish were released into the tributaries at the point of capture.

2.3.3 Larval Drift Net Sampling

Two drift nets with 99 cm long, 500µm nets set on 46 cm wide and 31 cm high frames were used to capture larval fish drifting downstream in each creek in spring.

Larval drift nets were set between June 12 and 16 at the end of the hoop net study. Nets were secured with twine to rebar hammered in the stream substrates usually just upstream of the hoop nets. The depth of placement depended on the water depth and substrate composition but nets were generally placed mid-height in the water column when conditions allowed. The type of habitat sampled varied by site but was mostly run habitat.

The time of day, water velocity at the drift net mouth (measured with a Swoffer digital flow meter), and the approximate proportion of the total net mouth area submerged in the water was recorded each time a net was checked and reinstalled. The drift was removed from the net and transferred into a tray. A magnifying glass and forceps were used to sort through the drift to find larval fish. Larval fish were placed in formalin for approximately five minutes and then stored for later identification in ethyl-alcohol. Larval fish were sent to a subcontractor (North/South Consultants Inc., Winnipeg, Manitoba) for identification.

2.3.4 Data Analysis

For those species captured in sufficient numbers, the number of fish captured per day in each tributary was compared graphically to water discharge and temperature over the same period.

Mean length, weight, and condition factor were calculated for each fish species captured by hoop netting and electrofishing. Condition factor was calculated with the following equation:

$$K = \frac{10^5 W}{L^3}$$

Where K is the condition factor, or the coefficient of condition; W is the weight (g) and L is the length (mm) of the fish. Fish with higher condition factors are indicative of fish in better health than fish of the same species with lower condition factors.

Length-frequency distributions were plotted for longnose suckers in all tributaries and for salmonids where numbers captured were sufficiently large. Mean, minimum, and maximum length- and weight-at-age were determined for all fish species for which sufficient aging structures were analyzed. Length-weight relationships were developed for all fish species captured in numbers greater than 15 individuals from each tributary sampled.

Catch-per-unit effort (# of fish/100 seconds) was calculated for all species captured electrofishing in each tributary. Total catch was divided by the total electrofishing time to determine CPUE in each tributary.

Density of larval fish captured in drift nets, by species, was calculated for each net set. Density of fish was calculated as the number of fish collected by cubic meter per second of water filtered.

2.4 Juvenile Rearing Surveys

Discrete habitat units (pools, riffles, and runs) were sampled with a backpack electrofisher in tributaries of the Peace River between July 30 and August 1, 2006. Maps with the location of the sampling sites are available in Appendix

D (Figure 9-18). An attempt was made to sample three sites of each discreet habitat type in both the lower and upper reaches (i.e., above and below the anticipated normal reservoir operating level) of each tributary (Table 5). Site locations were selected prior to the commencement of fieldwork based on habitat assessments and mapping conducted in 2005 (AMEC and LGL, 2006a). Final site selection was altered as necessary in the field in response to flow conditions and logistical constraints posed by high or low water conditions. Due to safety concerns and issues regarding fishing efficiencies, only wadeable sites were sampled.

Table 5: Number of habitat units sampled in Peace River tributaries during summer rearing surveys, 2006

Tributaty	Pool		Riffle		Run		Total
	Lower	Upper	Lower	Upper	Lower	Upper	
Moberly River	4	2	4	4	5	4	23
Wilder Creek	-	-	-	-	-	-	0
Cache Creek	3	2	2	3	2	3	15
Red Creek	-	0	-	3	-	3	6
Farrell Creek	3	3	3	3	3	3	18
Lynx Creek	3	3	3	3	3	3	18
Maurice Creek	-	3	-	3	-	3	9

The Moberly River was sampled from July 29 to August 1. In the lower reach, four pools, five riffles and five runs were sampled. There was less pool habitat available in the area sampled in the upper reach. Therefore, only two pools, four riffles and four runs were sampled in the upper reach. Some of the sample sites were in wadeable sections of the Moberly River mainstem and others were located in side channels.

There was very little water and no discernible flow in Wilder Creek at the time of sampling (Plate 13 and 14). As a result, Wilder Creek could not be sampled in the same manner as other tributaries because it did not have any discrete habitat units.

Plate 13: Wilder Creek, small discontinuous pools of water

Plate 14: Wilder Creek, dry channel with high iron concentrations

Cache Creek was sampled on July 20, 23 and 28. Water flow was very low in the lower reach and many habitat units sampled were isolated without flow. Due to low flows and scarcity of some habitat types, only three pools, two riffles, and two runs were sampled in the lower reach of Cache Creek. In the upper reach, three riffles, three runs and two pools were sampled. A third pool in the upper reach of Cache Creek was not sampled due to time constraints on the day sampled and the difficulty accessing the upper reach of Cache Creek on more than one day.

Red Creek was sampled on July 28. There were two beaver dams located close to the line of potential inundation in Red Creek. The first was smaller and was located about 500 m downstream from the line of potential inundation (Plate 15). The second was larger (Plate 16) and was located approximately 150 m upstream from the first. A combination of steep banks, deep water, and unstable stream bottom prevented access past the beaver ponds to the upper reach. Instead, sites were sampled just below the smaller, downstream beaver dam. In this area, water depths and flow velocities were extremely low and only riffles and runs were sampled.

Plate 15: Red Creek, small beaver dam 500 m downstream of inundation point

Plate 16: Red Creek, large beaver dam 350 m downstream of inundation point

Farrell Creek was sampled on July 26, 27, and 29. Three habitat units for each habitat type were sampled in the lower and upper reaches and so, in total, 18 habitat units were sampled.

Lynx Creek was sampled on July 22 and 23. Three habitat units for each habitat type were sampled in the lower and the upper reaches for a combined total of 18 habitat units.

Maurice Creek was sampled on July 21 and 22. The line of potential inundation in Maurice Creek is very close to its confluence with Peace River and habitat in this lower reach is entirely dependent on flow levels in the Peace River. For this reason, habitat in this lower reach is more representative of backwater habitat in the Peace River instead of habitat in Maurice Creek thus, all habitat units sampled were located above the line of potential inundation. Three habitat units for each habitat type were sampled in Maurice Creek for a total of nine habitat units sampled.

2.4.1 Habitat Characteristics

Sampling sites were selected based on the habitat classifications defined in the 2005 habitat assessments (AMEC & LGL 2006a). Riffles were short segments of relatively shallow and fast-moving water, their channels characterized by steep gradients and coarse, loose substrates with very few fines present. Runs were fairly homogenous reaches consisting of intermediate water depths, water velocities, and substrate sizes to those found in pools and riffles. In 2006, water depths were very low and pools were considered areas of relatively deeper and slower moving water. In 2005, pools were defined as one in which maximum pool depth multiplied by the percent cover was greater than or equal to 30 (AMEC & LGL 2006a) however, this criterion was for adult holding pools and not relevant to the 2006 investigation because rearing juveniles were the targeted age classes.

Habitat characteristics were measured at three transects per site including: wetted channel width, water depth, and water velocity (providing water depth was sufficient to submerge the flow meter propeller), and estimates of substrate composition and cover. UTM coordinates were determined with a GPS and photographs were taken at the upstream and downstream ends of each site.

2.4.2 Fish Capture

Fish were collected with a Smith-Root D15 backpack electrofisher. The method involved a single-pass of electroshocking progressing in an upstream direction in each site. Sampling crews consisted of three people: one operating the electrofishing unit, another operating a single-person lip seine and the third person responsible for fish removal to, and care of, the bucket while occasionally operating a dip net as required. Prior to shocking, 10 mm mesh stop nets were installed at the upstream and downstream ends of the sample site to minimize immigration and emigration during sampling. This was done at all tributaries except the Moberly River where flows were too high to maintain stop nets.

Single passes require less effort than three pass depletion estimates and can be an efficient use of time and resources. However, single passes can only be used as an index of relative abundance and so it is difficult to determine whether fish community structure and absolute abundance are changing over time (Meador et al., 2003). Therefore, a three-pass depletion estimate (Zippin, 1958; Lockwood and Schneider, 2000) was attempted in one of each of the habitat types (run, riffle, and pool) within the lower reach of each tributary. Length and width of each sampling site was measured to determine the sample area and the duration of electrofishing effort was recorded after each pass.

Fish captured during each pass were held separately and processed after the final pass. Fish captured at each site were identified, measured for fork length (total length for sculpin) and weighed. However, at some sites, young-of-the-year (YOY) fish were so numerous (>500) that enumeration and identification was not feasible in the field. In these cases, all fish collected were weighed and then a representative subsample of YOYs was weighed separately and preserved for later analysis. Fish in these samples were identified to species or family, enumerated, and a length range was determined in the laboratory. The proportion of each species in the preserved subsample was then used to extrapolate the abundance of each species in the total catch at each site. All live fish were released at the point of capture at the end of sampling.

2.4.3 Data Analysis

Total catches of fish were determined for each species by individual habitat unit, habitat type, lower and upper reach, and tributary.

CPUE (# of fish/100 seconds) was calculated for all the species captured in each habitat unit during the first pass. CPUE was calculated separately for young-of-the-year (0+) and juvenile (1+ or greater) stages of large-bodied fish (e.g., salmonids and suckers) captured during the first pass in each sampling site. Total catch was divided by the total electrofishing time to determine average CPUE values for individual habitat types, reaches, and for all fish captured in each tributary. This was done for all species.

When the assumptions of the triple-pass depletion estimate were met, a population density estimate (# of fish/ 100 m^2) was calculated using the "Zippin method" (Zippin, 1958) as described in Lockwood and Schneider (2000).

Differences in the abundance (CPUE) of each fish species among habitat types and between reaches were tested with an ANOVA for each site. Tukey-Kramer multi-comparisons were used to determine statistical differences among habitat types and between the reaches.

2.5 Radio Telemetry

2.5.1 Radio Transmitters

Pulse-coded microprocessor transmitters fabricated by Lotek Engineering Inc. were used to tag adult fish in the Peace River. Two transmitter sizes were used depending on the size of the fish. For the smaller fish (<400 mm fork length), the tags used were model MCFT-3FM, which were 11 mm in diameter, 59 mm in length, and weighed 10 g in air (4.6 g in water). For the larger fish (>400 mm fork length), the tags were model MCFT-3A, which were 16 mm in diameter, 46 mm long, and weighed 16 g in air (6.7 g in water). Both tag sizes had a 400-mm long antenna (150 MHz, 3-element Yagi) and a 3-v battery to transmit the signal. At a transmission rate of 1 pulse every 5 s (set at the time of manufacture), the estimated operational life was 560 and 761 days for the small and large tags, respectively. The tags were estimated to lose 2% of their useable life per week between the time of manufacture and deployment.

2.5.2 Mobile Zones and Fixed-Stations

A map of the upper Peace River system showing the zones of watersheds and mainstem units used in mobile tracking of fish is shown in Figure 3. Each of the zones is delineated on the basis of the watershed area of a stream or river, with some zones encompassing whole watershed areas and others a specific portion of the whole (usually a secondary tributary). In addition to the zones, there were several fixed station receiver sites to monitor fish movements. In all, nine fixed stations were established at strategic locations in the Peace River system (Table 6) in autumn 2005 for use in monitoring the movements of radio-tagged fish in the mainstem and several tributaries during 2006. A waterproof metal enclosure to house the receiver, switcher and battery was installed at each of the stations.

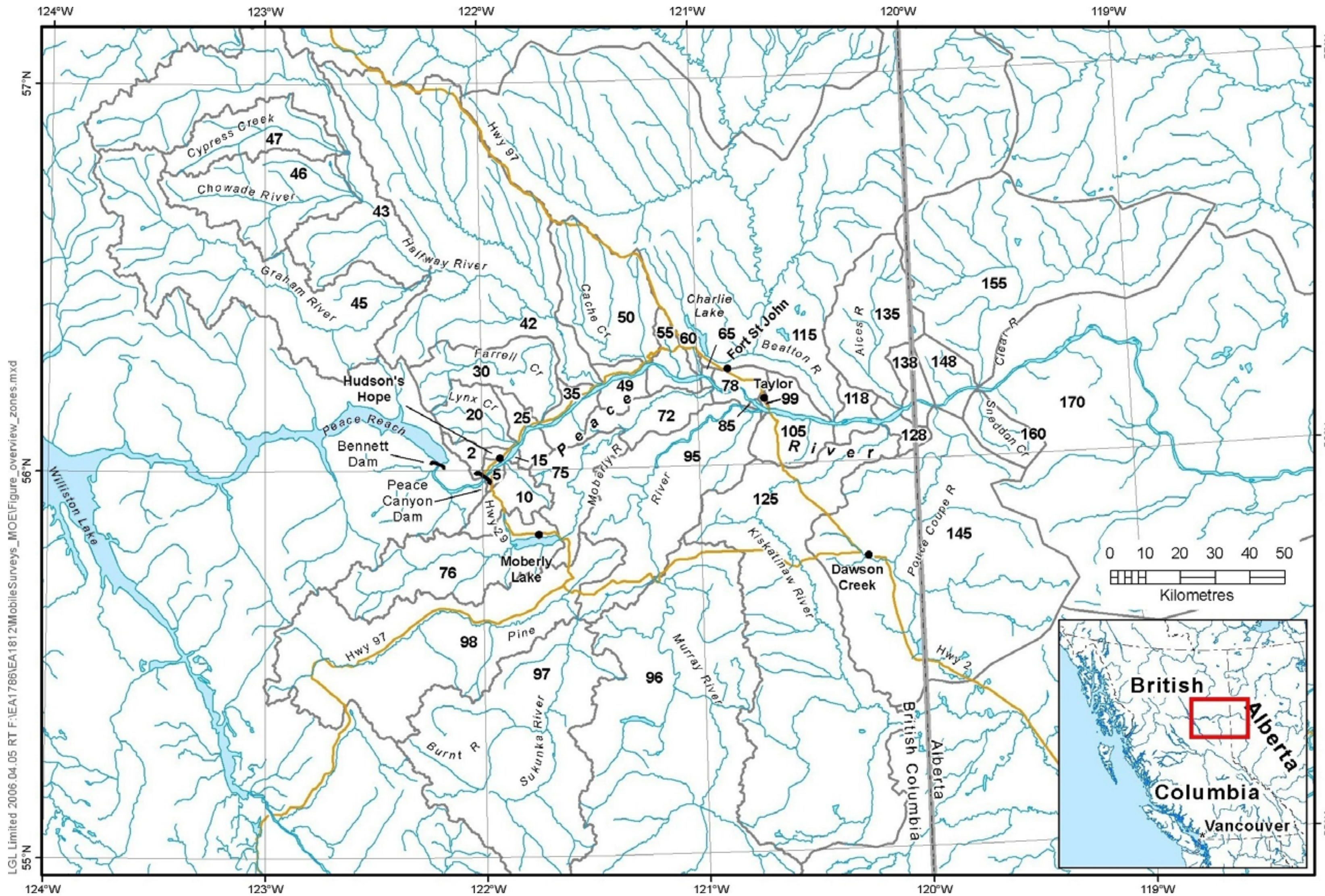


Figure 3: Map of upper Peace River system showing the zones of watersheds (numbered) used in fish mobile tracking

Six of the fixed stations were located at the confluences of the Peace River and the following tributaries: Beatton River, Pine River, Moberly River, Halfway River, Farrell Creek and Lynx Creek. Two receivers were installed along the Peace River mainstem. One was approximately three km downstream of the Halfway River confluence, and the other was approximately 200 m downstream of the Peace Canyon Dam. One receiver was sited at the mouth of the Graham River, a headwater tributary of the Halfway River (~60 km upstream from the mouth of the Halfway River).

Both the reception and directionality of the receiver at each station were thoroughly tested using the following telemetry equipment and components: two or more directional antennae (four-element "Yagi") were secured to the trunk of a tree and orientated to provide signal detections from the directions that fish were likely to be moving; a peripheral switching unit (to switch between antennae); a Lotek model SRX-400 or 600 receiver that was programmable for frequencies ranging from 148.000-152.000 MHz; a 12-v deep cycle battery; and high-grade (specialty) co-axial cable from the antennae to the switching unit (attached to port connectors in the enclosure).

Table 6: Locations of fixed stations in the Peace River system, 2006

Station Number	Station Name	Receiver Type
1	Peace Canyon Dam	Lotek SRX 400
20	Lynx Creek mouth	Lotek SRX 400
30	Farrell Creek mouth	Lotek SRX 400
40	Halfway River mouth	Lotek SRX 400
44	Graham River mouth	Lotek SRX 400
48	Peace River (3 km below Halfway)	Lotek SRX 400
70	Moberly River mouth	Lotek SRX 600
90	Pine River mouth	Lotek SRX 400
110	Beatton River mouth	Lotek SRX 600

Antennae arrangements for the fixed receivers varied with location on the river. Receivers that were installed along the mainstem of the river (i.e., not at the confluence of a tributary) were equipped with two antennae (one to detect signals originating from upstream locations and the other to detect signals from downstream locations). Receivers that were situated at the confluence of a tributary and the mainstem, had three antennae installed: one to detect signals originating from upstream mainstem locations: the second to detect signals from the tributary: and the third to detect signals from downstream mainstem locations. Sequential detections on the two or three different antenna arrangements at each station permitted determination of movement direction.

The testing procedure involved two people with hand-held radios and use of an inflatable boat at the deeper water sites. From a position in the middle of the mainstem, a live radio tag (same as those implanted in the fish) attached to a weight was lowered to a depth of 5-10 m. With the other person positioned at the receiver site and in communication with hand-held radios, the signal reception and strength of a radio tag were determined at different locations and depths in the river. Typically, testing started from 500-700 m upstream of the receiver station and continued downstream for approximately the same distance below the station.

Upon completion of testing at each station, only the receiver housing and antennae arrangement were left intact for the duration of the winter period; all other equipment was removed and re-installed in April/May 2006 to monitor the movements of radio-tagged fish through to late October 2006, at which time each of the stations was decommissioned in the manner mentioned above.

2.5.3 Fish Collection, Tagging and Releasing

The fish used in the radio telemetry study were collected from the mainstem with a Smith-Root electrofishing machine operated from a jet boat. The captured fish were held onboard in large plastic containers filled with fresh river water. Usually several fish were collected before tagging was begun. The fish holding procedures differed slightly between years. In 2005, the complete tagging operation was done onboard the boat. In 2006, because of prevailing warm water temperatures (>18°C) by the time tagging was begun in late June, the holding and tagging operations were carried out at streamside, with the fish held in a pen made of minnow mesh stretched over a plastic pipe frame (1 m per side) with a removable plywood cover. Whether on board the boat or at streamside, a minimum of 15 minutes was allowed for the fish to recover from capture before proceeding with surgically implanting a radio tag in the peritoneal cavity of a fish. In both years, the tagging procedure was as follows. An individual fish was taken from the holding container and placed in an anaesthetic bath of clove oil for about 3 min, or until it lost equilibrium. The fork length and wet weight of the fish were recorded, and the tag size used was based on the length of the fish. The anaesthetized fish was placed ventral side up on a measuring board soaked with a diluted solution of Stress Coat (Aquarium Pharmaceuticals Inc., Chalfont, PA) to minimize scale loss and help maintain the exterior mucous covering. The tag and dissecting instruments were soaked in Hibitane germicide solution before use. The gills were continuously flushed with the anaesthetic solution and the eyes were covered with a moistened paper towel.

To implant the transmitter in a fish, an incision approximately 15 mm long was made 3 mm away from and parallel to the mid-ventral line, starting about 3 mm forward of the pelvic girdle. The incision was just deep enough to penetrate the peritoneum. To provide an outlet in the body wall of the fish for the antenna to exit, a sheathed catheter was inserted in the incision, with the pointed end positioned 5-10 mm off-center from the mid-ventral line and posterior to the origin of the pelvic fins (Adams et al., 1998). Pulling the sheath back slightly onto the catheter shaft exposed the pointed end, and pressure was then applied until both the catheter and sheath pierced the skin of the fish. The catheter was then withdrawn from the incision, leaving the sheath in position through which to guide the transmitter antenna through the body wall of the fish.

The magnet deactivating the transmitter was removed and the signal emitted from the transmitter was tested just prior to being soaked in the germicide solution. The transmitters used to tag fish in September 2005 had a factory-built 20-week delay after they were first activated so that they would remain inactive during the first winter. For these tags, upon removal of the magnet, the signal emitted for approximately 1 minute to test if the tag was working, after which it stopped and remained dormant for 20 wks until it automatically became reactivated. The transmitters used in June 2006 had no inbuilt delay, and remained activated after the magnet was removed. In both years, the tag implantation procedure was the same. The transmitter number was recorded and tag implantation was begun by first threading the antenna through the catheter sheath. Both the antenna and sheath were then gently pulled posteriorly, while the transmitter was being inserted into the body cavity. The position of the transmitter in the fish was adjusted by gently pulling on the antenna until the transmitter was horizontal and directly under the incision. An intraperitoneal antibiotic, Liquimycin, was pipetted (50 μl) into the incision to prevent infection. The incision was closed with three or four interrupted, absorbable sutures, evenly spaced along the length of the incision. The antenna was attached to the side of the fish with a single suture in the caudal peduncle area about 5-6 mm posteriorly to the antenna exit site. A small amount of a cyanoadhesive compound (Nexaband) was applied to the incision and antenna exit site to secure the sutures in place. Any excess adhesive was wiped off with Q-tips. About one minute prior to completion of surgery, the flow of anaesthetic solution to the gills of the fish was replaced with fresh river water to start the fish’s recovery.

The tag implanting procedure (including the time it took for the fish to become anaesthetized initially) usually took 6-7 min to complete. Upon completion of tag implantation, onboard the boat each fish was held in a large plastic container with fresh river water, whereas at streamside each fish was held in a replicate holding pen (as described above). In both situations, the tagged fish were held for several minutes to ensure that they were in a healthy state before released. The surgical equipment was disinfected with the diluted germicidal solution after each fish.

The locations and numbers of Arctic grayling, rainbow trout and walleye that were radio-tagged and released in the Peace River mainstem during 2005 are shown in Figure 4. The same is shown for mountain whitefish, grayling and rainbow trout that were radio-tagged and released in the Peace River mainstem during 2006 (Figure 5).

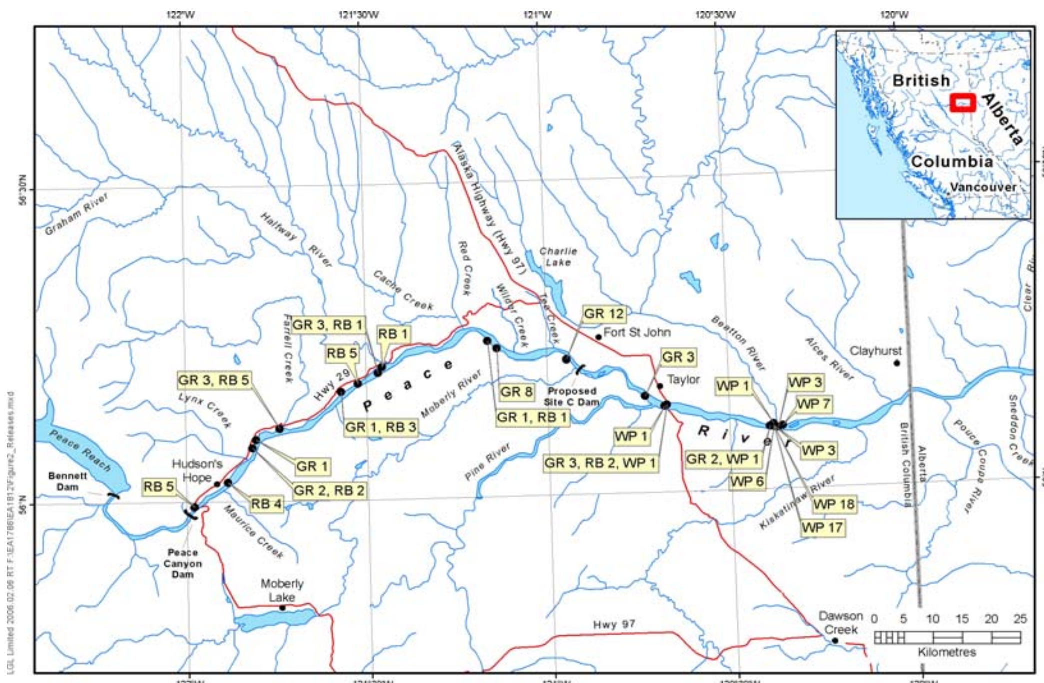


Figure 4: ***Locations and numbers of radio-tagged grayling, rainbow trout and walleye released in the Peace River mainstem, September 2005***

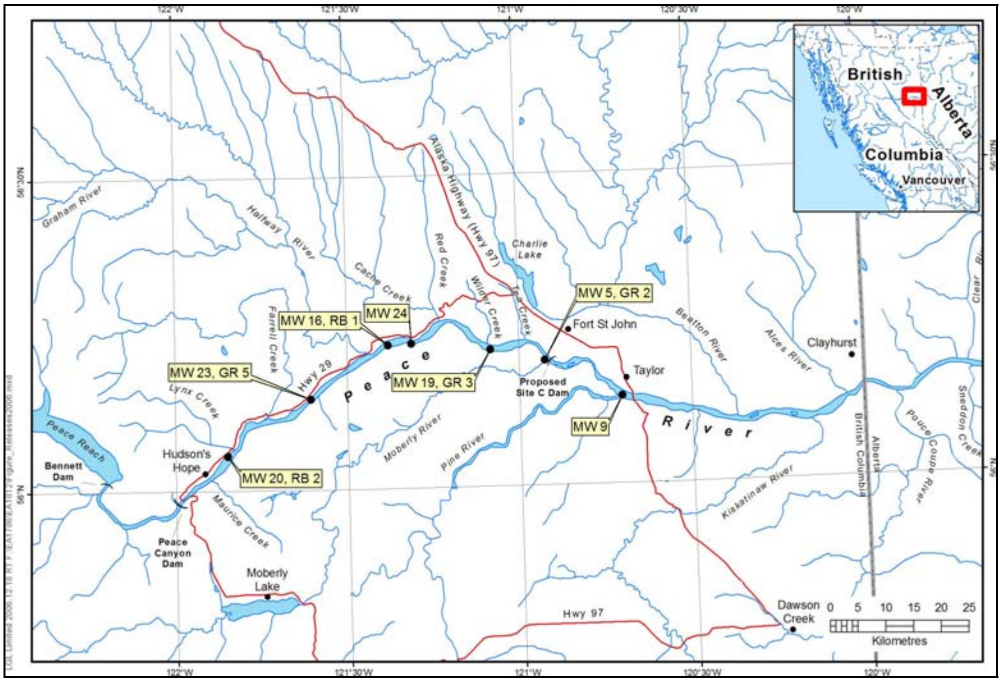


Figure 5: ***Locations and numbers of radio-tagged mountain whitefish, grayling and rainbow trout released in the Peace River mainstem, June 2006***

During September 2005, a total of 126 fish was tagged in the Peace River mainstem, comprising 29 rainbow trout, 39 Arctic grayling, and 58 walleye; during June 2006; a total of 129 fish was tagged constituting three rainbow trout, 10 Arctic grayling and 116 mountain whitefish (Table 7). For details on each of the above tagged fish see Appendix C. It was intended to spread the distribution of tagged fish of each species fairly evenly along the Peace mainstem between approximately Hudson's Hope and the Beatton River mouth. However, this was not possible as the species were clumped. Walleye, for example, were mostly captured within the vicinity of the mouth of the Beatton River, as that is where the population was most concentrated. Overall, the distribution of the releases of tagged fish differed slightly between years (see Figures 4 and 5), with the releases in 2005 extending from near the Peace Canyon Dam to the Beatton River mouth. In 2006, the releases were less widespread, being from approximately Hudson's Hope to Taylor, with the majority of them being mountain whitefish. Although mountain whitefish was fairly evenly distributed in the Peace mainstem, the distance between release groups is quite widespread because fish were not collected in extensive river sections used by Mainstream Aquatics Ltd for ongoing mark and recapture studies of the population.

With the exception of mountain whitefish, there was virtually no mortality experienced during tagging operations. The relatively high mortality (~30% of the fish captured and held for tagging) encountered with mountain whitefish was probably largely attributable to their greater sensitivity to capture and handling during the prevailing hot and dry weather conditions and warm river temperatures.

Table 7: Summary of radio-tagged fish released in the Peace River system, 2005-2006

	Number of fish	
Species	**2005**	**2006**
Mountain whitefish	0	116
Arctic grayling	39	10
Rainbow trout	29	3
Walleye	58	0
Bull trout[1]	0	54
Total	126	206

Notes: [1] these fish were tagged by Golder Associates in the Pine River system in August/September, 2006, and are not reported further herein.

2.5.4 Monitoring Fish Movement

2.5.4.1 Fixed Stations

Because of its greater memory capacity, a Lotek SRX600 receiver was installed at the Beatton River mouth (Station 110) to handle the relatively large number of tagged fish that tended to congregate at this site. Initially, a SRX600 was also installed at the Lynx Creek mouth (Station 20), but was later replaced with a SRX400 as the number of detections at this site was far fewer than expected and the SRX600 was used at the Moberly River station instead.

With the exception of the receiver located at the mouth of the Graham River (Station 44), most fixed station receivers were downloaded at approximately biweekly intervals over the duration of the monitoring period (Table 8). This operation entailed downloading the telemetry data to a portable computer and subsequently uploading it to either the AMEC or LGL ftp site. Because of its distant location up the Halfway River and few fish detected at this site, the Graham station was usually downloaded once a month. At the start of each downloading operation, a date, time and frequency check was carried out on the receiver. After downloading, and before erasing the internal memory in the receiver, a diagnostic program was run on the download file to ensure that all of the data had been transferred, the file was readable, and the receiver and antennae had been operating properly. Generally, at each of the stations, all was in good working order throughout the monitoring period. At one of the stations the receiver was severely damaged by brush and grass fires in spring and had to be replaced, and at another (Station 20) the solar panel was stolen, although no data were lost as battery power was sufficient until the next download. The solar panel at this station was not replaced for the rest of the season, instead, the battery was checked regularly and replaced with a fully charged one as necessary.

Table 8: Dates of downloads for each of the fixed stations, 2006

Date	Fixed Stations								
	1	20	30	40	44	48	70	90	110
10 April	-	-	-	-	-	-	-	X	X
2-4 May	X	X	X	X	X	X	X	X	X
9-10 May	-	-	-	-	-	-	X	-	X
16-18 May	X	X	X	X	-	X	-	X	-
21 May	-	-	-	-	-	-	X	-	-
30 May	-	-	-	-	-	-	-	-	X
1 June	X	X	X	X	-	-	-	-	-
7-9 June	-	-	-	-	-	X	X	X	-
15 June	X	X	X	X	-	X	-	-	-
19-20 June	-	-	-	-	X	-	X	X	X
1-2 July	X	X	X	X	-	X	X	X	X
15-16 July	X	X	X	X	X	X	X	X	X
26-27 July	X	X	X	X	-	X	X	X	X
7-8 August	X	X	X	X	X	X	X	X	X
18 August	-	X	-	-	-	-	-	-	-
23-24 August	X	X	X	X	X	X	X	X	X
5-6 September	X	X	X	X	X	X	X	X	X
21-23 September	X	X	X	X	X	X	X	X	X
12-13 October	X	X	X	X	X	X	X	X	X
21-23 October	X	X	X	X	X	X	X	X	X

Note: - indicates that stations were not visited.

2.5.4.2 Mobile Tracks

During 2006, mobile tracks of the Peace River mainstem and specific tributaries were conducted monthly between February and June, inclusive. Thereafter, as the movement of fish dropped-off appreciably, mobile tracks were conducted bimonthly, with one in August and another (the final track in 2006) in October. In all mobile tracks, two Lotek receivers (either SRX 400 or a combination of SRX400 and SRX600) were on board the aircraft. In addition to the aircraft GPS system, the observer(s) on board had a dedicated Garmin GPS unit which automatically logged track-line positions which were later used to reconstruct the survey tracks on the fish distribution maps (see Maps 1-12). Both the February and March aerial surveys were done with the use of a helicopter, whereas the April survey was done with a fixed-wing aircraft. Thereafter, the surveys were completed with a mix of helicopter and fixed-wing aircraft. The fixed-wing was generally used for the long-distance flights along the Peace River mainstem (downstream of the Beatton River mouth into Alberta) and some of the tributaries which had fewer fish. However, in both the August and October surveys the use of a fixed-wing aircraft was abandoned due to interference from the aircraft's navigational system with the Lotek receivers onboard, and so these surveys were done solely by helicopter.

Maps 1-12 show the dates and flight paths for each of the aerial surveys. Typically, mobile surveys were conducted along the Peace River mainstem from the Peace Canyon Dam to about as far as Dunvegan, Alberta (~140 km east of Fort St John); in addition, variable distances were tracked up the Beatton (max ~42 km), Moberly (max ~50 km), and Pine (max ~ 30 km) rivers. Both the August and October tracks included surveys up the Halfway River to check for the presence of tagged fish on the spawning grounds in the headwaters of this system. At the end of each survey, the radio telemetry and GPS data were downloaded to a portable computer and then uploaded to either the AMEC or LGL ftp site. All radio-tagged fish detected during mobile surveys were assigned to zones of the Peace River watershed (see Figure 3). Later the data were accessed for analysis with LGL's *Telemetry Manager* and a combination of ArcGIS and Visual FoxPro software to plot the distribution of fish detections on maps for each of the mobile surveys.

2.5.4.3 Data Processing

Analysis of the radio telemetry data of both the mobile tracking surveys and fixed-station receivers was done using custom database software. This software facilitates data organization, validation and analysis through the systematic application of user defined criteria. All raw data were archived so that these criteria could be changed at any time to provide results for different spatial or temporal resolution, or to test alternate noise filtering criteria. An important component of radio telemetry study is the removal of false records in receiver files that originate from electronic noise. Several fixed station receivers picked up considerable environmental noise, despite various adjustments to the receivers in the field to overcome/reduce the problem. The noise problem was mostly on receivers at the mouths of the Beatton, Pine and Moberly rivers, and near the Peace Canyon Dam, but particularly excessive on the SRX 600 receiver at the mouth of the Beatton. The noise was probably largely due to radios and other communicative devices in existence in the area. Initially, individual hits with power levels greater than 30 were accepted as valid detections. However, due to the presence of numerous bogus hits at high power levels, various levels of filtering were conducted on the database. Finally, the criteria used for valid records were that they had power levels >50 (on a scale of 1-232), two detections within the same zone or fixed station within one minute, and were spatially between earlier and later records for the same individual fish. This level of filtering produced satisfactory results for all stations except the Beatton. A re-examination of the raw data from the Beatton fixed station revealed that this station still had an unusually high number of noise records, many of which corresponded to valid tag code combinations. As there was no objective way of discriminating between noise and valid detections, the data from the Beatton station were not included in the analysis.

As a final check, the mobile tracking and fixed station data were re-examined collaboratively to develop a data set in which possible outliers were carefully assessed and removed, if warranted. Any outliers that were either multiple detections of the same fish or consistent with the other mobile and fixed station data, were retained in the final data set.

The software then created a compressed database of the sequential detections for each radio-tagged fish. Each record identified the individual fish by a unique tag number, the zone number, first and last time and date for the sequential detections in a specific zone, and the maximum power level for all detections in that interval. The compressed database was used to determine where each fish was at a particular time in the Peace River system, residence times at each station, distance moved between detections, sites of first, last and all detections, movement past Site C, etc.

Various analyses/graphical presentations were conducted on the data set using *Telemetry Manager*, *Visual FoxPro*, *MS Excel* and *AMP version 4.0* (statistical package) to determine and assess the detections, distributions, and movements of the tagged populations. Based on these analyses, etc., the results presented include the following:

- a plot of the number of detections of different fish of each species for each of the fixed stations;
- spreadsheets of the number of detections for each species from the mobile tracking data by zone and release site to determine whether the detections were upstream or downstream of the release site;

- plots of the movements of all fish of each species, as well as two examples of sequential movement of individual fish (outliers and others) of each species, on maps of the Peace River study area;
- plots of the mean number of movements and distances moved by species shown monthly and for the overall tracking period;
- the distance moved in either an upstream or downstream direction by each fish of each species over the duration of the tracking period was computed using eastings and northings between successive detections to approximate river distance. The incremental distances moved were then summed to obtain an estimate of the total distance moved by each fish. These values were used in box plots showing median, 25th to 75th percentiles, and minimum and maximum distances moved by each species during the period tracked;
- Plots of fish upstream and downstream movements by species in the Peace River mainstem during the period tracked, with the distance moved between successive detections computed from values of eastings and northings. Fish movement westward (upstream) was recorded as positive, and eastward (downstream) as negative;
- An estimate of the percentage of the tagged population of each species moving past Site C, using Moberly River mouth (Station 70) as an approximation of the location of a Site C dam. The movement of tagged fish in either an upstream or downstream direction past Station 70 and fixed station data was tallied from the mobile tracking data to obtain an estimate of the percentage of each of the tagged populations moving past this site. The fish were grouped into two groups, with one group comprising all fish upstream, and the other group constituting all fish downstream of Site C. The percentage of the tagged population of each species moving past Site C is shown graphically. Differences between species pairs were tested by Wilcoxon/Kruskal-Wallis nonparametric tests (based on rank sums of fish counts past Station 70); and
- Also, the directional movement (i.e., upstream vs. downstream) of fish past Site C by species by month is shown graphically for the period tracked.

3.0 RESULTS

3.1 Environmental Characteristics

3.1.1 Discharge

Flow data at Water Survey of Canada stream gauges on the Peace River at Taylor, and Halfway, Moberly and Pine rivers for the ten year period between 1996 and 2006 (WSC 2006a; 2006b) are presented in Appendix A (Tables 1 to 4). It is important to note that all 2006 discharge data are preliminary and subject to change upon final calibration by Water Survey of Canada.

Peace River flows in 2006 ranged between the 10 year average and the 10 year minima (Figure 6) and, although flow regulation is attenuated downstream by discharge from unregulated tributaries, Peace River flows at Taylor are largely dictated by flows out of Peace Canyon Dam. In the Halfway, Moberly, and Pine rivers, two consistent and important features are evident from the 2006 hydrographs: 1) an initial spring freshet peak occurred earlier than normal; and 2) the peak discharge and receding summer volumes were similar to the 10 year minimum discharge (Figures 7 to 9).

For the smaller Peace River tributaries, hydrographs estimated using stage-discharge relationships show peak spring flows occurred around May 24 and then recede to low summer levels by mid-June (Figures 10 to 13). Although there is no data for the rest of the year, it is likely that flow patterns in the tributaries are similar to those seen in the larger tributaries. In fact, when the small tributaries were visited in the summer and the fall, discharge was very low and some habitat units were isolated without flow. In Maurice Creek there were two locations where flow was measured. The downstream gauge placed near the hoop net recorded the influence of the Peace River while the upstream gauge was placed beyond the back flow zone and recorded the flow regime of Maurice Creek (Figure 13).

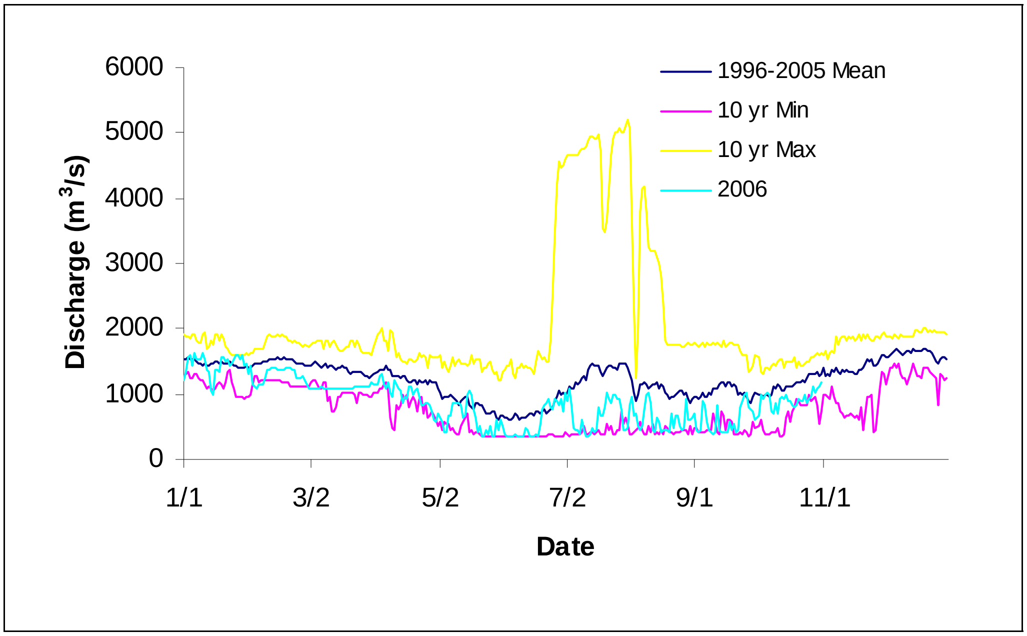


Figure 6: ***Daily discharge (m3/s) of the Peace River for 2006, and mean, minima and maxima for the period 1996 to 2005***

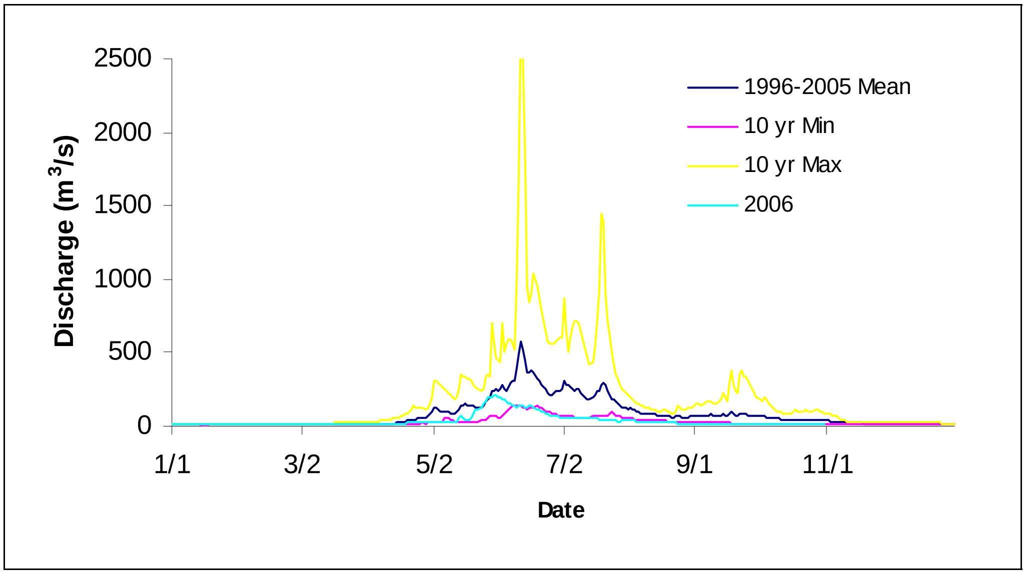


Figure 7: ***Daily discharge (m^3/s) of the Halfway River for 2006, and mean, minima and maxima for the period 1996 to 2005***

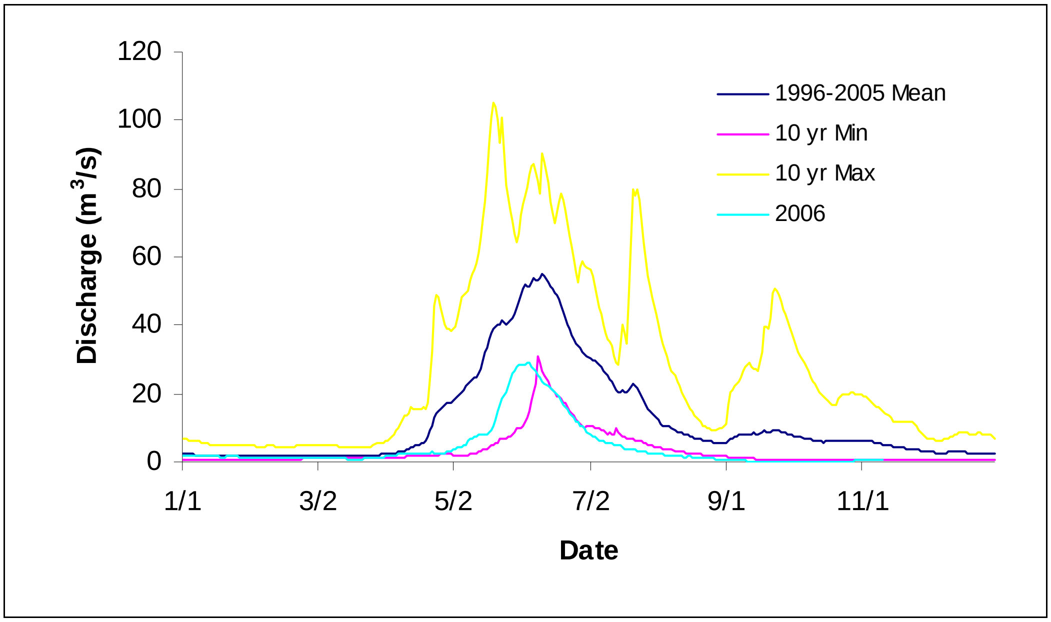


Figure 8: ***Daily discharge (m^3/s) of the Moberly River for 2006, and mean, minima and maxima for the period 1996 to 2005***

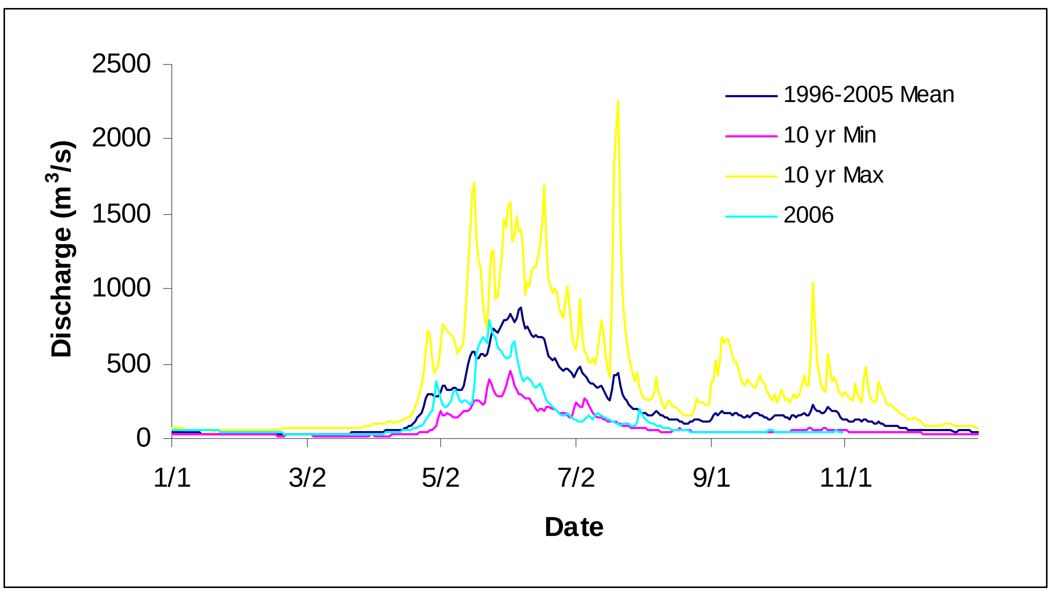


Figure 9: ***Daily discharge (m^3/s) of the Pine River for 2006, and mean, minima and maxima for the period 1996 to 2005***

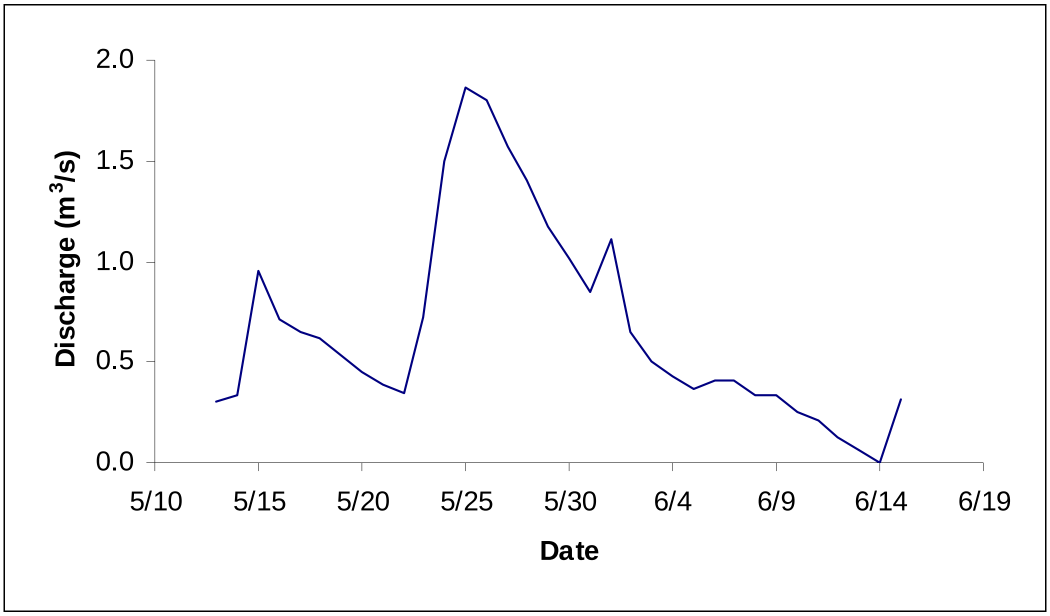


Figure 10: ***Estimated daily discharge (m^3/s) of Cache Creek during spring 2006 sampling***

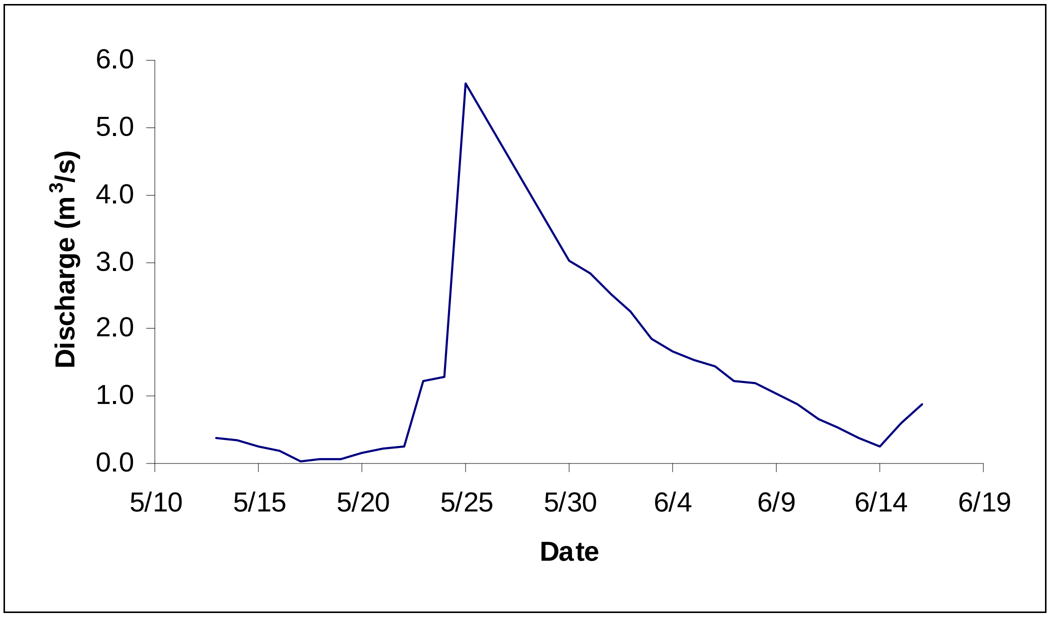


Figure 11: ***Estimated daily discharge (m^3/s) of Farrell Creek during spring 2006 sampling***

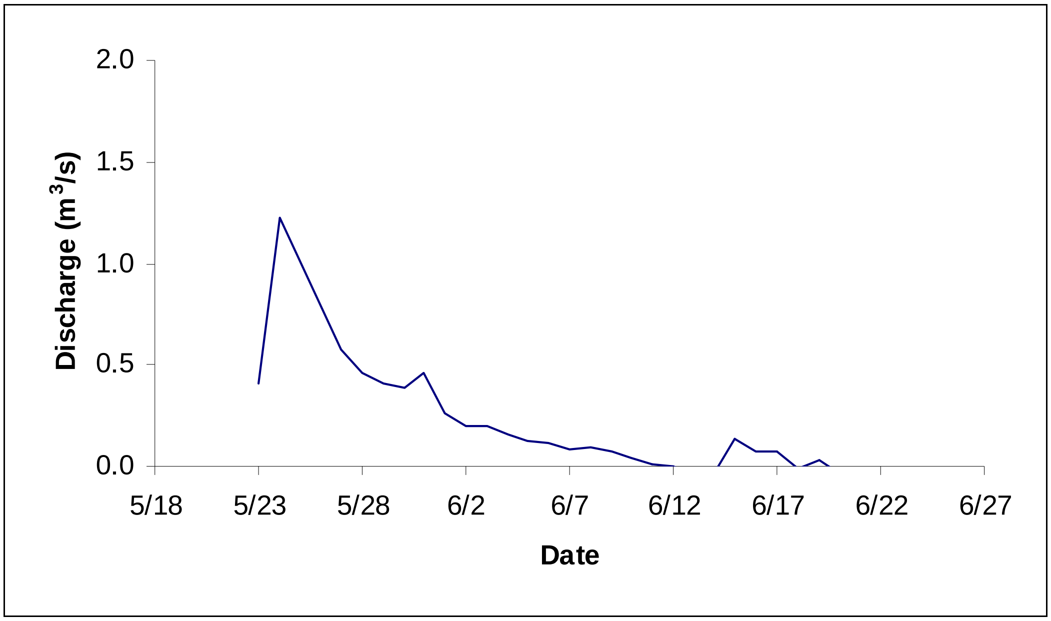


Figure 12: ***Estimated daily discharge (m^3/s) of Lynx Creek during spring 2006 sampling***

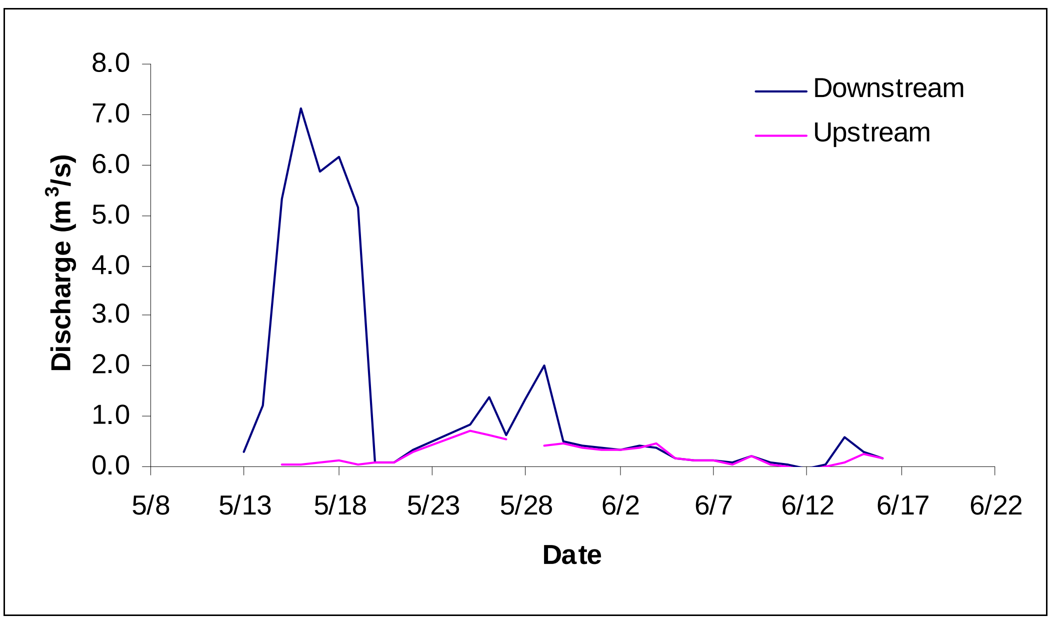


Figure 13: ***Estimated daily discharge (m^3/s) of Maurice Creek during spring 2006 sampling. The downstream gauge near the hoop net shows the influence of the Peace River while the upstream gauge was placed beyond the back flow zone.***

3.1.2 Water Temperatures

Mean daily water temperatures in the Peace River at the proposed Site C dam site, and near the mouths of the Beatton, Pine, and Moberly rivers, Wilder Creek, Cache Creek, the Halfway River, and Farrell, Lynx, and Maurice creeks for the fall 2005 and spring, summer, fall 2006 are presented in Appendix A, and in Figures 14 to 23, respectively. Mid-summer temperatures in the Peace River were more moderate (<17ºC) than in any of the Peace River tributaries which, in the smaller creeks, midday temperatures exceeded 25ºC on some days in July. Temperature fluctuations in the Peace River were also less variable than in any of the Peace River tributaries. Water temperatures in the Peace River are largely dictated by the temperature of water released through Peace Canyon Dam and, hence, by temperatures in Dinosaur Reservoir. Daily and monthly temperature fluctuations are smaller in the Peace River than in its tributaries because of its larger volume and, hence, its larger thermal mass. In the Beatton, Pine and Halfway rivers, summer temperatures rarely peaked above 25ºC. Water temperatures were highest in Farrell Creek and peaked at 29ºC in late June (Appendix A). Of the Peace River tributaries monitored, Halfway River and Maurice Creek were the coolest and temperatures in these tributaries never reached 25ºC (Figure 20 and 23, respectively). Wilder Creek was dry most of the year so only water temperatures for fall 2005 and spring 2006 could be reported (Figure 18). For sites monitored in 2005 and 2006, fall temperature ranges were similar in both years.

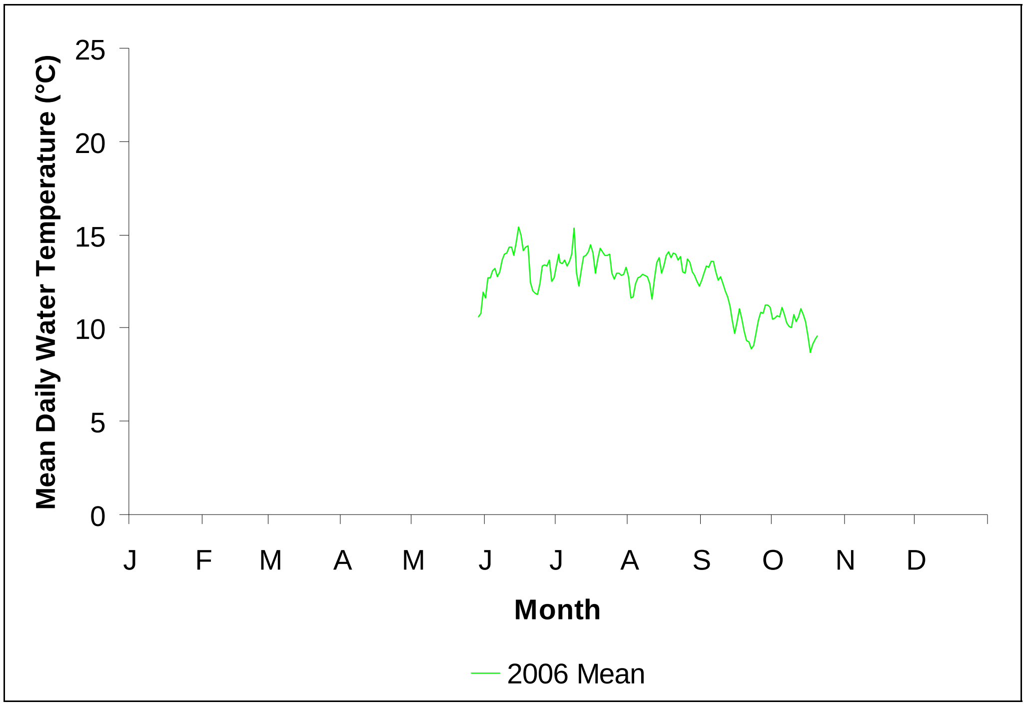


Figure 14: ***Water temperatures for Peace River at proposed Site C dam location***

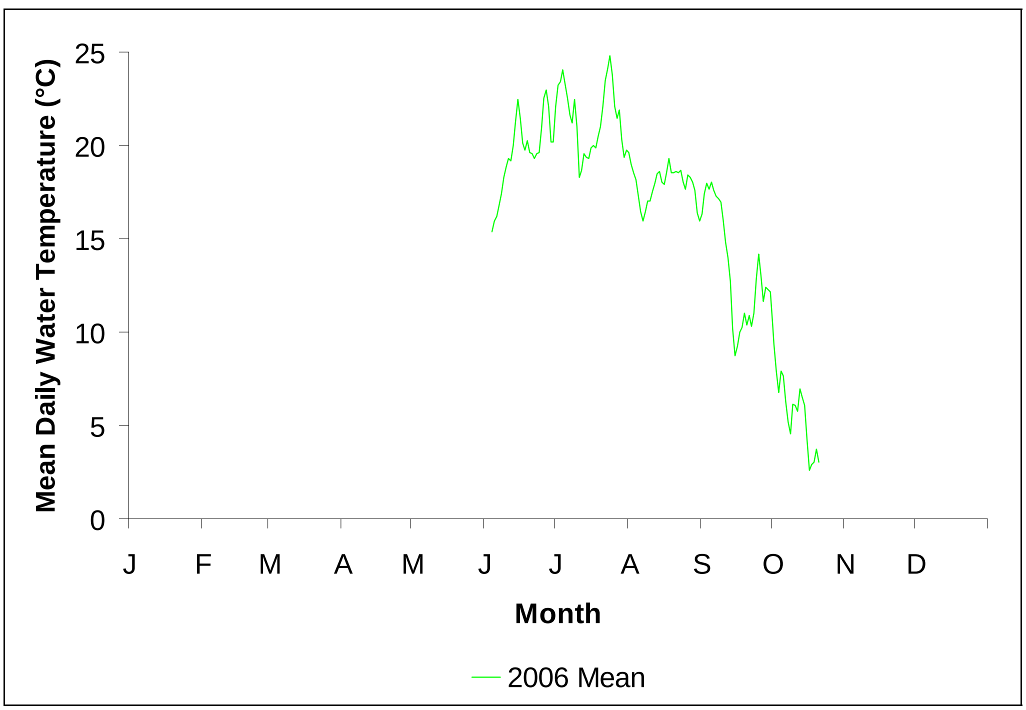


Figure 15: ***Water temperatures for the Beatton River***

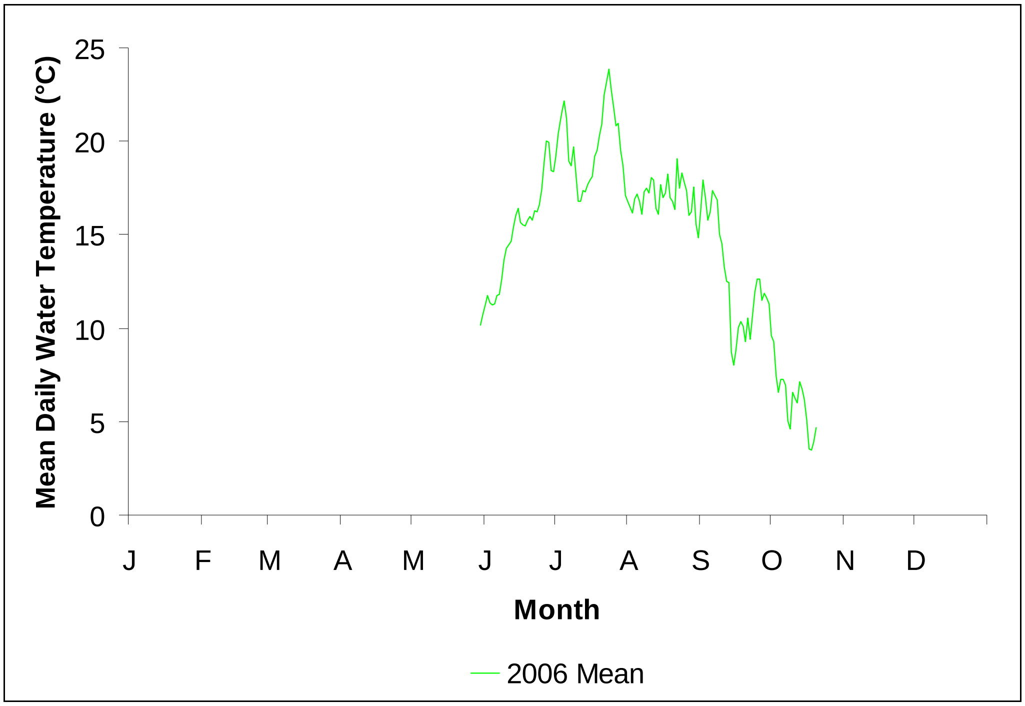


Figure 16: Water temperatures for the Pine River

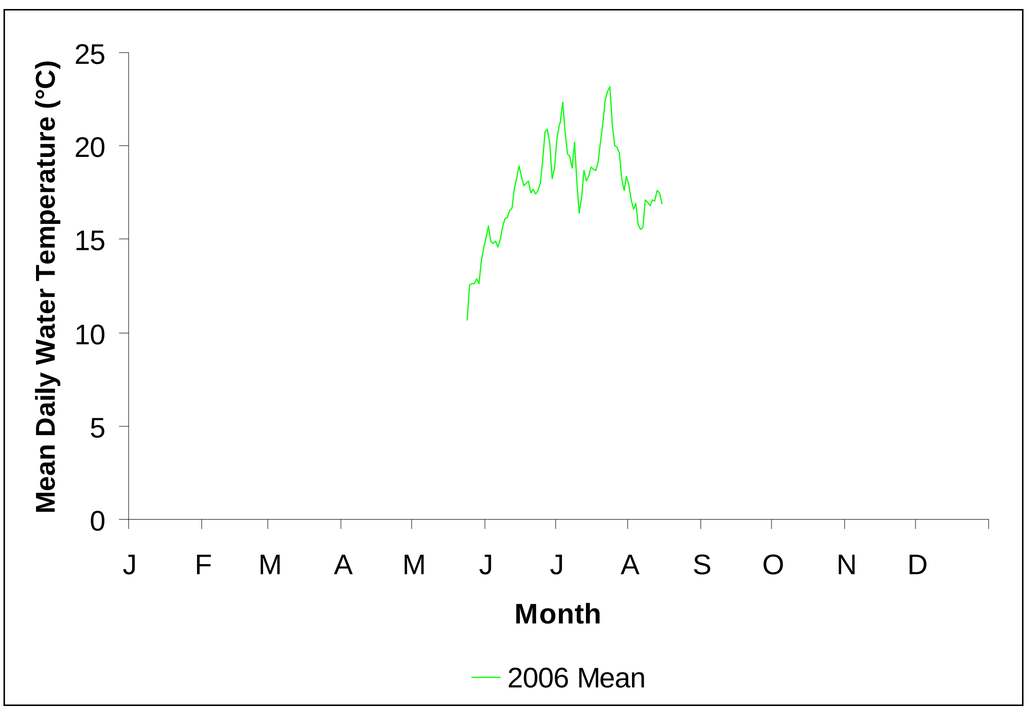


Figure 17: Water temperatures for the Moberly River

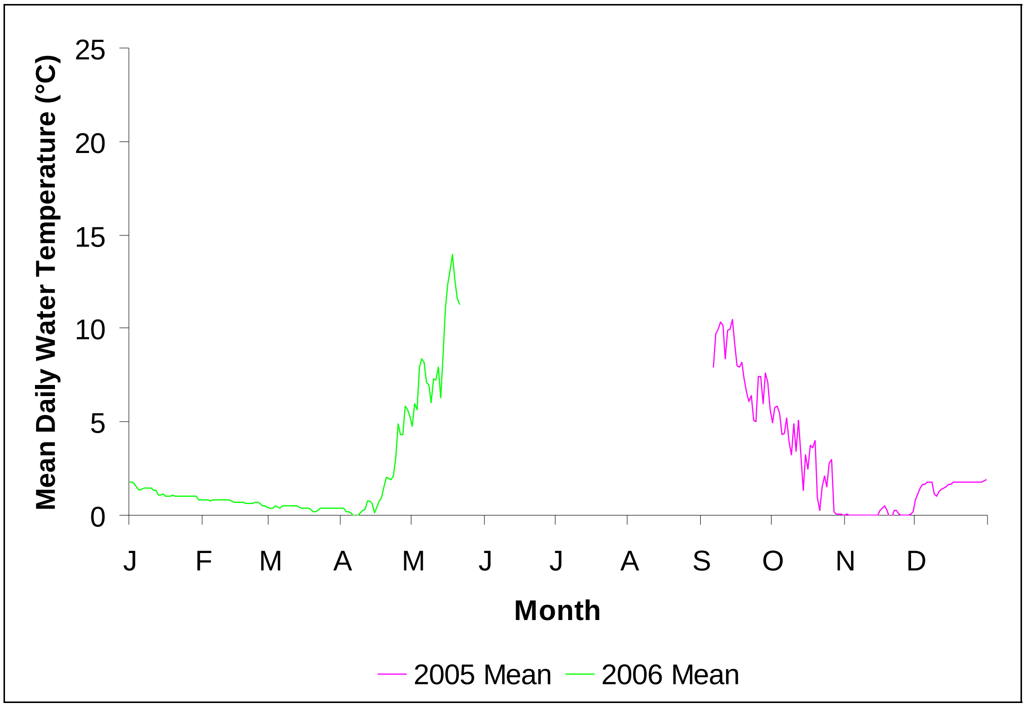


Figure 18: Water temperatures for Wilder Creek

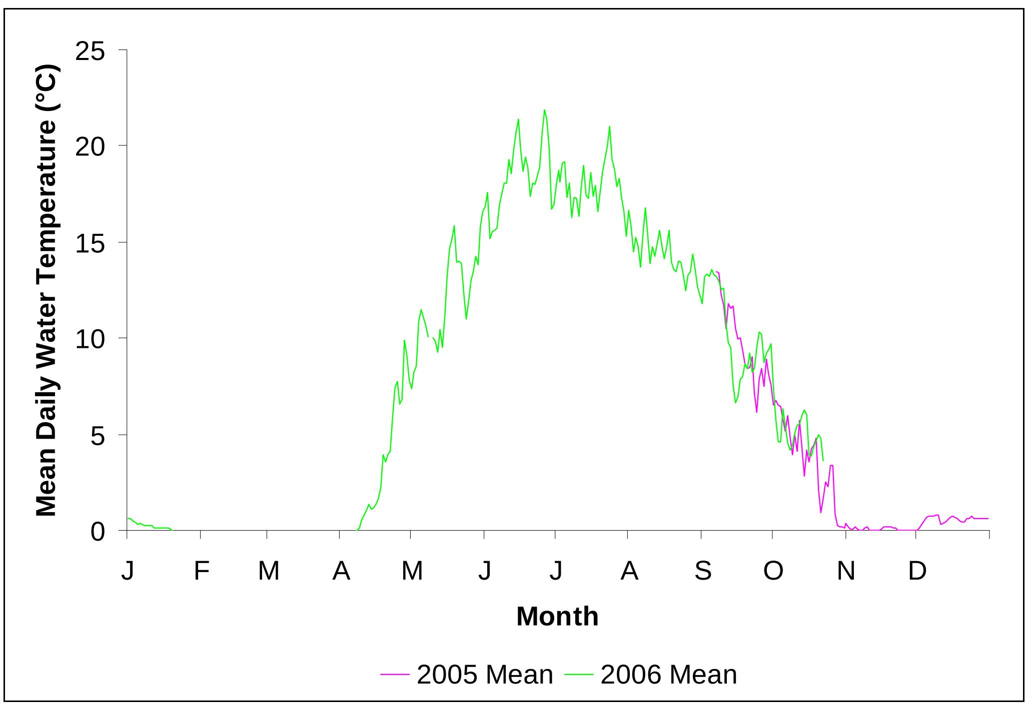


Figure 19: Water temperatures for Cache Creek

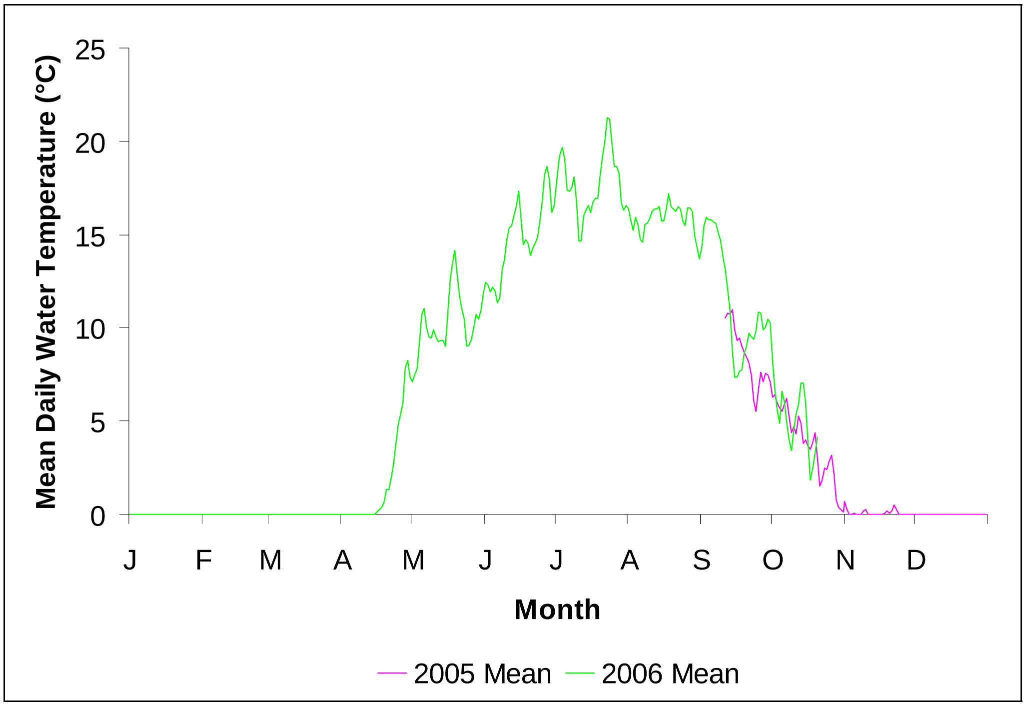


Figure 20: Water temperatures for the Halfway River

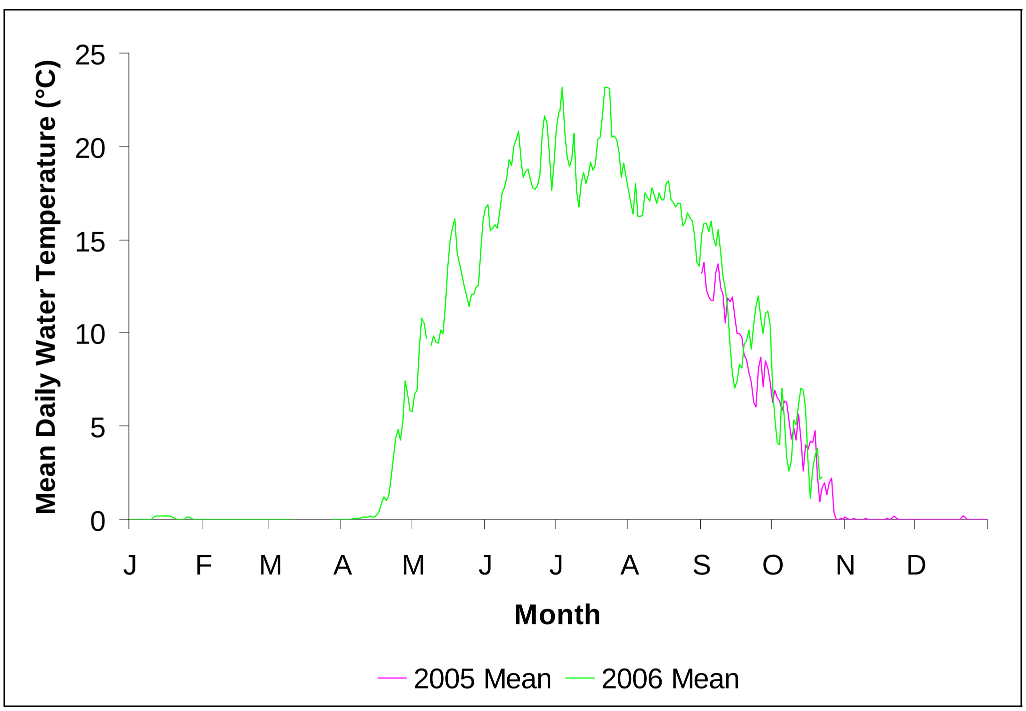


Figure 21: Water temperatures for Farrell Creek

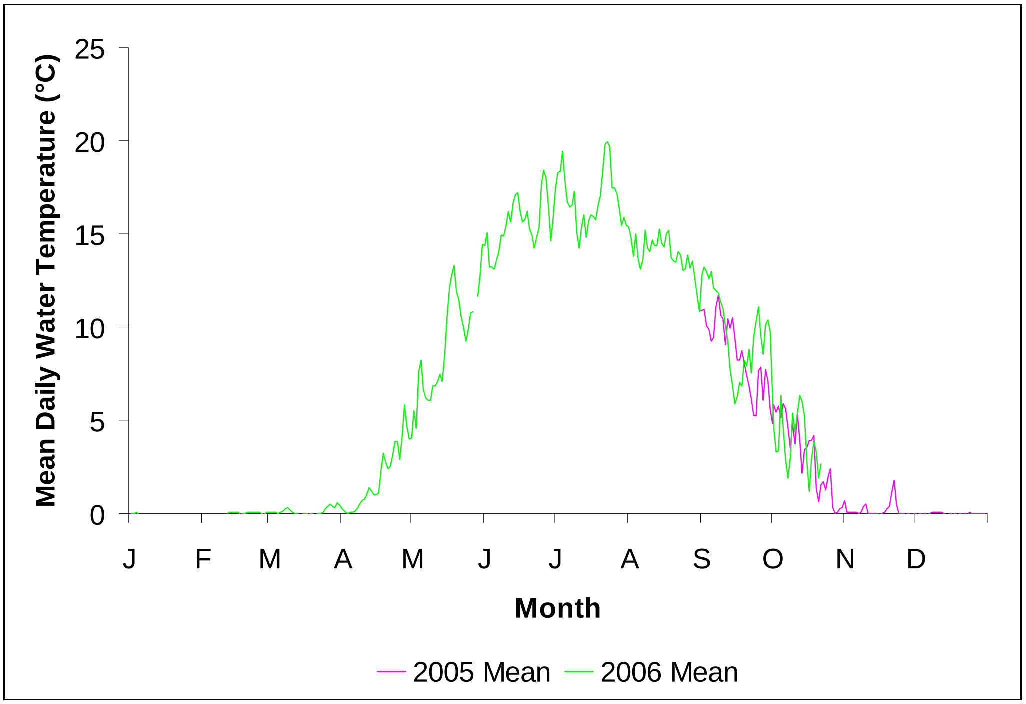


Figure 22: Water temperatures for Lynx Creek

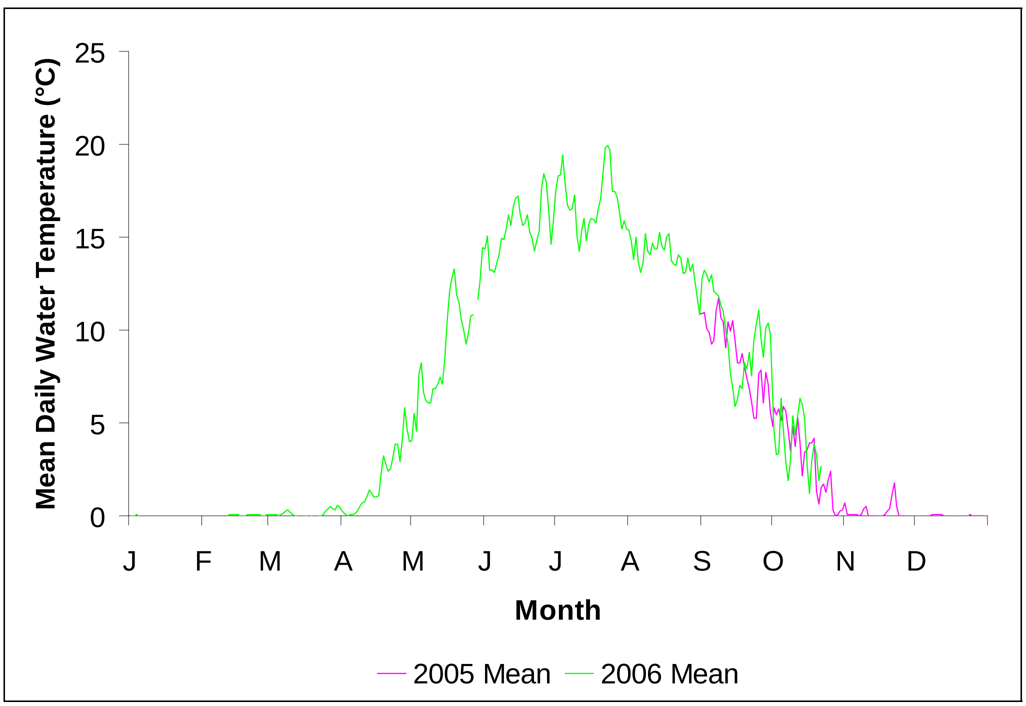


Figure 23: Water temperatures for Maurice Creek

3.2 Spring Spawning Run Enumerations

A total of 19 fish species was captured during the 2006 fisheries investigations. These included six sportfish species, three species of suckers, seven species of minnow, and three species of sculpin. Species captured included the provincially blue-listed bull trout and the provincially red-listed spottail shiner. Common and scientific names and fish codes used throughout this document are presented in Table 9.

Table 9: Fish species recorded in Peace River tributaries, 2006

Category	Code	Common Name	Scientific Name
Sportfish	ARGR	Arctic grayling	Thymallus arcticus
	BLTR	Bull trout	Salvelinus confluentus
	BURB	Burbot	Lota lota
	KOKA	Kokanee	Oncorhynchus nerka
	MNWH	Mountain whitefish	Prosopium williamsoni
	RNTR	Rainbow trout	Oncorhynchus mykiss
Suckers	LRSC	Largescale sucker	Catostomus macrocheilus
	LNSC	Longnose sucker	Catostomus catostomus
	WHSC	White sucker	Catostomus commersonii
Minnows	FLCH	Flathead chub	Platygobio gracilis
	LKCH	Lake chub	Couesius plumbeus
	LNDC	Longnose dace	Rhinichthys cataractae
	NRPM	Northern pikeminnow	Ptychocheilus oregonensis
	PMCH	Peamouth	Mylocheilus caurinus
	RDSH	Redside shiner	Richardsonius balteatus
	SPSH	Spottail shiner	Notropis hudsonius
Sculpins	PRSC	Prickly sculpin	Cottus asper
	SLSC	Slimy sculpin	Cottus cognatus
	SPSC	Spoonhead sculpin	Cottus ricei

A total of 1,853 fish was captured in Peace River tributaries in hoop nets during the spring sampling program in 2006 (Table 10). Longnose sucker were the most commonly captured fish species, comprising 47% of the total hoop net catches in all tributaries. Redside shiner, northern pikeminnow, and largescale sucker were the next most commonly captured fish species, comprising 18%, 11%, and 9% of the total hoop net catches, respectively. No other fish species comprised more than 4% of the total catch. Rainbow trout were the most commonly captured sportfish species but only comprised 4% of the total catch. As a group, suckers comprised 59% of the total catch while minnows, sportfish, and sculpins comprised 33%, 8%, and <1% of the total catch. Daily fish captures, by species, for each tributary sampled in spring 2006 are summarized in Appendix B, Tables 6-11. Individual fish data are presented by tributary in Appendix B.

Longnose sucker were the most abundant species captured moving upstream in all Peace River tributaries except in the Moberly River where longnose sucker were second only to northern pikeminnow. In all tributaries, longnose sucker comprised at least 28% of the total catch with the highest percentage in Maurice Creek where longnose sucker comprised 73% of the total catch.

Arctic grayling and mountain whitefish were captured moving upstream in the greatest numbers in the Moberly River. These two species each comprised 11-12% of the total Moberly hoop net catch but no more than 2% each in any other tributary. In fact, the only other Arctic grayling captured in the hoop nets in any other tributary was one fish captured in the Halfway River.

Table 10: Number and relative abundance of fish captured in Peace River tributaries in Spring 2006 hoop netting.

		Tributary													
		Maurice		Lynx		Farrell		Halfway		Cache		Moberly		All Sites	
Group	Species	n	%	n	%	n	%	n	%	n	%	n	%	n	%
Sportfish	ARGR	0	0.0	0	0.0	0	0.0	1	0.3	0	0.0	20	11.3	21	1.1
	BLTR	2	0.9	6	1.9	1	0.3	1	0.3	0	0.0	1	0.6	11	0.6
	BURB	0	0.0	0	0.0	0	0.0	11	3.5	1	0.2	0	0.0	12	0.6
	KOKA	1	0.5	0	0.0	1	0.3	1	0.3	0	0.0	0	0.0	3	0.2
	MNWH	3	1.4	3	1.0	5	1.5	2	0.6	0	0.0	21	11.9	34	1.8
	RNTR	34	15.4	31	9.9	9	2.7	1	0.3	0	0.0	0	0.0	75	3.9
	Subtotal	40	18.1	40	12.8	16	4.8	17	5.4	1	0.2	42	23.7	156	8.1
Suckers	LNSC	161	72.9	160	51.3	107	32.1	131	41.6	287	50.4	50	28.2	896	46.5
	LRSC	1	0.5	3	1.0	86	25.8	50	15.9	26	4.6	8	4.5	174	9.0
	WHSC	0	0.0	1	0.3	0	0.0	1	0.3	0	0.0	5	2.8	7	0.4
	Subtotal	162	73.3	164	52.6	193	58.0	182	57.8	313	54.9	63	35.6	1077	55.9
Minnows	FLCH	0	0.0	0	0.0	0	0.0	5	1.6	1	0.2	0	0.0	6	0.3
	LKCH	0	0.0	0	0.0	0	0.0	2	0.6	7	1.2	0	0.0	9	0.5
	LNDC	6	2.7	6	1.9	1	0.3	4	1.3	10	1.8	4	2.3	31	1.6
	NRPM	1	0.5	15	4.8	88	26.4	29	9.2	19	3.3	52	29.4	204	10.6
	PMCH	0	0.0	6	1.9	5	1.5	0	0.0	2	0.4	0	0.0	13	0.7
	RDSH	0	0.0	51	16.3	21	6.3	69	21.9	199	34.9	14	7.9	354	18.4
	SPSH	0	0.0	0	0.0	0	0.0	1	0.3	0	0.0	0	0.0	1	0.1
	Subtotal	7	3.2	78	25.0	115	34.5	110	34.9	238	41.8	70	39.5	618	32.1
Sculpin	SLSC	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	2	1.1	2	0.1
	Subtotal	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	2	1.1	2	0.1
Grand Total		209		282		324		309		552		177		1853	

The number of fish captured backpack electrofishing and the catch-per-unit-effort (CPUE) by tributary are provided in Table 11. Individual fish data are presented by tributary in Appendix B. In total, 772 fish were collected and 15 species were represented in the electrofishing catch.

Sportfish species captured included bull trout, mountain whitefish and rainbow trout. However, sportfish contributed <10% to the overall electrofishing catch, in all sites except Maurice Creek. In Maurice Creek, rainbow trout were abundant and comprised 29% of the catch.

The proportion of fish in the electrofishing catch was different than those captured in the hoop net. Longnose sucker (27% of catch) and redside shiners (15%) were abundant species encountered in both sampling. However, longnose dace and sculpin, species rarely captured in the hoop net, were very abundant in electrofishing surveys comprising 25% and 11% of catch, respectively. These differences are not unexpected given that electrofishing targets small-bodied fish while the purpose of the hoop net sampling is to capture spawning adults of large-bodied species. These electrofishing data suggest that the hoop net did not miss any large-bodied adults moving into any of the tributaries to spawn.

Table 11: ***Number, relative abundance, and catch-per-unit-effort, by species, for fish captured backpack electrofishing in Peace River tributaries during spring 2006***

		Cache Creek			Halfway River			Farrell Creek			Lynx Creek			Maurice Creek			Combined Total		
Group	**Species**	**n**	**%**	**CPUE *100s**[1]	**n**	**%**	**CPUE *100s**	**n**	**%**	**CPUE *100s**	**n**	**%**	**CPUE *100s**	**n**	**%**	**CPUE *100s**	**n**	**%**	**CPUE *100s**
Sportfish	BLTR	0	0	0	1	0.6	0.03	0	0	0	0	0	0	1	0.7	0.02	2	0.3	0.05
	MNWH	1	0.4	0.05	15	9.1	0.40	1	1.9	0.04	7	5.4	0.24	4	2.9	0.08	28	3.6	0.81
	RNTR	0	0	0	0	0	0	0	0	0	2	1.5	0.07	40	28.8	0.79	42	5.4	0.86
	Subtotal	1	0	0	16	10	0	1	2	0	9	6.9	0.31	45	32.4	0.88	72	9.3	1.71
Suckers	LNSC	59	20.8	2.86	37	22.4	0.98	25	46.3	0.94	83	63.8	2.89	1	0.7	0.02	205	26.6	7.69
	LRSC	7	2.5	0.34	2	1.2	0.05	0	0	0	0	0	0	0	0	0	9	1.2	0
	WHSC	0	0	0	0	0	0	0	0	0	2	1.5	0.07	0	0	0	2	0.3	0
	Subtotal	66	23	3	39	24	1	25	46	1	85	65.4	2.96	1	1	0	216	28.0	8
Minnows	FLCH	1	0.4	0.05	2	1.2	0.05	0	0	0	0	0	0	0	0	0	3	0.4	0
	LKCH	38	13.4	1.84	3	1.8	0.08	1	1.9	0.04	0	0	0	0	0	0	42	5.4	2
	LNDC	67	23.6	3.25	67	40.6	1.78	26	48.1	0.97	23	17.7	0.80	6	4.3	0.12	189	24.5	6.92
	NRPM	1	0.4	0.05	1	0.6	0.03	0	0	0	2	1.5	0.07	0	0	0	4	0.5	0
	PMCH	0	0	0	0	0	0	0	0	0	6	4.6	0.21	0	0	0	6	0.8	0
	RDSH	110	38.7	5.33	3	1.8	0.08	1	1.9	0.04	5	3.8	0.17	0	0	0	119	15.4	6
	Subtotal	217	76.4	10.52	76	46.1	2.02	28	51.9	1.05	36	27.7	1.26	6	4	0	363	47.0	15
Sculpin	PRSC	0	0	0	23	13.9	0.61	0	0	0	0	0	0				23	3.0	0.61
	SLSC	0	0	0	5	3.0	0.13	0	0	0	0	0	0				5	0.6	0.13
	SPSC	0	0	0	6	3.6	0.16	0	0	0	0	0	0	0	0	0	6	0.8	0
	Sculpin	0	0	0	0	0	0	0	0	0	0	0	0	87	62.6	1.71	87	11.3	1.71
	Subtotal	0	0	0	34	21	1	0	0	0	0	0	0	87	62.6	1.71	121	15.7	2.61
Total		284		13.77	165		4.38	54		2.02	130		4.53	139		2.73	772		4.69
Elapsed Time			2062			3766			2670			2868			5091			16457	

Notes: [1] Catch-per-unit-effort (CPUE) is the number of fish captured divided by the elapsed time spent electrofishing; values listed have been multiplied by 100 to give CPUE for 100 seconds of electrofishing.

3.2.1 Moberly River

3.2.1.1 Hoop Netting

A total of 177 fish, representing ten species, was captured in the Moberly River in spring 2006 (Table 10). Northern pikeminnow and longnose suckers were the most common species captured moving upstream in the Moberly River, comprising 29% and 28% of the total catch, respectively. Mountain whitefish and Arctic grayling were the most abundant sportfish species, each comprising almost 12% of the total catch. One bull trout, eight largescale sucker, and five white suckers were the only other large-bodied fish species captured. Longnose dace and slimy sculpin were the only small-bodied fish species caught (n<10). None of the fish captured were recaptures from this or previous studies.

Arctic grayling were first captured in the Moberly River on May 16, five days after the hoop net was installed. Numbers of Arctic grayling captured in the hoop net peaked on May 25 and the last fish was captured on May 30 (Figure 24). Water temperatures in the Moberly River during this peak were approximately 12°C and increased to near 15°C by the end of the survey. Arctic grayling spawning occurs at water temperatures between 7°C and 10°C (Scott and Crossman, 1973; Beauchamp, 1990), however, spawning migrations are known to begin during ice break-up (McPhail and Lindsey, 1970; Scott and Crossman, 1973). Therefore, while it is possible that the hoop net captured fish as they first started moving into the Moberly River, it is more likely that the Arctic grayling spawning run began before the hoop net was installed, probably during the initial spring freshet pulse in early May.

The hoop net in the Moberly River could not be fished in the thalweg due to safety concerns and the hoop net was effectively fishing only 20% of the total river width during most of the spring survey. Therefore, numbers of Arctic grayling captured in the Moberly River hoop net should not be interpreted as an indication of absolute numbers of upstream migrants but instead only as indication of the presence of a spawning run and a representation of the relative magnitude of run in comparison to other tributaries sampled.

Numbers of mountain whitefish moving into the Moberly River peaked on May 26 and the majority of mountain whitefish were captured between May 22 and May 30 (Figure 25). Most of these fish (90%) were adult mountain whitefish (i.e., >250 mm) and because mountain whitefish are fall spawners, the purpose of this movement of fish into the Moberly River in spring is unclear.

Longnose suckers were captured from May 16 to June 10 in the Moberly River. Numbers of upstream migrants peaked at eight fish on May 20 and 21

(Figure 26) and the majority (62%) of fish were captured between May 16 and May 22. Longnose sucker spawning occurs when water temperatures are between 8°C and 16°C (Scott and Crossman, 1973; Tripp and McCart, 1974). Water temperatures in the Moberly River were 10°C on May 24. Although the hoop net data in the Moberly River do not represent absolute numbers of upstream migrants and may not have captured fish at the beginning of the run (for similar reasons explained above), water temperatures in the river coincided with the known spawning temperature range for longnose sucker and it is likely then that the peak of the longnose sucker spawning run in the Moberly River occurred during the second and third weeks of May in 2006.

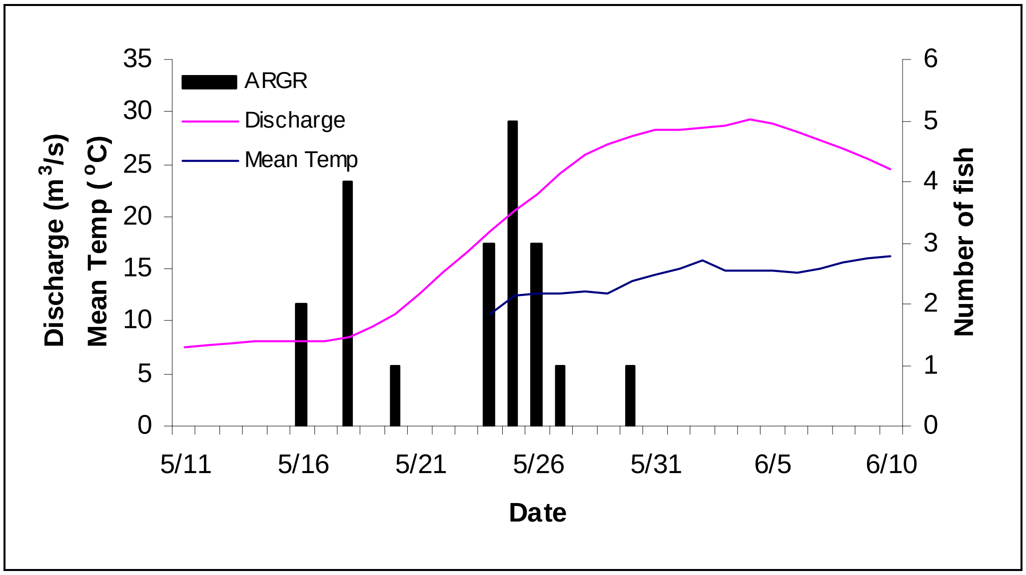


Figure 24: ***Abundance of Arctic grayling, estimated discharge and water temperature by date for Moberly River spring 2006 hoop net sampling***

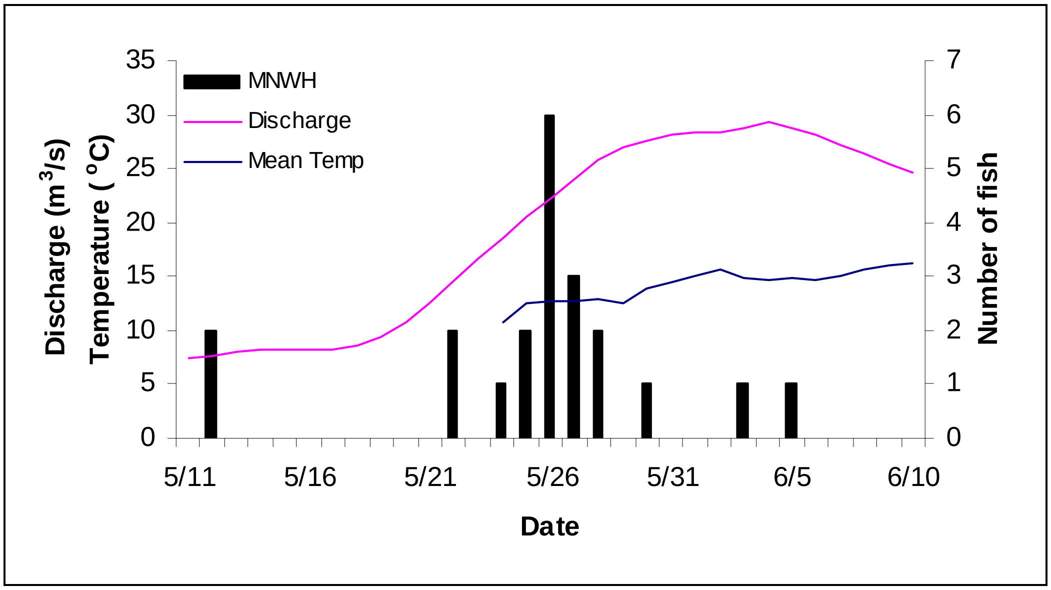


Figure 25: ***Abundance of mountain whitefish, estimated discharge and water temperature by date for Moberly River spring 2006 hoop net sampling***

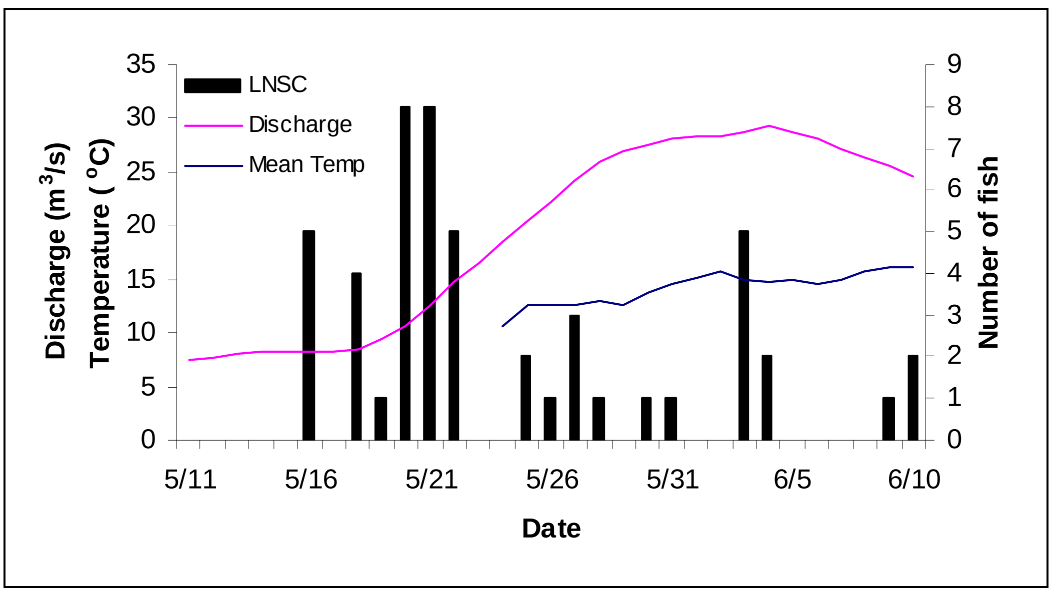


Figure 26: ***Abundance of longnose sucker, estimated discharge and water temperature by date for Moberly River spring 2006 hoop net sampling***

Mean length, weight, and condition factor for fish captured in the Moberly River hoop net is provided in Table 12. Arctic grayling ranged in size from 150 mm to 344 mm and had an average length of 251 mm and an average weight of 169 g (Table 12). Most (85%) Arctic grayling captured were between 200 and 300 mm (Figure 27). Only one Arctic grayling, a female captured on May 20th was ripe and all others were identified as mature.

Longnose suckers had an average length and weight of 283 mm and 169 g, respectively (Table 12). Longnose suckers ranged in length between 92 and 422 mm, with modal length class of 275 mm to 300 mm. Many of the longnose suckers (14%) captured were ripe males between 310 and 422 mm. Mountain whitefish had an average length and weight of 213 mm and 191 g, respectively. Mountain whitefish ranged in length from 113 mm to 360 mm and had a modal length class of 120 mm to 140 mm (Figure 28). Longnose suckers had a mean length of 283 mm and had a modal length class of 280 mm to 300 mm (Figure 29). Northern pikeminnow had a mean length and weight of 390 mm and 793 g, respectively. Northern pikeminnow ranged in length between 244 mm and 505 mm with a modal length class of 400 mm to 440 mm (Figure 30). Sixty-five percent of the northern pikeminnow captured were ripe males between 330 and 440 mm. Length-weight relationships for fish captured in Moberly River spring hoop net sampling are presented in Table 13.

Table 12: Length, weight and condition factor of fish captured during spring hoop net sampling in Moberly River

		Length (mm)					Weight (g)					Condition				
Group	**Species**	**n**	**Mean**	**SD**	**Min**	**Max**	**n**	**Mean**	**SD**	**Min**	**Max**	**n**	**Mean**	**SD**	**Min**	**Max**
Sportfish	ARGR	20	251	38	150	344	18	169	82	30	400	18	1.0	0.12	0.7	1.2
	BLTR	1	301				1	275				1	1.0			
	MNWH	21	213	79	113	360	18	191	151	17	500	18	1.2	0.27	0.9	2.1
Suckers	LNSC	49	283	74	92	422	46	355	245	8	950	46	1.2	0.18	0.9	1.7
	LRSC	8	364	68	257	470	8	680	395	198	1350	8	1.3	0.14	1.0	1.5
	WHSC	5	252	48	194	317	5	221	134	81	420	5	1.2	0.09	1.1	1.3
	SUCKER	1	47				1	1				1	1.2			
Minnows	LNDC	4	57	18	41	82	4	3	3	1	6	4	1.1	0.32	0.9	1.6
	NRPM	52	390	48	244	505	52	793	304	125	1880	52	1.3	0.12	0.9	1.5
	RDSH	14	94	17	64	126	14	12	7	3	28	14	1.3	0.12	1.1	1.6
Sculpin	SLSC	2	62	6	57	66	2	2	1	2	3	2	0.9	0.04	0.9	1.0

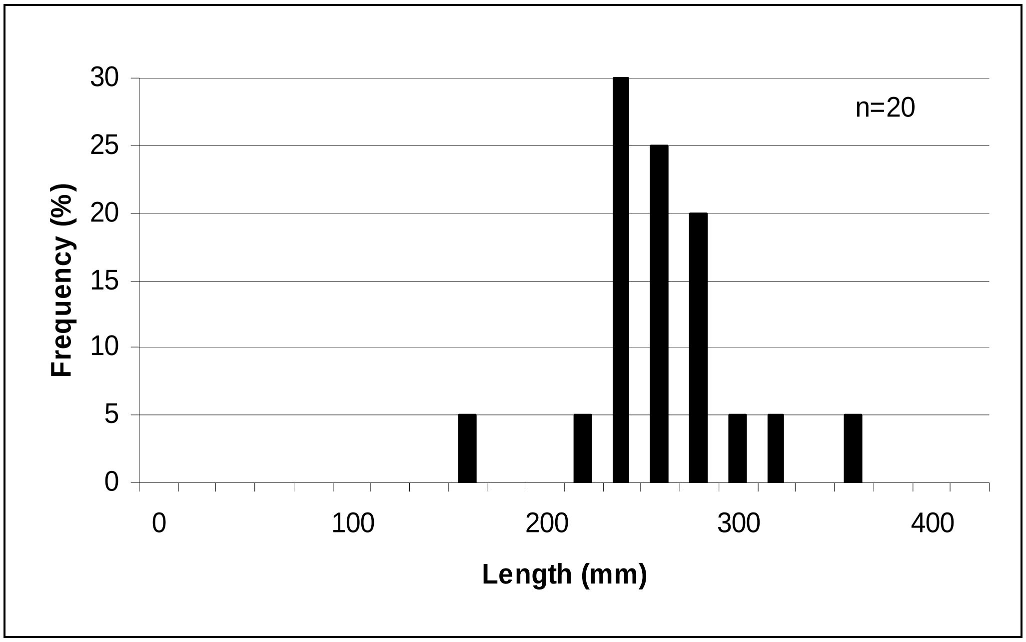


Figure 27: ***Length-frequency distribution of Arctic grayling captured during spring hoop net sampling in Moberly River***

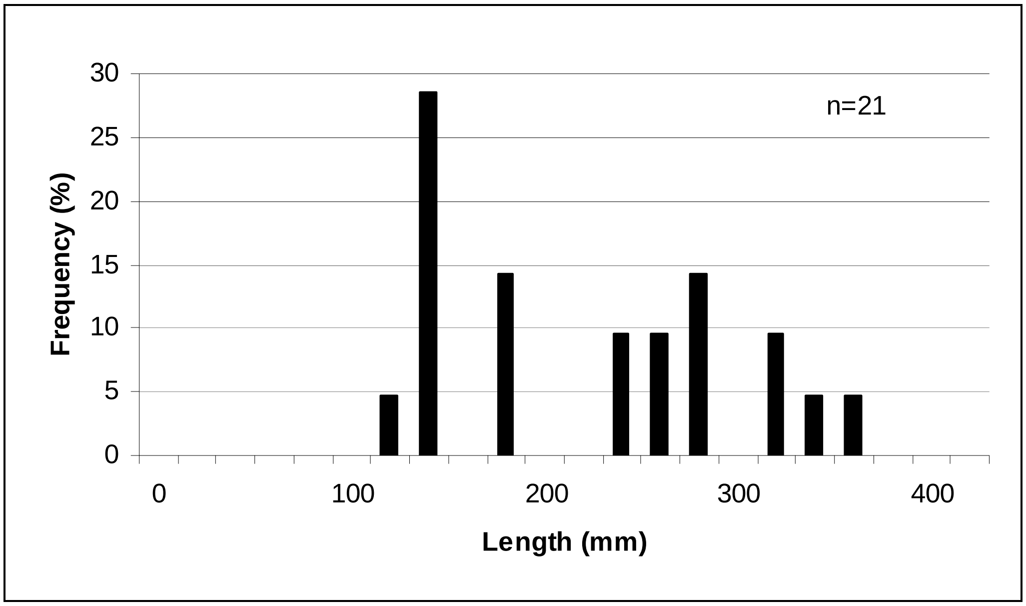


Figure 28: ***Length-frequency distribution of mountain whitefish captured during spring hoop net sampling in Moberly River***

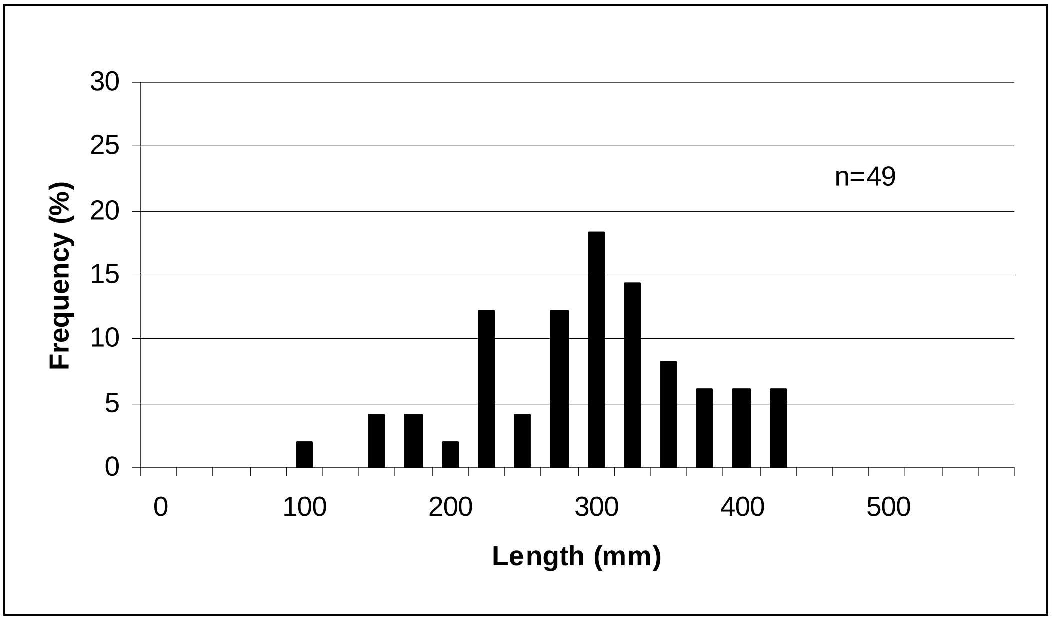


Figure 29: ***Length-frequency distribution of longnose sucker captured during spring hoop net sampling in Moberly River***

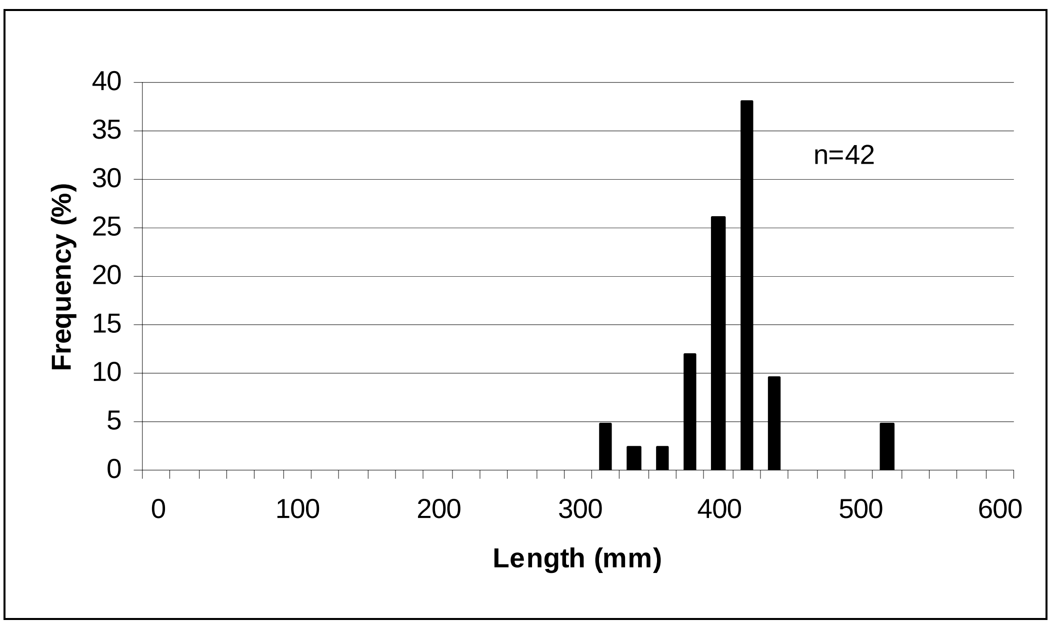


Figure 30: ***Length-frequency distribution of northern pikeminnow captured during spring hoop net sampling in Moberly River***

Table 13: ***Length-weight relationship for fish captured in Moberly River spring hoop net sampling***

Species	n	Length - Weight Relationship
ARGR	18	Log (length) = 3.15[Log (weight)] - 5.38
MNWH	18	Log (length) = 3.19[Log (weight)] - 5.38
LNSC	46	Log (length) = 3.21[Log (weight)] - 5.43
NRPM	52	Log (length) = 3.37[Log (weight)] - 5.88

Aging structures were analyzed for Arctic grayling, bull trout, mountain whitefish, longnose suckers and largescale suckers from the Moberly River (Table 14). Arctic grayling ranged between 2 and 8 years old with most fish (70%) captured greater than 3 years old. The only bull trout captured in Moberly River was 3 years old. Mountain whitefish ranged in age from 2 to 10 years old. Longnose suckers ranged in age from 1 to 11 years old (Table 14) and although ages were not determined from all fish captured, most longnose suckers aged in the Moberly River were six years old or younger. The eight largescale suckers aged ranged between 4 and 11 years old.

Table 14: ***Length- and weight-at-age by species for Moberly River spring hoop net sampling***

			Length (mm)			Weight (g)		
Species	**Age**	**n**	**Mean**	**Min**	**Max**	**Mean**	**Min**	**Max**
Arctic grayling	2	2	189	150	228	70	29.7	110
	3	4	243	220	256	160	145.3	175
	4	8	246	229	264	156	90	200
	5	5	270	236	304	185	125	300
	8	1	344	344	344	400	400	400
Bull trout	3	1	301	301	301	275	275	275
Mountain whitefish	2	6	126	113	134	23	16.8	29.8
	3	3	158	125	178	45	18.8	60.3
	4	1	165	165	165	50	49.5	49.5
	5	1	233	233	233	150	149.9	149.9
	6	3	249	222	267	248	230	265
	7	4	278	249	324	277	173	425.8
	8	1	305	305	305	312	312	312
	9	1	317	317	317	375	375	375
	10	1	360	360	360	500	500	500
Longnose sucker	1	1	92	92	92	8	8.1	8.1
	3	4	199	170	248	93	49	167.8
	4	4	251	203	279	179	101.6	267.9

Species	Age	n	Length (mm)			Weight (g)		
			Mean	Min	Max	Mean	Min	Max
	5	7	276	223	333	278	115	530
	6	6	323	285	380	408	264.3	600
	7	1	359	359	359	700	700	700
	9	1	383	383	383	725	725	725
	11	1	402	402	402	950	950	950
Largescale sucker	4	1	320	320	320	340	340	340
	5	1	374	374	374	780	780	780
	6	4	341	257	436	575	198	1135
	8	1	382	382	382	675	675	675
	11	1	470	470	470	1350	1350	1350

3.2.1.2 Electrofishing

Electrofishing was not conducted on the Moberly River during spring 2006 because water flows were too high to wade and operate backpack electrofishing equipment safely.

3.2.2 Cache Creek

3.2.2.1 Hoop Netting

A total of 552 fish, representing nine species, was captured in Cache Creek in spring 2006 (Table 10). Longnose suckers were the most common species accounting for 50% of the total catch in Cache Creek. Redside shiners were the second most common species comprising 35% of the total catch. Redside shiner move into streams in spring to spawn as soon as water temperatures exceed 10°C (Scott and Crossman, 1973). The upstream migrations of large numbers (>190 fish) of both longnose sucker and redside shiner in Cache Creek indicate that both species use this tributary for spawning.

No other species comprised more than 5% of the total catch. Other species captured, in order of abundance, included largescale suckers, northern pikeminnow, lake chub, flathead chub, longnose dace and peamouth, and burbot. No salmonids (Arctic grayling, bull trout, kokanee, rainbow trout, or mountain whitefish) were captured in the Cache Creek hoop net in spring 2006.

Longnose suckers were captured on the first day after installation of the hoop net in Cache Creek and were captured moving upstream until June 11, four days before the net was removed on June 15. Most (62%) longnose suckers were captured moving upstream between May 15 and May 19 coinciding with increases in discharge and water temperature at this time (Figure 31). The peak migration of 80 fish occurred on May 17.

Redside shiners were captured moving upstream between May 11 and June 10 however numbers peaked on May 12 (Appendix B, Table 7).

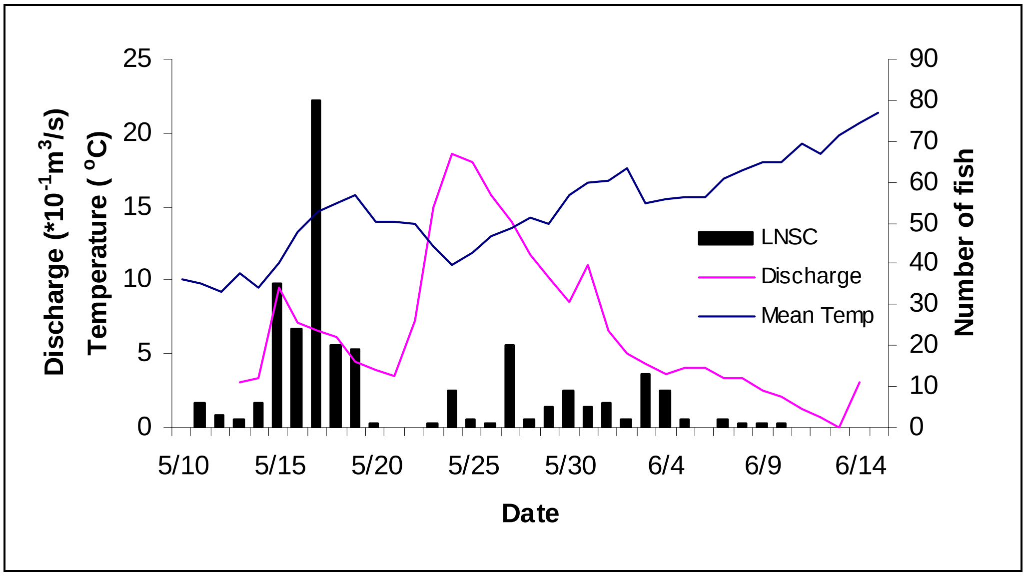


Figure 31: ***Abundance of longnose sucker, estimated discharge and water temperature by date for Cache Creek spring 2006 hoop net sampling***

Length, weights and condition factor for fish captured in Cache Creek are provided in Table 15. The only sportfish captured was a burbot that measured 437 mm and weighed 450 g. Longnose suckers had mean lengths and weights of 302 mm and 426 g, respectively. Longnose sucker lengths ranged from 105 to 440 mm but most (59%) were greater than 320 mm (Figure 32). No ripe females were confirmed; however, 29% were ripe males with lengths ranging from 286 to 412 mm. Length-weight relationships for fish captured in Cache Creek spring hoop net sampling are presented in Table 16.

Table 15: Length, weight and condition factor of fish captured during spring hoop net sampling in Cache Creek

		Length					Weight					Condition				
Group	**Species**	**n**	**Mean**	**SD**	**Min**	**Max**	**n**	**Mean**	**SD**	**Min**	**Max**	**n**	**Mean**	**SD**	**Min**	**Max**
Sportfish	BURB	1	437				1	450				1	0.5			
Suckers	LNSC	304	302	91	105	440	301	426	297	14	1115	301	1.2	0.20	0.1	2.8
	LRSC	26	219	95	112	480	24	227	367	23	1400	24	1.1	0.14	1.0	1.6
Minnows	FLCH	1	251				1	232				1	1.5			
	LKCH	8	113	16	94	137	7	18	8	8	28	7	1.2	0.15	1.0	1.3
	LNDC	10	110	5	101	118	7	17	3	13	20	7	1.3	0.07	1.2	1.3
	NRPM	20	214	73	115	317	17	171	130	21	425	17	1.1	0.11	1.0	1.3
	PMCH	2	162	90	98	225	2	64	72	13	114	2	1.2	0.27	1.0	1.4
	RDSH	199	107	10	91	143	131	17	8	9	41	131	1.4	0.15	0.8	1.7

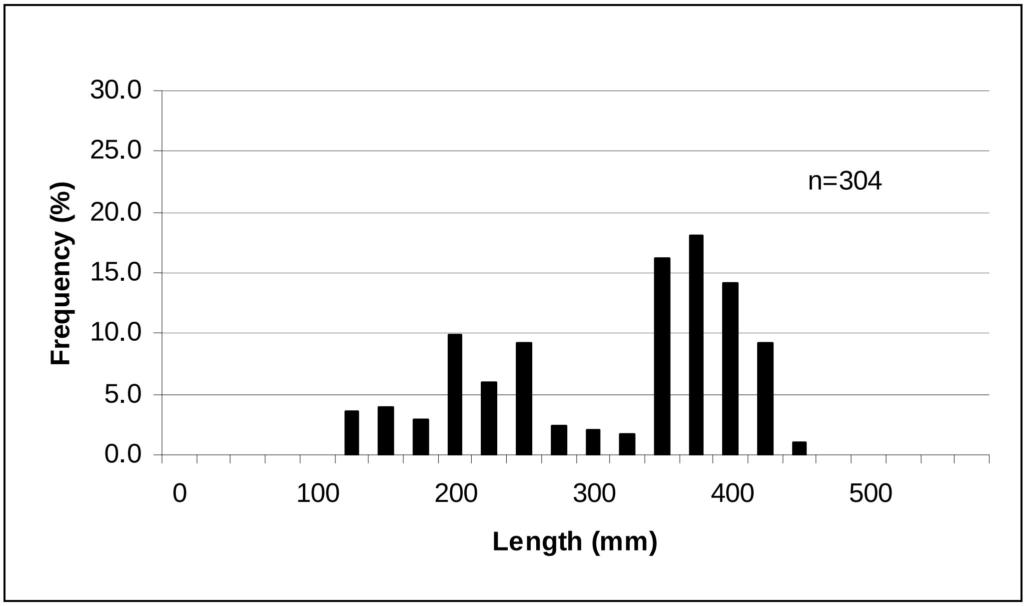


Figure 32: ***Length-frequency distribution of longnose sucker captured during spring hoop net sampling in Cache Creek***

Table 16: ***Length-weight relationship for fish captured in Cache Creek spring hoop net sampling***

Species	n	Length/Weight Relationship
LNSC	301	Log (length) = 3.15[Log (weight)] - 5.29
LRSC	24	Log (length) = 3.17[Log (weight)] - 5.37
NRPM	17	Log (length) = 3.16[Log (weight)] - 5.34
RDSH	131	Log (length) = 2.92[Log (weight)] - 4.71

Longnose and largescale suckers were the only species aged in Cache Creek (Table 17). Longnose suckers ranged in age between 2 and 11 years and fish 8 and 9 years old were the most common. Largescale suckers ranged in age from 2 to 15 years old with most fish aged at 4 years old.

Table 17: ***Length- and weight-at-age by species in Cache Creek spring hoop net sampling***

			Length (mm)			Weight (g)		
Species	**Age**	**n**	**Mean**	**Min**	**Max**	**Mean**	**Min**	**Max**
Longnose sucker	2	1	106	106	106	14	14	14
	3	5	163	131	193	43	23	68
	4	9	216	170	266	201	56	900
	5	4	272	225	327	225	160	400
	6	4	304	254	343	445	168	675
	7	3	355	347	367	520	460	600

Species	Age	n	Length (mm) Mean	Length (mm) Min	Length (mm) Max	Weight (g) Mean	Weight (g) Min	Weight (g) Max
	8	10	362	323	403	632	425	1115
	9	13	389	359	430	626	58	1000
	10	3	377	360	395	698	585	785
	11	1	414	414	414	1000	1000	1000
Largescale sucker	2	1	130	130	130	23	23	23
	3	6	164	139	204	113	29	424
	4	7	215	167	290	135	52	400
	5	3	194	173	215	81	55	114
	6	1	244	244	244	185	185	185
	13	1	480	480	480	1250	1250	1250
	15	1	480	480	480	1400	1400	1400

3.2.2.2 Electrofishing

A total of 284 fish, representing eight species, was captured electrofishing in Cache Creek (Table 11). Redside shiners were the most common species (38% of the total catch) followed by longnose dace (24%), longnose suckers (21%) and lake chub (13%). Flathead chub, largescale suckers and northern pikeminnow were also captured electrofishing but in low numbers (n<10). A single juvenile mountain whitefish was the only fish species captured electrofishing that was not represented in the hoop net catch in Cache Creek. The relative abundance of fish species captured by electrofishing was similar to that for the hoop net catch for all fish species except longnose dace and lake chub, which had much higher relative abundances in the electrofishing surveys (24% and 13%) than in the hoop net (<2% each), and longnose sucker, which had a much higher relative abundance in the hoop net catch (50%) than in the electrofishing survey (21%). These differences are not unexpected given that small-bodied fish species such as longnose dace and lake chub were likely not effectively sampled by the hoop net. These electrofishing data suggest that the hoop net did not miss any other spawning runs of large-bodied fish species in Cache Creek. The CPUE for all fish species combined in the Cache Creek electrofishing survey was 13.77 fish per 100 seconds of shocking, which was higher than all other sites.

Mean length, weight, and condition factor for fish species captured electrofishing in Cache Creek are presented in Table 18. The only sportfish captured was a juvenile mountain whitefish that measured 111 mm and weighed 12 g. Longnose dace had a mean length of 61 mm. Longnose sucker ranged in length from 39 mm to 190 mm and had a modal length class of 100 mm to 120 mm (Figure 33). These fish were juveniles and indicate that Cache Creek is used by longnose suckers for rearing.

Table 18: Length, weight and condition factor of fish captured during spring electrofishing surveys in Cache Creek

		Length (mm)					Weight (g)					Condition Factor				
Group	**Species**	**n**	**Mean**	**SD**	**Max**	**Min**	**n**	**Mean**	**SD**	**Max**	**Min**	**n**	**Mean**	**SD**	**Max**	**Min**
Sportfish	MNWH	1	111				1	12				1	0.8			
Suckers	LNSC	31	110	35	39	190	3	22	20	2	41	3	1.0	0.18	0.8	1.2
	LRSC	7	93	36	52	150	2	5	3	3	7	2	1.2	0.20	1.1	1.4
Minnows	FLCH	1	75				0					0				
	LKCH	38	77	15	56	108	0					0				
	LNDC	68	61	20	32	115	5	4	4	1	9	5	0.9	0.23	0.5	1.0
	NRPM	1	123				0					0				
	RDSH	77	74	30	30	115	4	5	4	2	12	4	1.1	0.10	0.9	1.1

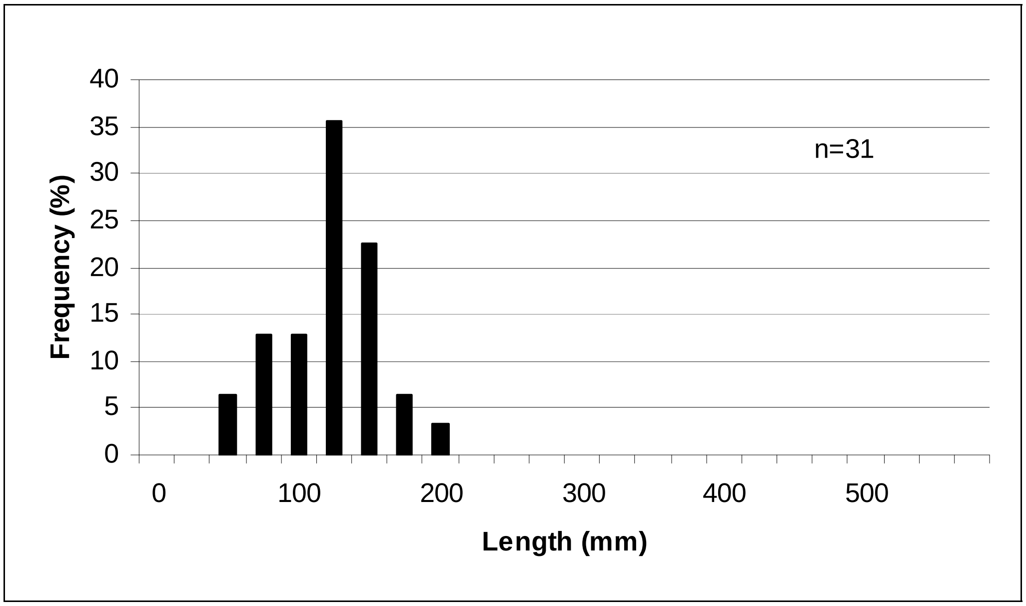


Figure 33: ***Length-frequency distribution of longnose sucker captured during spring electrofishing surveys in Cache Creek***

3.2.3 Halfway River

3.2.3.1 Hoop Netting

In total, 309 fish, representing 15 species, were captured in the Halfway River hoop net in spring 2006 (Table 10). Burbot was the most common sportfish species while small numbers (n<3) of Arctic grayling, bull trout, kokanee, mountain whitefish and rainbow trout were also captured. Sportfish species comprised only 5% of the total hoop net catch in the Halfway River. Longnose suckers were the most common species, accounting for 42% of the catch. After longnose sucker, the most abundant species captured were redside shiners (22%), largescale suckers (16%) and northern pikeminnow (9%). All of these species are spring spawners and the hoop net data, therefore, suggests that spawning runs of each of these four species occur in the Halfway River. White sucker, lake chub, flathead chub, longnose dace, and all six sport fish species each comprised less than 4% of the total catch. One spottail shiner was also captured in the Halfway River. This is notable because this species is currently red listed in BC (BC MOE 2006).

Longnose sucker were captured between May 11, the first day after the net was installed, and June 21, the last day the net was fished (Figure 34). The net could not be checked between May 22 and May 28 due to high water and this explains the lack of fish observed during this period. The abundance of longnose suckers captured in the hoop net peaked at 37 fish on May 19

(Figure 34). This dramatic increase coincided with simultaneous increases in river discharge (from ~5.8 m^3/sec to ~8.5 m^3/sec) and water temperature (~ 9°C to 14°C) (Figure 34).

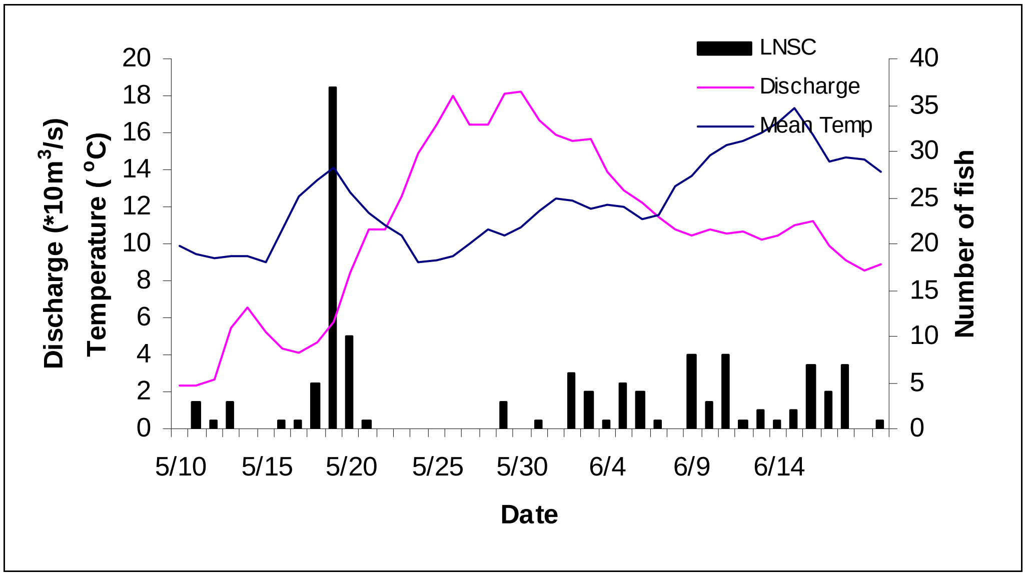


Figure 34: Abundance of longnose sucker, estimated discharge and water temperature by date for Halfway River spring 2006 hoop net sampling

Mean length, weight, and condition factors for fish captured in the Halfway River are provided in Table 19. Burbot had an average length and weight of 496 mm and 724 g, respectively. Longnose suckers had an average length and weight of 314 mm and 470 g, respectively and ranged in length from 71 mm to 496 mm. Most (67%) longnose sucker captured were greater than 300 mm in length (Figure 35). Of the longnose suckers captured, 26% were ripe adults. All ripe fish were between 320 and 496 mm long. Length-weight relationship for fish captured in the Halfway River spring hoop net sampling are presented in Table 20.

Table 19: Length, weight and condition factor of fish captured during spring hoop net sampling in Halfway River

		Length (mm)					Weight (g)					Condition				
Group	**Species**	**n**	**Mean**	**SD**	**Min**	**Max**	**n**	**Mean**	**SD**	**Min**	**Max**	**n**	**Mean**	**SD**	**Min**	**Max**
Sportfish	ARGR	1	324				1	133				1	0.4			
	BLTR	1	309				1	400				1	1.4			
	BURB	11	496	83	385	635	11	724	348	325	1425	11	0.6	0.08	0.5	0.7
	KOKA	1	177				1	49				1	0.9			
	MNWH	2	97	28	77	116	2	9	7	4	13	2	0.9	0.00	0.9	0.9
	RNTR	1	319				1	325				1	1.0			
Suckers	LNSC	134	314	101	71	496	134	470	340	4	1425	134	1.2	0.17	0.3	1.8
	LRSC	52	295	136	111	512	52	520	558	13	1725	52	1.2	0.14	0.9	1.7
	WHSC	1	264				1	235				1	1.3			
Minnows	FLCH	5	127	19	107	157	5	25	13	14	47	5	1.1	0.07	1.1	1.2
	LKCH	2	100	8	94	105	2	11	3	9	13	2	1.1	0.02	1.1	1.2
	LNDC	4	87	12	71	98	3	9	8	4	19	3	1.3	0.60	0.9	2.0
	NRPM	30	272	105	127	450	30	375	401	22	1325	30	1.2	0.16	0.9	1.5
	RDSH	69	97	15	52	135	52	14	6	2	28	52	1.4	0.16	1.1	1.7
	SPSH	1	48				1	1				1	1.1			

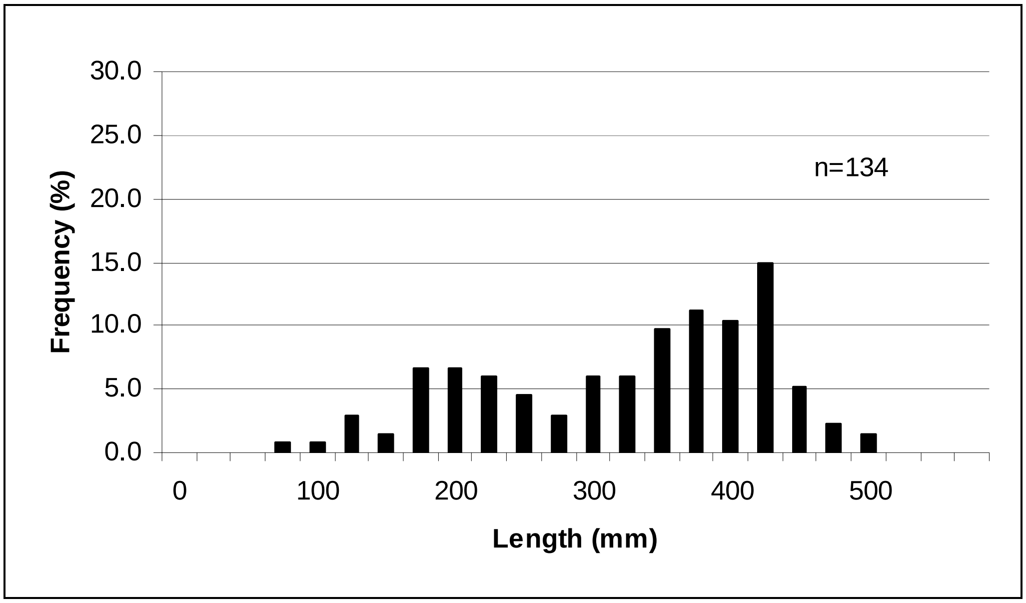


Figure 35: ***Length-frequency distribution of longnose sucker captured during spring hoop net sampling in Halfway River***

Table 20: ***Length-weight relationship for fish captured in Halfway River spring hoop net sampling***

Species	n	Length-Weight Relationship
LNSC	134	Log (length) = 3.11[Log (weight)] - 5.23
LRSC	52	Log (length) = 3.09[Log (weight)] - 5.16
NRPM	30	Log (length) = 3.26[Log (weight)] - 5.55
RDSH	52	Log (length) = 3.22[Log (weight)] - 5.30

Length- and weight-at-age for all fish species for which aging structures were analyzed are presented in Table 21. Longnose suckers were 3 to 20 years old and for aged individuals there were peaks in the frequency of age 3, 5, and 9. Largescale suckers were between 2 to 22 years old while most of the aged samples were 3 and 4 years old.

Table 21: Length- and weight-at-age by species for Halfway River spring hoop net sampling

			Length (mm)			Weight (g)		
Species	**Age**	**n**	**Mean**	**Min**	**Max**	**Mean**	**Min**	**Max**
Arctic grayling	4	4	339	324	365	402	133.1	625
Bull trout	2	1	309	309	309	400	400.0	400.0
Kokanee	2	1	177	177	177	49	48.9	48.9
Mountain whitefish	2	1	116	116	116	13	13.4	13.4
Rainbow trout	5	1	319	319	319	325	325	325
Longnose sucker	2	2	118	111	125	17	15.0	19.6
	3	6	181	160	206	62	38.2	89
	4	2	235	225	245	147	125.7	168.2
	5	6	300	217	496	194	19.9	350
	6	1	272	272	272	300	300	300
	7	1	317	317	317	295	294.5	294.5
	8	4	382	352	424	700	510	1025
	9	5	366	325	413	654	475	925
	10	2	389	367	410	663	575	750
	12	2	362	343	380	593	575	610
	13	1	395	395	395	700	700	700
	14	3	421	399	454	917	825	1025
	15	1	426	426	426	1015	1015	1015
	16	1	432	432	432	975	975	975
	20	1	422	422	422	875	875	875
Largescale sucker	2	2	116	111	121	17	12.8	20.4
	3	11	147	122	187	71	24.6	275
	4	8	207	168	244	97	36.3	174.3
	5	3	233	205	280	203	111.4	300
	6	3	263	225	300	262	126.5	450
	7	1	258	258	258	72	72.4	72.4
	9	3	392	355	419	758	625	850
	10	1	435	435	435	1025	1025	1025
	11	2	420	416	424	830	800	860
	12	1	487	487	487	1050	1050	1050
	13	2	448	442	454	1080	1050	1110
	14	1	478	478	478	1625	1625	1625
	15	2	497	492	502	1600	1475	1725
	17	1	508	508	508	1400	1400	1400
	18	1	479	479	479	1375	1375	1375
	22	1	498	498	498	1625	1625	1625

3.2.3.2 Electrofishing

A total of 165 fish, representing 12 species, was captured in Halfway River (Table 11). Total CPUE in the Halfway River for all species combined was 4.38 fish per 100 s of shocking (Table 11). Longnose dace were the most common species (41% of the total catch) followed by longnose suckers (22%), prickly sculpin (14%) and mountain whitefish (9%). No other species comprised more than 4% of the electrofishing catch. Differences between the electrofishing and hoop net catches were primarily due to differences in gear selectivity and included:

- a higher proportion of juvenile (i.e., <150 mm) mountain whitefish in the electrofishing catch (9%) than in the hoop net (<1%);
- a higher proportion of longnose sucker and largescale sucker in the hoop net (42% and 16%, respectively) than in the electrofishing catch (22% and 1%, respectively);
- a much higher proportion of longnose dace in the electrofishing catch (41%) than in the hoop net catch (1%);
- a higher proportion of northern pikeminnow and redside shiner in the hoop net (9% and 22%, respectively) than in the electrofishing catch (1% and 2%, respectively); and
- the absence of sculpin species from the hoop net catch and the presence of prickly sculpin, slimy sculpin, and spoonhead sculpin in the electrofishing catch.

Although differences in the catches existed, the electrofishing survey did not suggest that the hoop net missed any upstream spawning migrations of any large-bodied fish species.

Mean length, weight, and condition factor for each species captured electrofishing in the Halfway River in spring are presented in Table 22. The only bull trout captured was an adult, 581 mm in length. Most (80%) mountain whitefish captured were juveniles less than 150 mm in length. Longnose sucker ranged in length from 41 mm to 477 mm and included a large proportion (62%) of juvenile fish less than 200 mm long (Figure 36). Seven longnose suckers captured were ripe males. The presence of juvenile fish suggests that the Halfway River provides rearing habitat for longnose sucker and mountain whitefish.

Table 22: Length, weight and condition factor of fish captured during spring electrofishing surveys in Halfway River

Group	Species	Length (mm)					Weight (g)					Condition Factor				
		n	Mean	SD	Max	Min	n	Mean	SD	Max	Min	n	Mean	SD	Max	Min
Sportfish	BLTR	1	581				0					0				
	MNWH	15	121	54	75	272	0					0				
Suckers	LNSC	37	208	152	41	477	3	7	5	4	13	3	1.1	0.05	1.1	1.2
	LRSC	2	62	1	61	62	2	3	0	3	4	2	1.5	0.14	1.4	1.6
Minnows	FLCH	2	84	1	83	84	0					0				
	LNDC	67	66	60	29	495	9	3	2	1	6	9	1.1	0.24	0.8	1.6
	NRPM	1	136				1	28				1	1.1			
	RDSH	3	53	4	49	56	1	1		1	1	1	1.1			
Sculpin	PRSC	23	51	14	39	80	1	6		6	6	1	1.2			
	SLSC	5	59	10	48	72	1	2		2	2	1	0.8			
	SPSC	6	73	6	64	84	3	4	1	3	4	3	0.9	0.28	0.7	1.2

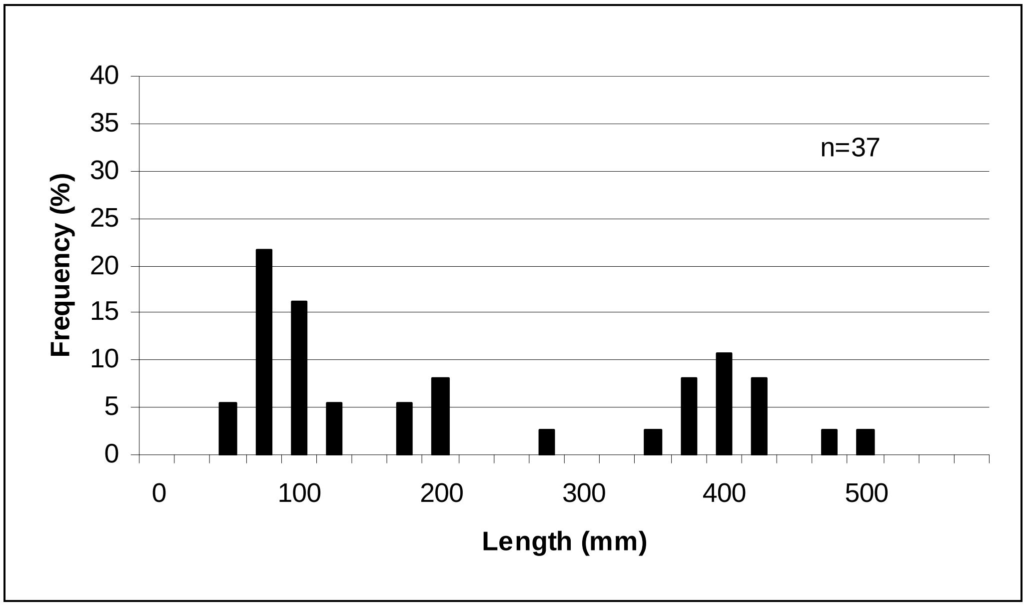


Figure 36: Length-frequency distribution of longnose sucker captured during spring electrofishing surveys in Halfway River

3.2.4 Farrell Creek

3.2.4.1 Hoop Netting

A total of 324 fish, representing ten species, was captured in Farrell Creek in spring 2006 (Table 10). Sportfish species present in the catch included: one bull trout, one kokanee, five mountain whitefish, and nine rainbow trout. Longnose suckers were the most common species (32% of the total catch) followed by largescale suckers (26%) and northern pikeminnow (26%). Redside shiners comprised 6% of the catch while longnose dace and peamouth were rare (<2 % of the total catch each).

Longnose sucker were captured moving upstream on the first day after the hoop net was installed suggesting that the upstream migration had commenced prior to May 10 in Farrell Creek (Figure 37). The majority (92%) of longnose sucker were captured between May 11 and May 24 with a peak on May 17. Nets could not be checked on May 25 to May 27, inclusive, due to high water. However, the small number of longnose sucker captured in the days leading up to the dramatic increase in discharge on May 24 and the small number captured after the net was re-installed on May 28 suggest that few longnose sucker were moving up Farrell Creek while the net was not fishing and that the upstream longnose sucker run was essential finished by May 24.

The majority (86%) of largescale suckers moved up into Farrell Creek between May 12 and May 24 (Figure 38). Unlike longnose suckers, the peak of the largescale sucker migration occurred on May 24 (17 fish), the day before the hoop net was blown out by high water. This, coupled with the presence of upstream migrants after the net was re-installed, suggests that largescale sucker were moving upstream in Farrell Creek while the hoop net was not fishing between May 25 and May 27. The number of fish missed on these days cannot be determined. Largescale suckers move into spawning streams in spring when water temperatures reach 8°C or 9°C (Scott and Crossman, 1973) usually from mid-May to late June (McPhail and Lindsay, 1970). Water temperatures between May 10 and May 24 when the majority of largescale suckers were captured in Farrell Creek were between 10°C and 15°C. These temperatures suggest that some proportion of the total largescale sucker spawning run may have begun moving into Farrell Creek prior to installation of the hoop net, most likely during an initial spring freshet in April as occurred in the Moberly and Pine rivers.

Northern pikeminnow were first captured moving upstream in Farrell Creek on May 12 but the majority (55%) of fish were captured between May 30 and June 4 when water temperatures began increasing from approximately 10°C to 14°C and when stream flows were receding after the spring peak on May 27 (Figure 39). The number of northern pikeminnow missed while the hoop net was not fishing between May 25 and May 27 is unknown but is presumed to be greater than zero. Northern pikeminnow spawn from late May to early July (McPhail and Lindsay, 1970) and information collected in the Farrell Creek hoop net would support this timing.

The nine rainbow trout captured in Farrell Creek were moving upstream between May 12 and June 15 in spring 2006. All of these fish were adults presumably using Farrell Creek for spawning.

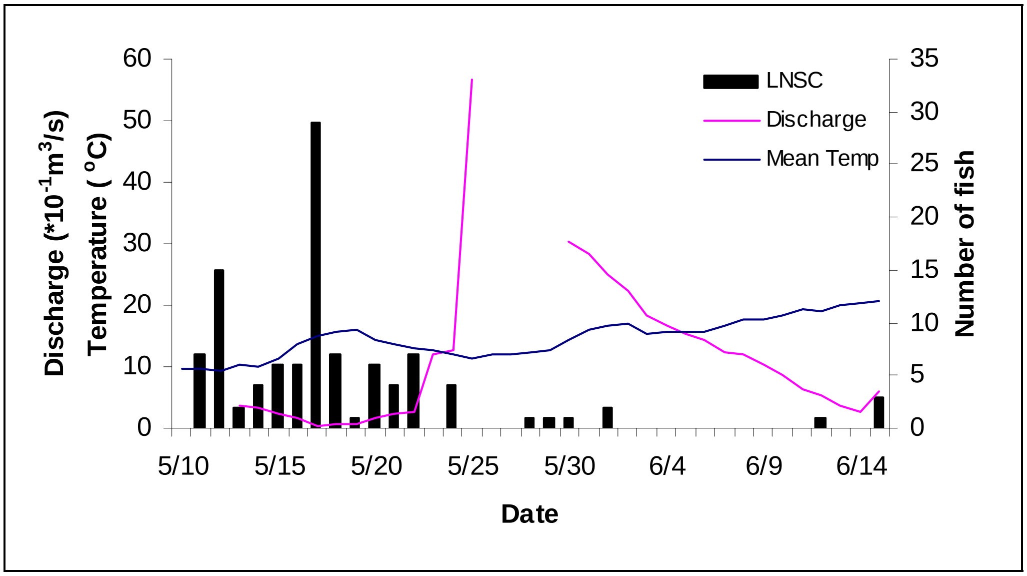


Figure 37: ***Abundance of longnose sucker, estimated discharge and water temperature by date for Farrell Creek spring 2006 hoop net sampling***

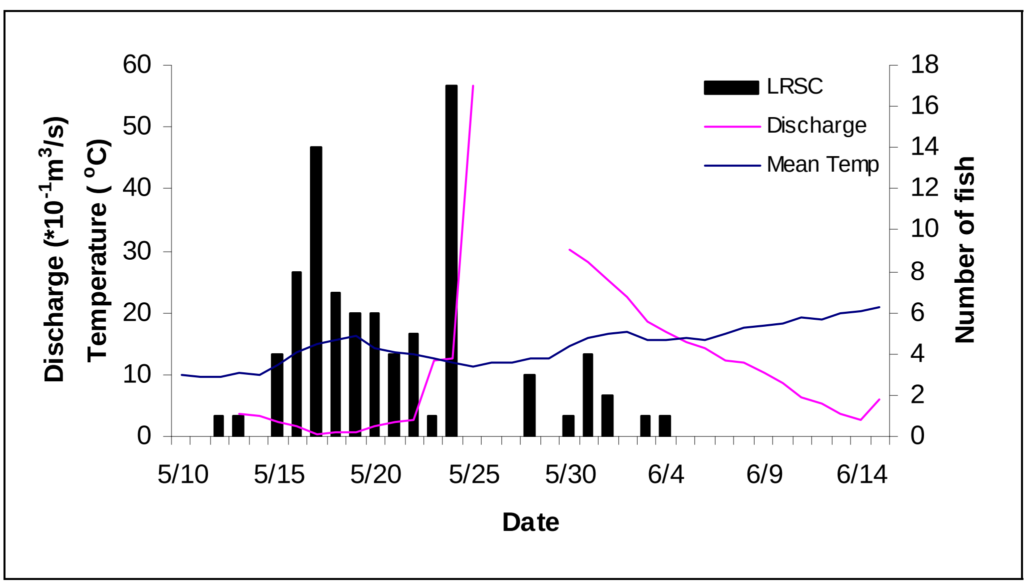


Figure 38: ***Abundance of largescale sucker, estimated discharge and water temperature by date for Farrell Creek spring 2006 hoop net sampling***

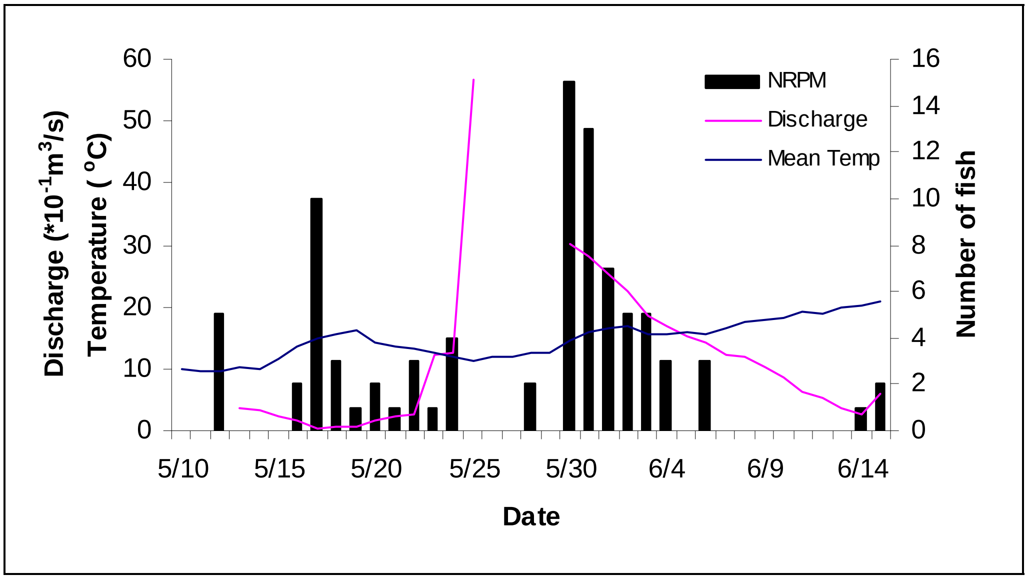


Figure 39: ***Abundance of northern pikeminnow, estimated discharge and water temperature by date for Farrell Creek spring 2006 hoop net sampling***

Mean lengths, weights and condition factors for fish captured in Farrell Creek are summarized in Table 23. Rainbow trout had mean length, weight and condition of 279 mm, 283 g and 1.1, respectively. Longnose had a mean length of 338 mm and a mean weight of 558 g. Longnose sucker ranged in length from 130 to 486 mm however most (81%) fish were over 300 mm (Figure 40). Almost half (48%) of the longnose suckers captured were ripe adults. All ripe longnose suckers were greater than 320 mm in length. Largescale sucker had a mean length and weight of 463 mm and 1353 g, respectively. The majority (81%) of largescale suckers captured were greater than 400 mm in length (Figure 41). Of the total largescale sucker catch, 23% were ripe males between 380 and 524 mm in length. Northern pikeminnow ranged in length between 183 mm and 491 mm but most (96%) fish captured were greater than 300 mm in length (Figure 42). Only 7% of the northern pikeminnow catch were ripe. The presence of ripe longnose sucker, largescale sucker, and northern pikeminnow indicates that all three species use Farrell Creek for spawning. Rainbow trout had an average length of 279 mm and lengths ranged from 115 mm to 326 mm. Length-weight relationships for fish captured in Farrell Creek spring hoop net sampling are presented in Table 24.

Table 23: Length, weight and condition factor of fish captured during spring hoop net sampling in Farrell Creek

Group	Species	Length (mm)					Weight (g)					Condition				
		n	Mean	SD	Min	Max	n	Mean	SD	Min	Max	n	Mean	SD	Min	Max
Sportfish	BLTR	1	251				1	146				1	0.9			
	KOKA	1	192				1	66				1	0.9			
	MNWH	5	237	86	115	326	4	199	135	16	300	4	1.0	0.12	0.9	1.2
	RNTR	10	279	67	155	365	10	283	201	36	625	10	1.1	0.20	0.7	1.4
Suckers	LNSC	110	338	79	130	486	109	558	333	22	1525	109	1.2	0.20	0.8	2.7
	LRSC	86	463	65	225	615	85	1353	525	100	2725	85	1.3	0.18	0.1	1.6
Minnows	LNDC	1	119				1	30				1	1.8			
	NRPM	93	351	56	183	491	91	605	322	60	1700	91	1.3	0.16	0.4	1.7
	PMCH	5	208	9	195	218	5	97	18	77	121	5	1.1	0.07	1.0	1.2
	RDSH	21	113	13	84	137	20	21	23	9	36	20	1.4	0.15	1.0	1.6

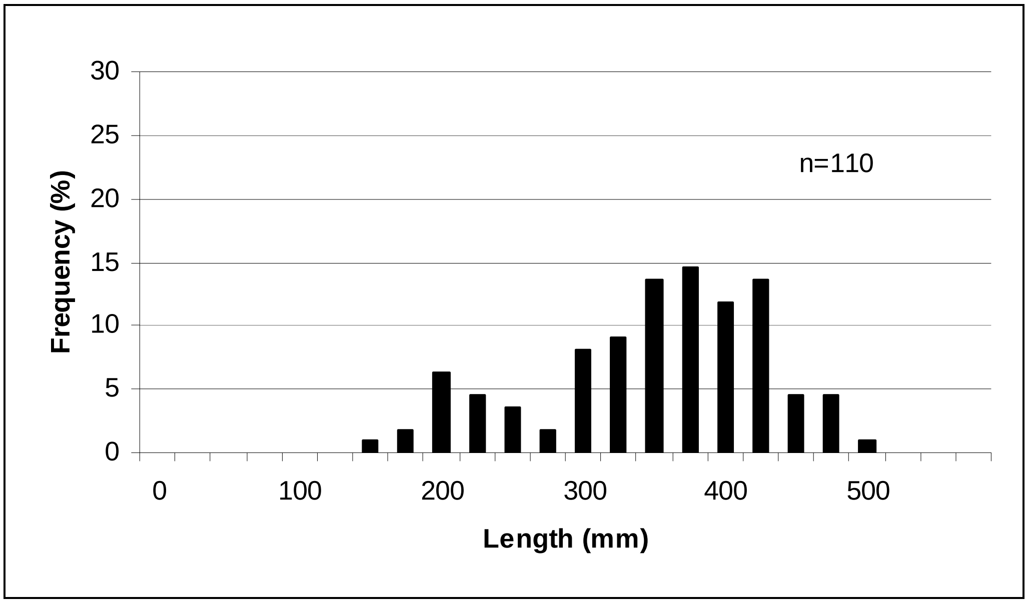


Figure 40: ***Length-frequency distribution of longnose sucker captured during spring hoop net sampling in Farrell Creek***

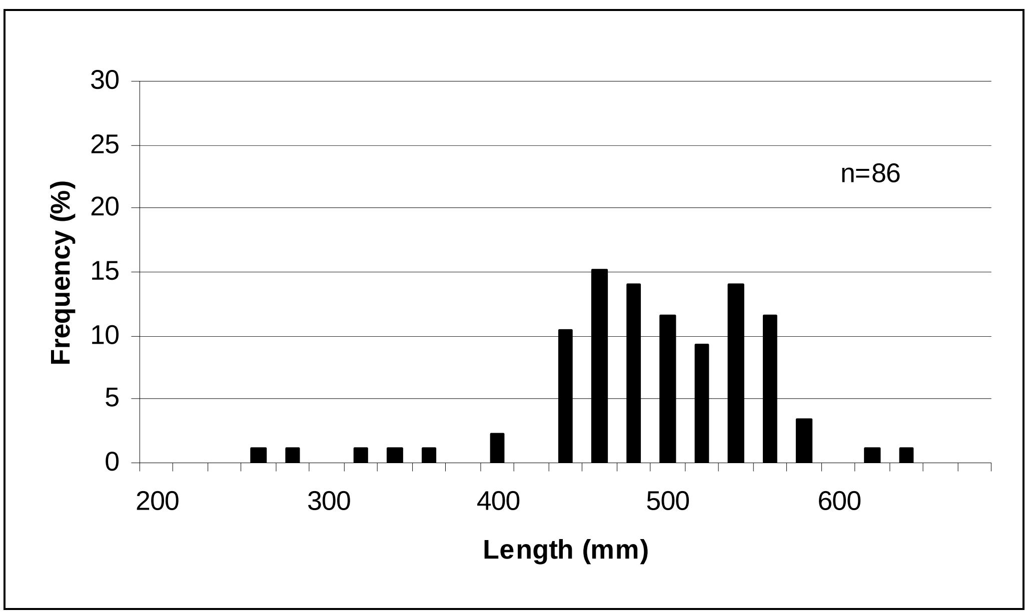


Figure 41: ***Length-frequency distribution of largescale sucker captured during spring hoop net sampling in Farrell Creek***

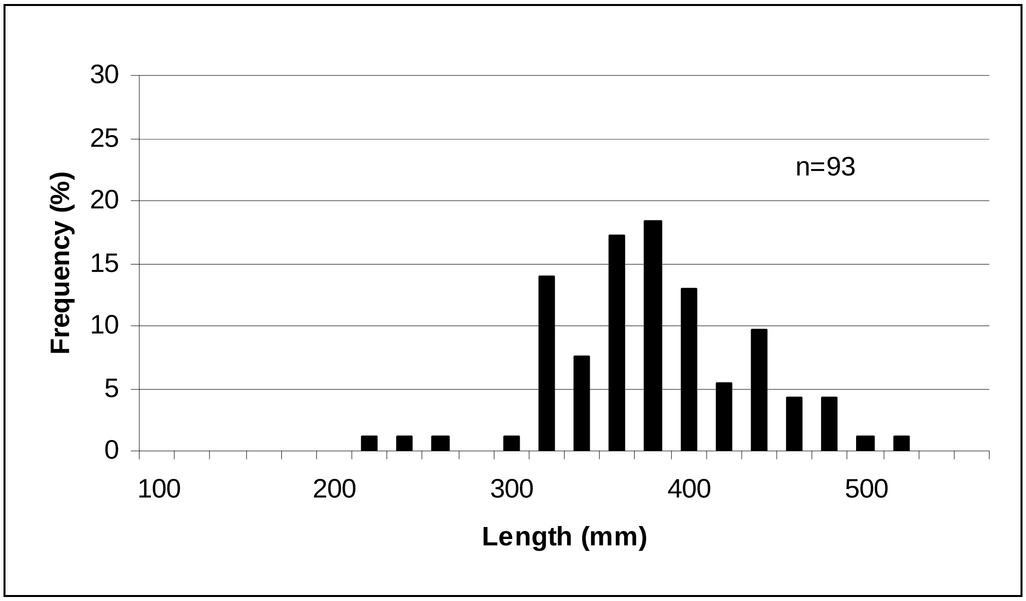


Figure 42: ***Length-frequency distribution of northern pikeminnow captured during spring hoop net sampling in Farrell Creek***

Table 24: ***Length-weight relationship for fish captured in Farrell Creek spring hoop net sampling***

Species	n	Length-Weight Relationship
LNSC	109	Log (length) = 3.23[Log (weight)] - 5.49
LRSC	85	Log (length) = 3.21[Log (weight)] - 5.45
NRPM	91	Log (length) = 3.31[Log (weight)] - 5.68
RDSH	20	Log (length) = 2.88[Log (weight)] - 4.62

Mean length- and weight-at-age for all fish species aged from Farrell Creek are presented in Table 25. The one bull trout and one kokanee aged from Farrell Creek were both 3 years old. All mountain whitefish aged were either 3 or 6 years old while the five rainbow trout aged were either 2 or 3 years old. Longnose sucker ranged in age from 3 to 18 years old and peaked at 7 years old. Largescale suckers ranged in age from 4 to 26 years old.

Table 25: Length- and weight-at-age by species for Farrell Creek spring hoop net sampling

Species	Age	n	Length (mm)			Weight (g)		
			Mean	**Min**	**Max**	**Mean**	**Min**	**Max**
Bull trout	3	1	251	251	251	146	146.1	146.1
Kokanee	3	1	192	192	192	66	66.4	66.4
Mountain whitefish	3	1	115	115	115	16	15.7	15.7
	6	2	311	295	326	300	300	300
Rainbow trout	2	1	155	155	155	36	35.9	35.9
	3	3	277	233	356	268	100	525
Longnose sucker	3	1	152	152	152	41	41.0	41.0
	4	2	283	195	371	313	75.3	550
	5	2	205	200	210	84	75	93.7
	6	2	349	335	362	525	450	600
	7	7	330	279	381	571	275	925
	8	4	364	315	411	619	350	900
	9	3	367	297	405	617	275	850
	10	1	392	392	392	700	700	700
	11	1	420	420	420	900	900	900
	13	1	457	457	457	1200	1200	1200
	18	1	448	448	448	1125	1125	1125
Largescale sucker	4	1	225	225	225	134	133.8	133.8
	5	1	254	254	254	183	182.7	182.7
	7	1	433	433	433	1150	1150	1150
	8	1	340	340	340	350	350	350
	10	3	419	401	437	925	850	1075
	11	1	419	419	419	1000	1000	1000
	12	3	442	423	471	1108	1000	1300
	13	2	435	410	460	1050	875	1225
	14	1	480	480	480	1425	1425	1425
	15	4	485	466	505	1619	1300	1950
	16	5	497	455	543	1605	1250	2000
	17	2	524	510	537	2025	1875	2175
	18	4	521	502	530	1881	1675	2225
	20	1	505	505	505	1500	1500	1500
	22	1	517	517	517	1825	1825	1825
	23	1	582	582	582	2600	2600	2600
	26	1	506	506	506	1580	1580	1580

3.2.4.2 Electrofishing

A total of 54 fish, representing five species, was captured in Farrell Creek electrofishing surveys (Table 11). Longnose dace and longnose sucker were the most common species and these two species dominated the catch (>95% combined). The only species captured electrofishing not captured in the hoop net was lake chub and only one fish was captured. The greatest differences between the hoop net catch and the electrofishing catch were the greater relative abundance of longnose dace in the electrofishing catch, the greater relative abundance of redside shiner in the hoop net catch and the absence of northern pikeminnow and rainbow trout from the electrofishing catch. Results of the electrofishing survey did not suggest that any large scale upstream migrations of large-bodied fish species were missed by the hoop net.

Mean length, weight and condition factors for fish species captured in Farrell Creek are provided in Table 26. The only sportfish captured was a juvenile mountain whitefish that measured 99 mm and weighed 10 g. Longnose dace had a mean length, weight and condition of 72 mm, 5 g and 1.1, respectively. The mean length of the longnose suckers captured electrofishing was 405 mm and most were maturing, ripe or spent adults (Figure 43). Spawning behaviour was observed during the stream survey; this involved congregations of 5-10 males chasing 1 or 2 females towards coarse gravel substrate and other adults were observed holding in groups of 5-15 individuals in deeper pools.

Table 26: Length, weight and condition factor of fish captured during spring electrofishing surveys in Farrell Creek

		Length (mm)					Weight (g)					Condition Factor				
Group	**Species**	**n**	**Mean**	**SD**	**Min**	**Max**	**n**	**Mean**	**SD**	**Min**	**Max**	**n**	**Mean**	**SD**	**Min**	**Max**
Sportfish	MNWH	1	99				1	10		10	10	1	1.0			
Suckers	LNSC	25	405	36	327	511	0*					0*				
Minnows	LKCH	1	54				1	1		1	1	1	0.8			
	LNDC	26	72	20	48	113	26	5	4	1	16	26	1.1	0.19	0.5	1.5
	RDSH	1	93				1	9				1	1.2			

Note: * Fish were not weighed because large scale was not available during the electrofishing survey.

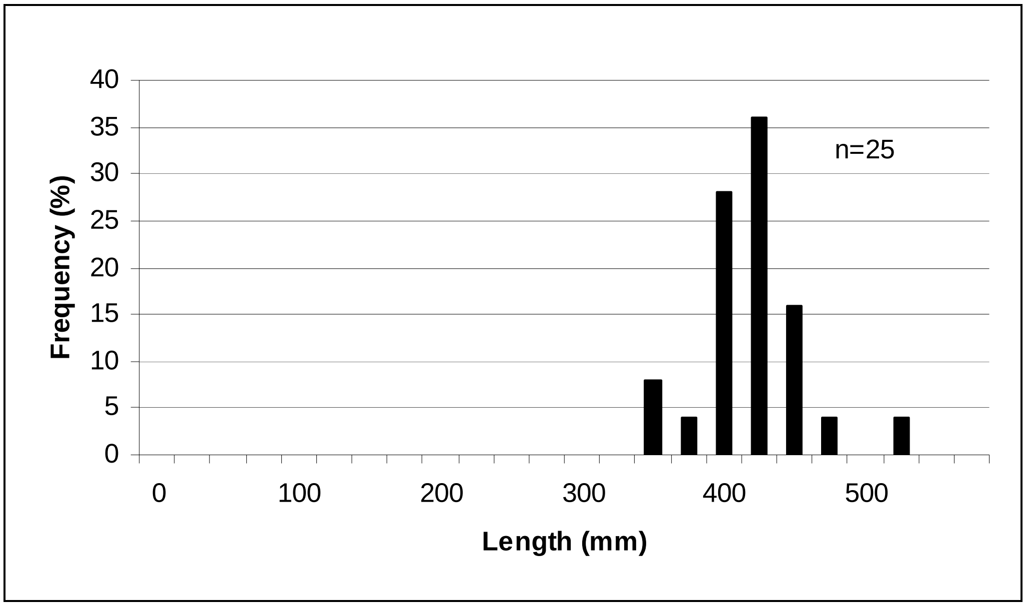


Figure 43: ***Length-frequency distribution of longnose sucker captured during spring electrofishing surveys in Farrell Creek***

3.2.5 Lynx Creek

3.2.5.1 Hoop Netting

A total of 282 fish, representing 10 species, was captured in Lynx Creek during spring 2006 (Table 10). Rainbow trout were the most common sportfish and they accounted for 10% of the total catch. Bull trout (2% of total catch) and mountain whitefish (1%) were captured in low numbers. Longnose suckers were the most common species accounting for over 50% of the catch. Redside shiners and northern pikeminnow were also a relatively common species accounting for 16% and 5% of the catch, respectively. Longnose dace (2%), peamouth (2%), largescale sucker (1%) and white sucker (0.3%) were rarely captured in Lynx Creek.

Rainbow trout were captured between May 11 and June 21 however, most (71%) were captured before May 23 while water temperatures and discharge were low (Figure 44). Rainbow trout are known to spawn in early spring when temperatures are between 10ºC and 15ºC (McPhail and Lindsey, 1970; Scott and Crossman, 1973). It is likely that some upstream movement was missed prior to hoop net installation so the number of rainbow trout moving upstream should indicate the presence of a spawning run rather than the absolute number of fish.

Longnose suckers were first captured on May 11 however, most (80%) of suckers were captured after May 31 as water temperatures increased (Figure 45) Although it is possible that some individuals were missed prior to the installation of the hoop net, it appears that the peak in the upstream migration occurred on June 3 (Figure 45).

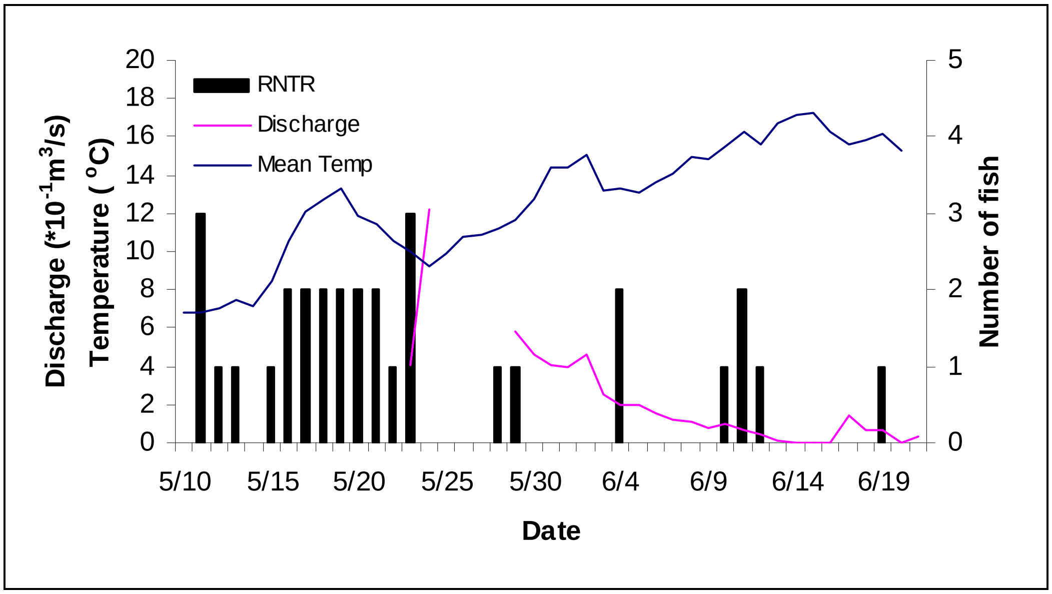


Figure 44: ***Abundance of rainbow trout, estimated discharge and water temperature by date for Lynx Creek spring 2006 hoop net sampling***

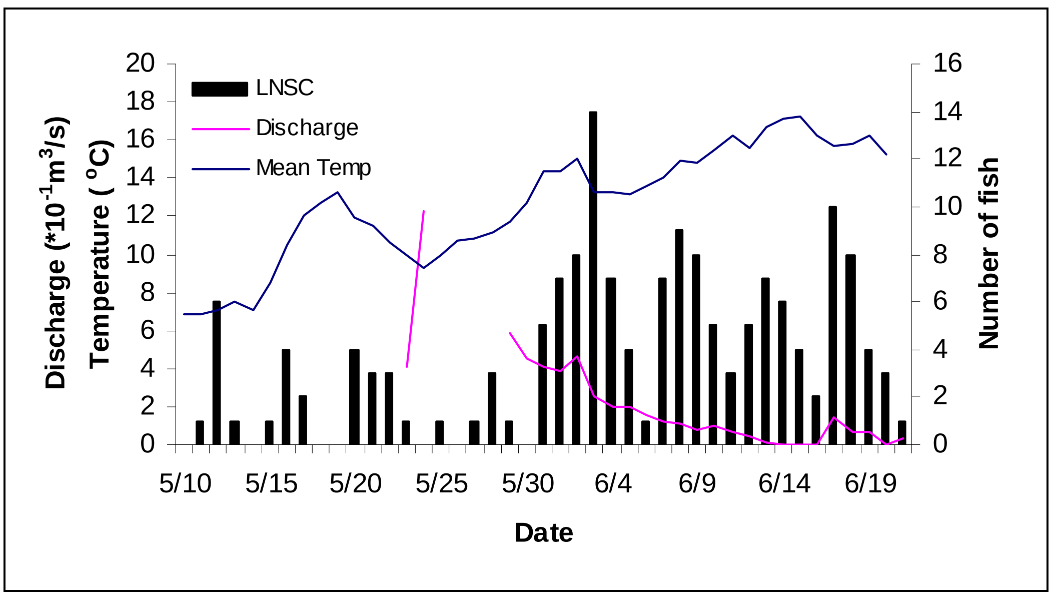


Figure 45: ***Abundance of longnose sucker, estimated discharge and water temperature by date for Lynx Creek spring 2006 hoop net sampling***

Mean lengths, weights, and condition factors for fish captured in Lynx Creek hoop net are presented in Table 27. Rainbow trout had mean length, weight and condition of 228 mm, 171 g and 1.1, respectively. Most (72%) of the rainbow trout captured were less than 250 mm and the modal length class was between 200 mm and 220 mm (Figure 46). Of the total rainbow trout catch, 16% were ripe adults. Six bull trout were captured and they ranged in length from 133 mm to 211 mm with a mean length of 184 mm. Longnose sucker ranged in length from 105 mm to 427 mm however most (82%) fish were less than 300 mm (Figure 47). Of the longnose captured, 12% were ripe males between 288 and 379 mm. Length-weight relationship for fish captured in Lynx Creek spring hoop net sampling are presented in Table 28.

Table 27: Length, weight and condition factor of fish captured during spring hoop net sampling in Lynx Creek

Group	Species	Length (mm)					Weight (g)					Condition				
		n	Mean	SD	Min	Max	n	Mean	SD	Min	Max	n	Mean	SD	Min	Max
Sportfish	BLTR	6	184	27	133	211	5	57	25	22	87	5	0.9	0.06	0.8	0.9
	RNTR	33	228	74	127	381	33	171	174	17	700	33	1.1	0.16	0.6	1.4
	MNWH	3	144	30	124	179	3	30	19	18	53	3	0.9	,03	0.9	1.0
Suckers	LNSC	186	222	69	105	427	181	163	170	15	900	181	1.1	0.16	0.4	2.5
	LRSC	3	162	22	138	180	3	47	17	29	62	3	1.1	0.03	1.1	1.1
	WHSC	2	430	0	430	430	2	988	18	975	1000	2	1.2	0.02	1.2	1.3
Minnows	LNDC	6	128	10	116	141	6	23	6	17	30	6	1.1	0.10	1.0	1.3
	NRPM	16	250	33	180	309	16	176	72	42	300	16	1.1	0.17	0.7	1.6
	PMCH	6	190	36	124	230	6	84	38	30	146	6	1.2	0.21	1.0	1.6
	RDSH	52	108	10	89	138	51	18	5	9	32	51	1.4	0.10	1.2	1.6

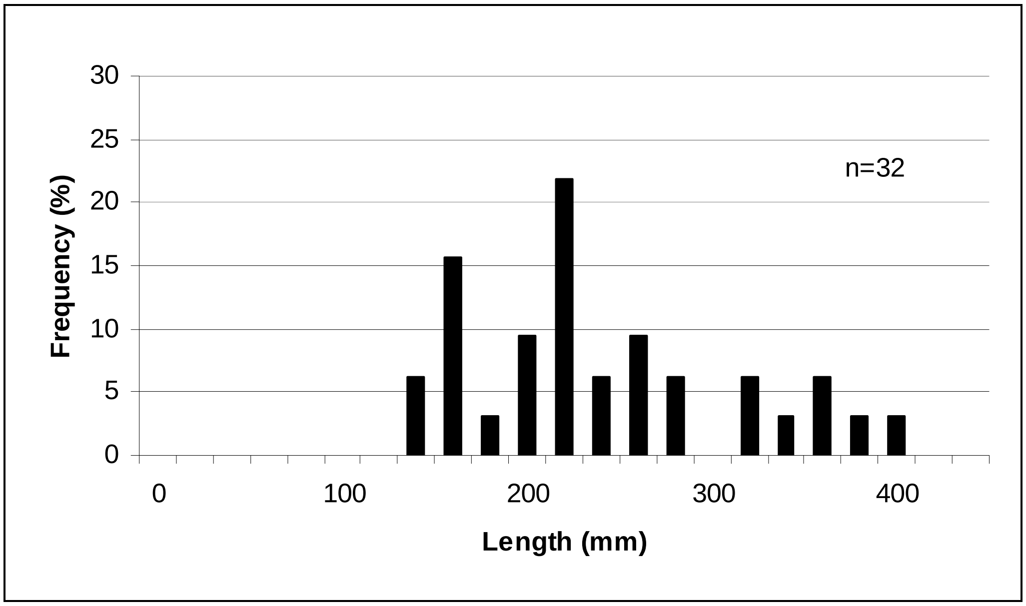


Figure 46: ***Length-frequency distribution of rainbow trout captured during spring hoop net sampling in Lynx Creek***

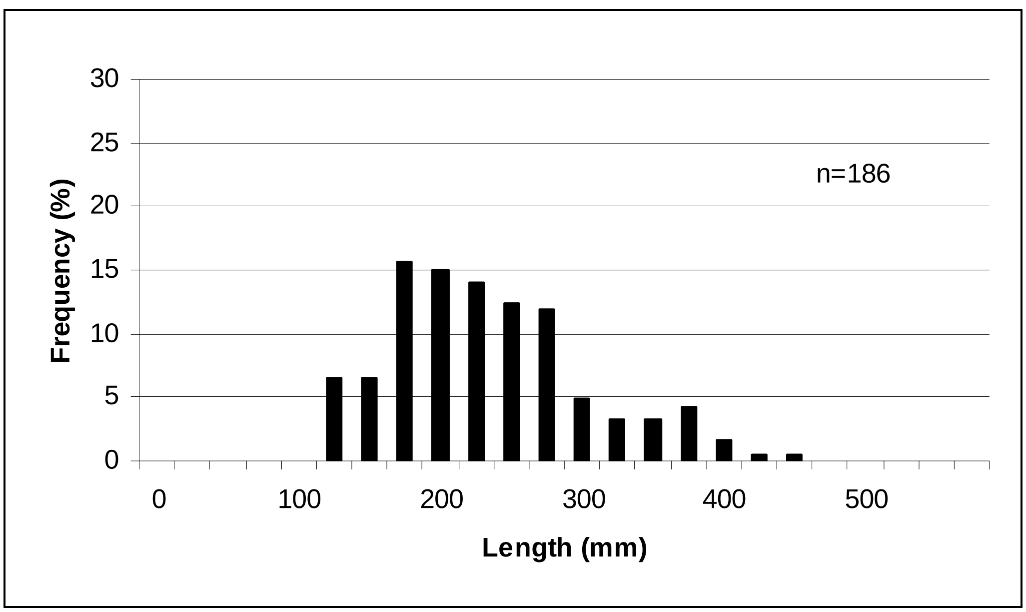


Figure 47: ***Length-frequency distribution of longnose sucker captured during spring hoop net sampling in Lynx Creek***

Table 28: Length-weight relationship for fish captured in Lynx Creek spring hoop net sampling

Species	n	Length-Weight Relationship
RNTR	33	Log (length) = 3.06[Log (weight)] - 5.12
LNSC	181	Log (length) = 3.08[Log (weight)] - 5.16
RDSH	51	Log (length) = 2.91[Log (weight)] - 4.68

Length- and weight- at age for all fish species for which aging structures were analyzed are presented in Table 29. Rainbow trout ranged in age from 2 to 6 years old and peaked at 3 years old. The longnose suckers aged were between 1 and 13 years old, with most fish around 3 and 5 years old.

Table 29: Length- and weight-at-age by species for Lynx Creek spring hoop net sampling

			Length (mm)			Weight (g)		
Species	**Age**	**n**	**Mean**	**Min**	**Max**	**Mean**	**Min**	**Max**
Bull trout	2	3	173	133	197	38	22.1	53.3
	3	1	211	211	211	87	87.4	87.4
Mountain whitefish	3	3	145	124	180	33	18.4	61.9
	4	1	179	179	179	53	52.5	52.5
Rainbow trout	2	6	153	127	181	37	16.5	61.7
	3	8	204	140	256	101	31.3	183.6
	4	7	248	202	333	176	88.2	400
	5	1	277	277	277	217	216.5	216.5
	6	2	353	348	357	355	260	450
Longnose sucker	1	1	118	118	118	16	15.6	15.6
	2	6	141	105	186	33	14.8	71.3
	3	11	160	114	184	45	14.6	65.6
	4	9	207	172	250	93	30.7	151
	5	15	244	190	275	159	77.1	244.2
	6	4	283	228	317	281	126.1	400
	7	3	324	288	357	415	271.2	500
	9	1	370	370	370	575	575	575
	10	2	349	337	360	475	450	500
	12	1	390	390	390	625	625	625
	13	1	427	427	427	900	900	900
Largescale sucker	2	2	153	138	168	40	29.1	50.3

3.2.5.2 Electrofishing

A total of 130 fish, representing eight species, was collected in electrofishing surveys in Lynx Creek (Table 11). Longnose sucker (64% of total catch) was the most abundant species followed by longnose dace (18%). Mountain whitefish (5%) and rainbow trout (2%) were the only sportfish species captured. No other species comprised more than 5% of the electrofishing catch. The greatest differences between the hoop net catch and the electrofishing catch were the greater relative abundance of longnose dace in the electrofishing catch, the greater relative abundance of redside shiner in the hoop net catch. Results of the electrofishing survey did not suggest that any upstream migrations of large-bodied fish species were missed by the hoop net.

Length measurements for the fish captured in Lynx Creek during summer electrofishing surveys are presented in Table 30. Weights were not taken on the sampling day because the scale malfunctioned. The mean length for mountain whitefish was 105 mm and the two rainbow trout captured were 208 and 219 mm. Longnose sucker lengths ranged from 85 mm to 403 mm and included a large proportion (71%) of juveniles fish less than 250 mm long (Figure 48). The mean length of longnose suckers captured in the hoop net were similar to those captured by electrofishing and the same proportion of the catch (12%) were ripe males. The presence of juvenile fish suggests that Lynx Creek provides rearing habitat for longnose suckers.

Table 30: Length of fish captured during spring electrofishing surveys in Lynx Creek

		Length (mm)				
Group	**Species**	**n**	**Mean**	**SD**	**Min**	**Max**
Sportfish	MNWH	7	105	11	91	121
	RNTR	2	214	8	208	219
Suckers	LNSC	83	218	71	85	403
	WHSC	2	273	223	115	430
Minnows	LNDC	23	86	28	30	123
	NRPM	2	262	5	258	265
	PMCH	6	108	57	33	195
	RDSH	5	111	7	103	119

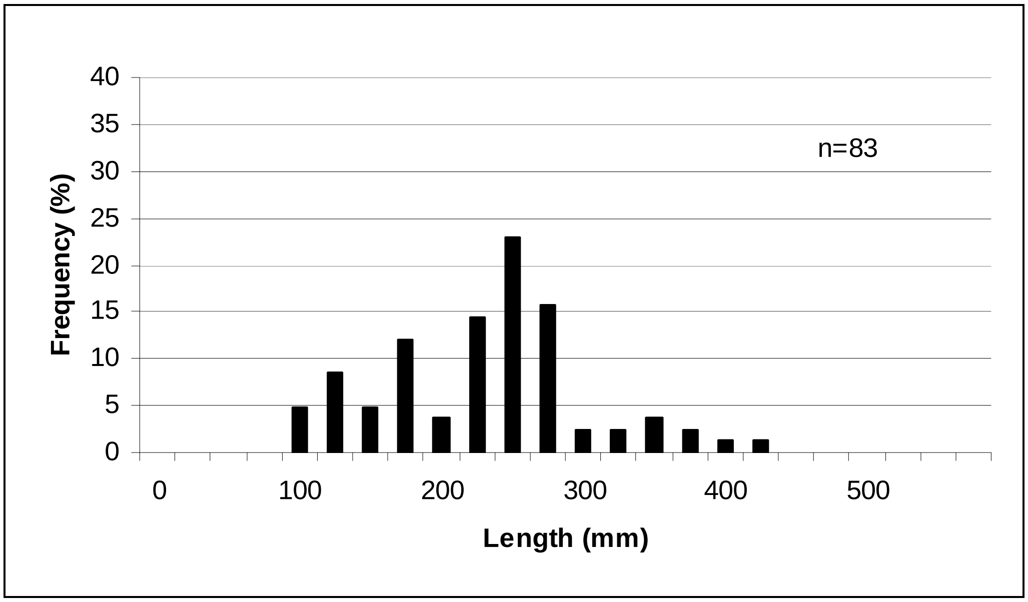


Figure 48: ***Length-frequency distribution of longnose sucker captured during spring electrofishing surveys in Lynx Creek***

3.2.6 Maurice Creek

3.2.6.1 Hoop Netting

A total of 209 fish, representing eight species, was captured in Maurice Creek during spring hoop netting (Table 10). Rainbow trout were the most common sportfish captured and they accounted for 15% of the total catch. Bull trout, kokanee and mountain whitefish were the other sportfish species captured but they each comprised less than 2% of the total catch. Longnose suckers were the most common species, accounting for 73% of the catch. Largescale sucker (0.5% of the total catch), northern pikeminnow (0.5%), and longnose dace (2.7%) were present but rare in Maurice Creek.

Rainbow trout were captured throughout the sampling period in Maurice Creek with fish captured on the first day of sampling (May 12) and the last fish was captured on June 10 (Figure 49). It is possible that some upstream movement of rainbow trout may have been missed prior to the installation of the hoop net. The net was not checked May 23 to 25, inclusively and it is possible that some individuals were missed moving upstream during that period. Given that some rainbow trout may have been missed, the number of rainbow trout moving upstream should indicate the presence of a spawning run rather than the absolute number of fish.

Longnose sucker were captured in Maurice Creek between May 15 and June 8 (Figure 50). The abundance of longnose suckers captured peaked on May

17, 30 and June 4 and coincides with warming water temperatures in Maurice Creek (Figure 50).

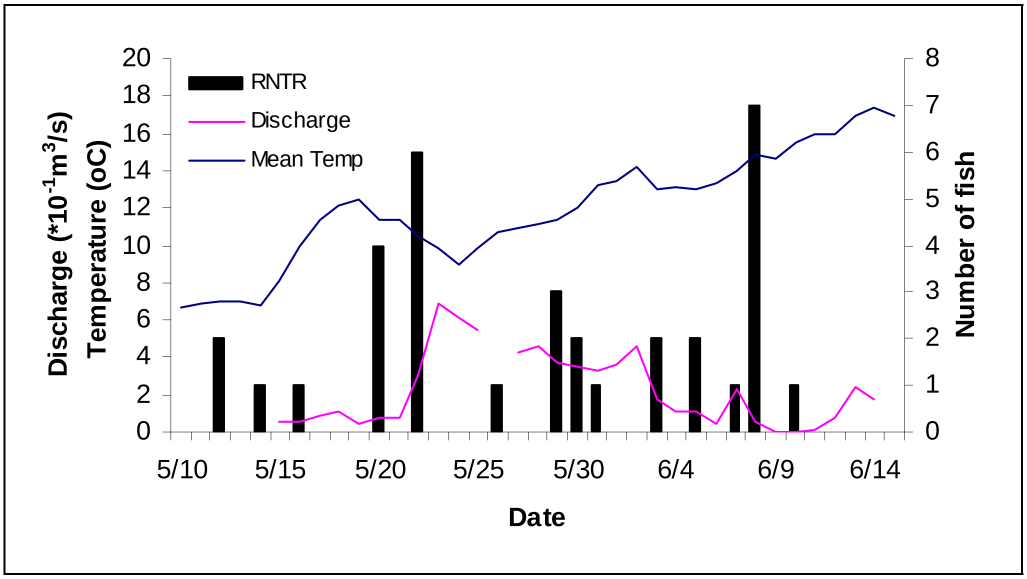


Figure 49: ***Abundance of rainbow trout, estimated discharge and water temperature by date for Maurice Creek spring 2006 hoop net sampling***

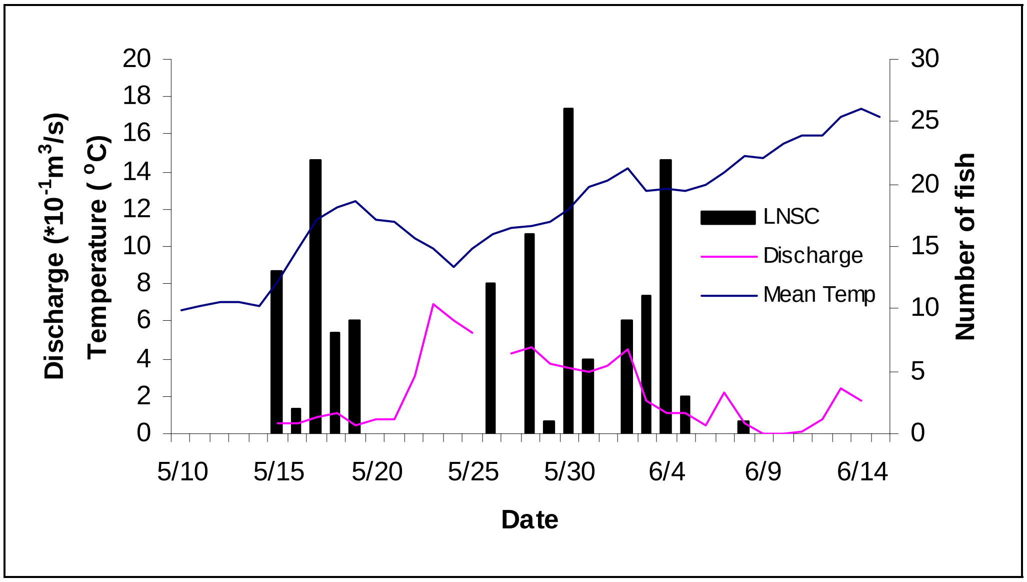


Figure 50: ***Abundance of longnose sucker, estimated discharge and water temperature by date for Maurice Creek spring 2006 hoop net sampling***

Mean length, weight and condition factor for the fish captured in Maurice Creek are presented in Table 31. Rainbow trout had mean length, weight and condition of 287 mm, 312 g and 1.1, respectively. Rainbow trout lengths ranged from 136 mm to 431 mm with a modal length class of 280 mm to 300 mm (Figure 51). Of the rainbow trout captured, 27% were ripe adults between 240 and 431 mm. Longnose sucker lengths ranged from 233 mm to 503 mm and had a modal length class of 400 mm to 450 mm (Figure 52). More than half (61%) of the longnose suckers were ripe adults between 277 and 491 mm. Length-weight relationships for fish captured in Maurice Creek spring hoop net sampling are presented in Table 32.

Table 31: Length, weight and condition factor of fish captured during spring hoop net sampling in Maurice Creek

		Length (mm)					Weight (g)					Condition				
Group	**Species**	**n**	**Mean**	**SD**	**Min**	**Max**	**n**	**Mean**	**SD**	**Min**	**Max**	**n**	**Mean**	**SD**	**Min**	**Max**
Sportfish	BLTR	2	179	8	173	185	2	50	7	45	55	2	0.9	0.0	0.9	0.9
	KOKA	1	173				1	58				1	1.1			
	MNWH	3	197	104	113	314	3	112	146	15	280	3	1.0	0.1	0.9	1.0
	RNTR	36	287	74	136	431	34	312	199	52	825	34	1.1	0.2	0.5	1.9
Suckers	LNSC	171	399	42	233	503	154	796	244	135	1600	154	1.2	0.1	0.4	1.8
	LRSC	1	312				0					0				
Minnows	LNDC	6	116	6	109	123	6	20	4	14	25	6	1.2	0.1	1.1	1.4
	NRPM	1	316				1	325				1	1.0			

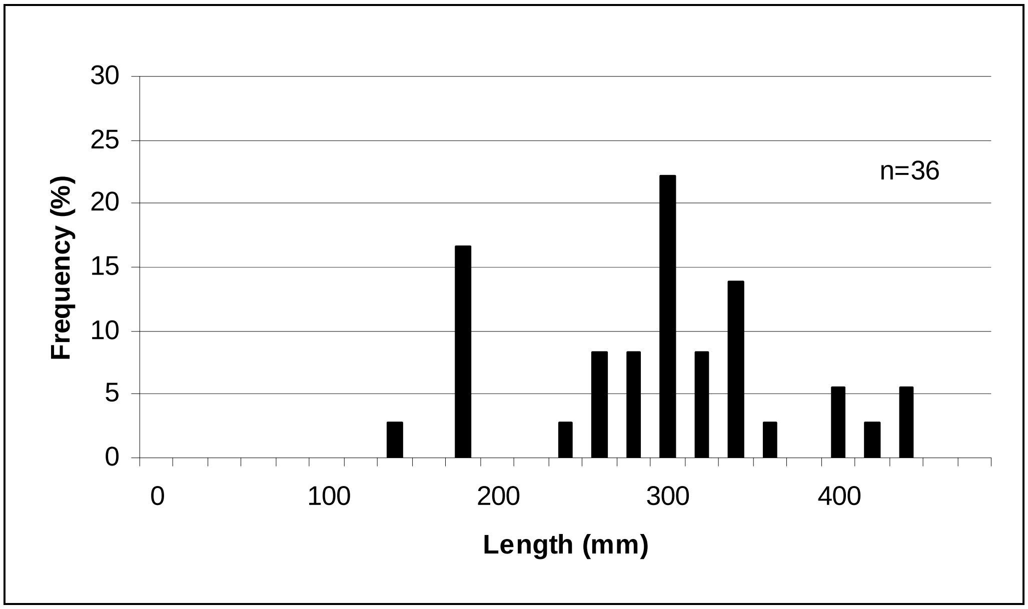


Figure 51: ***Length-frequency distribution of rainbow trout captured during spring hoop net sampling in Maurice Creek***

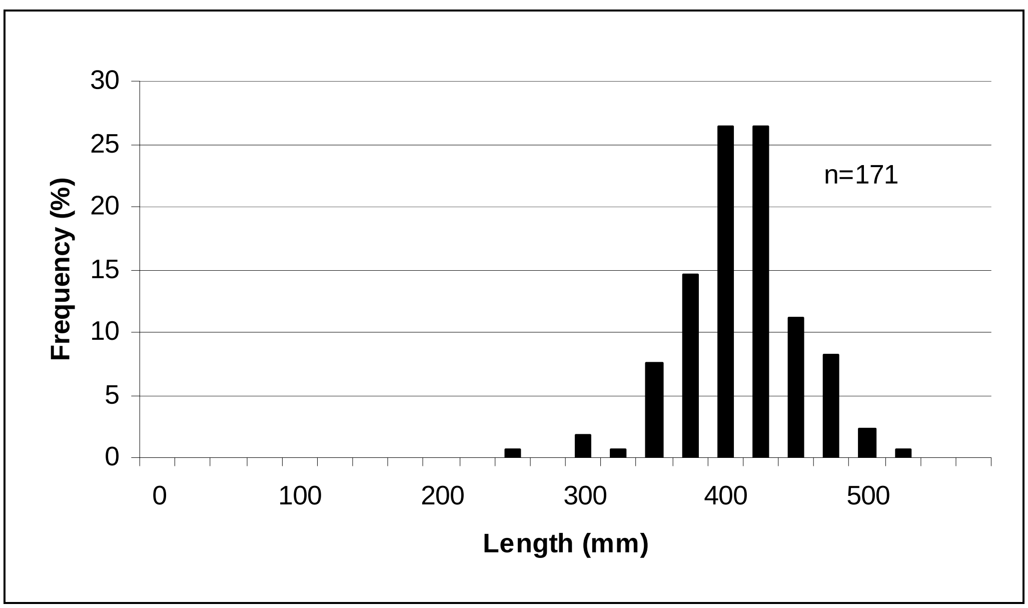


Figure 52: ***Length-frequency distribution of longnose sucker captured during spring hoop net sampling in Maurice Creek***

Table 32: Length-weight relationship for fish captured in Maurice Creek spring hoop net sampling

Species	n	Length-Weight Relationship
RNTR	34	Log (length) = 2.94[Log (weight)] - 4.82
LNSC	154	Log (length) = 3.00[Log (weight)] - 4.90

Length- and weight-at-age for all fish species for which aging structures were analyzed are presented in Table 33. Aged rainbow trout were between 2 and 6 years old while 4 year olds were most common. Longnose suckers were aged between 4 and 20 years old while most were 10 or 12-15 years old.

Table 33: Length- and weight-at-age by species for Maurice Creek spring hoop net sampling

			Length (mm)			Weight (g)		
Species	Age	n	Mean	Min	Max	Mean	Min	Max
Bull trout	2	2	179	173	185	50	45.4	55.4
Kokanee	3	1	173	173	173	58	57.6	57.6
Rainbow trout	2	5	167	136	179	57	55.5	57.8
	3	4	249	169	289	150	51.8	250
	4	8	311	277	336	322	229.3	450
	5	4	327	286	381	362	260.7	550
	6	2	372	360	383	563	500	625
Mountain whitefish	2	1	113	113	113	15	14.9	14.9
	4	1	164	164	164	41	40.5	40.5
	8	1	314	314	314	280	280.2	280.2
Longnose sucker	4	1	233	233	233	135	134.5	134.5
	6	1	298	298	298	295	294.5	294.5
	8	1	343	343	343	500	500	500
	9	1	401	401	401	800	800	800
	10	4	394	361	457	794	625	1250
	11	2	393	367	418	813	600	1025
	12	4	394	381	407	744	675	875
	13	4	418	348	469	938	500	1300
	15	4	408	378	446	881	625	1150
	16	2	383	340	425	700	500	900
	17	1	414	414	414	925	925	925
	18	1	443	443	443	1125	1125	1125
	20	1	498	498	498	1600	1600	1600

3.2.6.2 Electrofishing

A total of 139 fish, representing seven fish species, was captured in Maurice Creek spring electrofishing surveys (Table 11). The total CPUE was 2.73 fish per 100 s of shocking all species combined (Table 11). Sculpin species were the most abundant group (63% of total catch) of fish captured; the sculpin were a mix of prickly sculpin and slimy sculpin not differentiated in the field. Rainbow trout were also common and comprised 29% of the total catch. All the other species captured contributed less than 4% to the total catch and included bull trout, mountain whitefish and longnose dace.

Differences between electrofishing and hoop net catches were primarily due to differences in gear selectivity. There was a higher proportion of rainbow trout in the electrofishing catch (29%) than in the hoop net (15%) and most (~80%) of the rainbow trout captured in the electrofishing were juveniles. Longnose sucker comprised a much higher proportion of the hoop net catch (72%) than the electrofishing catch (1%). In addition, sculpin were absent from the hoop net catch while prickly sculpin and slimy sculpin comprised 63% of the electrofishing catch.

Although differences in the catches existed, the electrofishing survey did not suggest that the hoop net missed any upstream spawning migrations of any large-bodied fish species.

Mean lengths, weights and condition factors for fish captured in Maurice Creek spring electrofishing are presented in (Table 34). Rainbow trout had average length, weight and condition of 128 mm, 44 g and 1.2, respectively. Most of the rainbow trout were juvenile (~80%) and the modal length class was 80 mm to 100 mm (Figure 53). The only longnose sucker captured was not ripe and considering that 61% of the longnose suckers captured in the hoop net were ripe, it is likely that suckers were either spawning close to the mouth and leaving the tributary immediately after or they moved upstream past the upper extent of the electrofishing survey.

Table 34: Length, weight and condition factor of fish captured during spring electrofishing surveys in Maurice Creek

Group	Species	Length (mm)					Weight (g)					Condition Factor				
		n	**Mean**	**SD**	**Max**	**Min**	**n**	**Mean**	**SD**	**Max**	**Min**	**n**	**Mean**	**SD**	**Max**	**Min**
Sportfish	BLTR	1	244				0					0				
	MNWH	4	133	38	100	185	4	30	27	10	69	4	1.0	0.10	1.0	1.2
	RNTR	40	128	66	70	383	39	44	123	4	775	38	1.2	0.13	0.8	1.5
Suckers	LNSC	1	113				1	20				1	1.4			
Minnows	LNDC	6	117	13	101	139	6	20	8	11	35	6	1.2	0.13	1.1	1.4
Sculpin	PRSC + SLSC	87	73	15	35	147	77	5	6	1	48	77	1.1	0.22	0.7	2.3

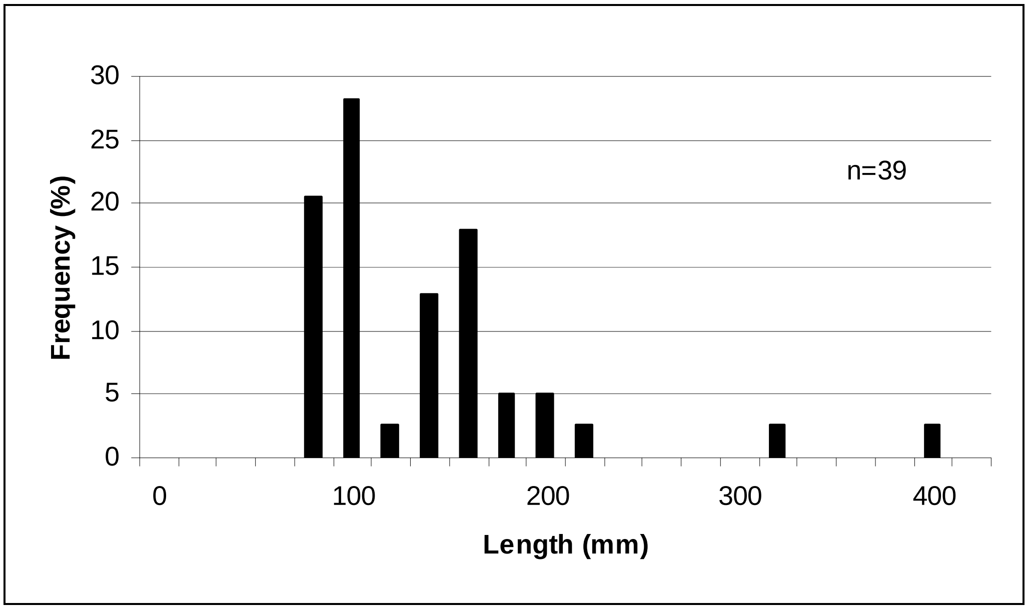


Figure 53: Length-frequency distribution of rainbow trout captured during spring electrofishing surveys in Maurice Creek

3.3 Larval Drift Net Sampling

A total of 14 larval drift samples was collected from Cache (2 samples), Farrell (3 samples), Lynx (2 samples) and Maurice (5 samples) creeks and the Halfway River (2 samples) in spring of 2006 (Table 35). The amount of time that larval nets were left fishing varied depending on the amount of instream debris and water velocity in each tributary. Average soak time for all sets was 7.5 hours with a minimum and maximum soak time of 2 hours and 32 hours, respectively.

The amount of time spent sorting samples also varied by tributary. Maurice Creek had very little drifting debris and so samples with long soak times (>12 hours) took approximately the same time to sort as samples with short soak times (< 6 hours) in other locations. The average time spent sorting larval fish samples was 1 hour but ranged from 10 minutes to 1 hour and 45 min (Table 35). All but two samples were sorted in the field. These other two samples were, preserved and then processed in the lab. These samples took similar time to sort as those sorted in the field.

Larval fish were collected in half of the samples collected (Table 35). However, most (71%) of the samples with fish were collected in Maurice Creek. These included larval suckers, sculpins, and minnow species. Larval minnows were also captured in Farrell Creek. Larval fish were not captured in Lynx Creek, Cache Creek or the Halfway River. Larval salmonids were not captured in any of the tributaries sampled.

Table 35: Date, soak and sort time, and fish data for larval drift sampling by tributary

Tributary	Date	Soak time (hr)	Sort time (hr)	# of fish	Density (fish/m^3s^{-1} water)	Species present
Maurice	12-Jun	10.4	1.5	6	0.0109	Sucker and sculpin species
Maurice	13-Jun	9.4	1.0	8	0.1069	Sucker and sculpin species
Maurice	14-Jun	32.1	1.2	2	0.0004	Sucker species
Maurice	15-Jun	15.4	1.5	10	0.0063	Sucker and sculpin species
Maurice	16-Jun	11.3	1.0	1	0.0007	Minnow species
Lynx	13-Jun	2.2	0.8	0	0	No fish collected
Lynx	15-Jun	1.7	1.0	0	0	No fish collected
Cache	12-Jun	6.0	1.0	0	0	No fish collected
Cache	13-Jun	6.5	0.3	0	0	No fish collected
Farrell	12-Jun	2.0	1.8	8	0.1558	Dried out and unidentifiable
Farrell	14-Jun	2.8	1.0	0	0	No fish collected
Farrell	16-Jun	2.4	1.3	2	0.0461	Minnow species
Halfway	14-Jun	1.8	0.2	0	0	No fish collected
Halfway	15-Jun	2.0	1.3	0	0	No fish collected
Total		106	14.9	37	0.3271	
Average		7.5	1.1	2.6	0.0234	

3.4 Juvenile Rearing Surveys

3.4.1 Habitat Characteristics

Habitat characteristics for each summer rearing sampling site are available in Appendix D and summarized in Table 36, photographs of each habitat unit are included in Appendix D.

With the exception of Moberly River, mean water depth was similar in all tributaries with pool depths between 0.4 m and 0.5 m and run and riffle depths of 0.1 m and 0.2 m, respectively. In Moberly River, pool, riffle and run habitats had deeper mean water depths (0.5 m, 0.2 m and 0.4 m, respectively). Moberly River also had the highest water velocity of all the tributaries sampled and in many of the tributaries the flow was too low to measure. In Red Creek, natural iron concentrations were high, so the water and dry channel bottom were often tinted red. Water flow in Red Creek was extremely low below the two beaver dams and water depths were typically less than 20 cm. Only run and riffle habitat existed and no pool habitat could be sampled.

3.4.2 Fish Species Composition, Abundance & Distribution

An estimated total of 23,253 fish, representing thirteen species, was captured in Peace River tributaries during summer electrofishing surveys (Table 37). Sportfish only accounted for 0.3% of the total catch and included mountain whitefish, rainbow trout, Arctic grayling and burbot. Minnows (81% of total catch) and suckers (18%) were the most abundant groups of fish captured. The two most abundant species were longnose dace (29%) and redside shiner (22%).

Moberly River had the highest diversity of species (11 species) while Red Creek had the lowest (4 species). Cache Creek had the highest abundance of fish, although, most of the fish captured were young-of-the-year (YOY) suckers and minnows. Maurice Creek (6.5% of total catch) and Lynx Creek (3.7%) had the highest proportion of sportfish of all the tributaries sampled. Arctic grayling and burbot were only captured in the Moberly River.

Table 36: Habitat characteristics, by habitat type, for summer rearing sampling sites in Peace River tributaries

Tributary	**Moberly River**			**Cache Creek**			**Red Creek**		**Farrell Creek**			**Lynx Creek**			**Maurice Creek**		
Habitat Type	**Pool**	**Riffle**	**Run**	**Pool**	**Riffle**	**Run**	**Riffle**	**Run**	**Pool**	**Riffle**	**Run**	**Pool**	**Riffle**	**Run**	**Pool**	**Riffle**	**Run**
Mean Area (m^2)	86.4	303.4	214.4	219.2	21.6	77.1	14.3	59.3	94.6	35.2	50.9	46.1	49.6	74.9	115.2	47.2	49.3
Wetted width (m)	4.5	12.7	11.7	6.1	1.5	3.3	1.1	3.1	5.5	2.5	4.2	4.3	4.2	4.9	4.4	3.6	3.9
Mean depth (m)	0.5	0.2	0.4	0.5	0.1	0.2	0.1	0.1	0.4	0.1	0.2	0.4	0.1	0.2	0.5	0.1	0.1
Min depth (m)	0.1	0.1	0.1	0.1	0.0	0.1	0.0	0.1	0.1	0.0	0.1	0.1	0.0	0.0	0.2	0.0	0.0
Max depth (m)	1.0	0.5	1.1	1.0	0.2	0.4	0.1	0.3	1.0	0.2	0.4	0.9	0.3	0.4	0.8	0.2	0.3
Mean velocity (m/s)	--	0.6	0.4	--	--	--	--	--	--	--	--	0.1	0.4	0.2	--	0.3	0.1
Min velocity (m/s)	--	0.1	0.0	--	--	--	--	--	--	--	--	0.0	0.0	0.0	--	0.0	0.0
Max velocity (m/s)	--	1.2	1.0	--	--	--	--	--	--	--	--	0.3	0.8	0.6	--	0.6	0.3

Note: The symbol '- - ' indicates that flows were too low to measure water velocities

Table 37: ***Number of fish, percent catch and catch-per-unit-effort, by species, for summer electrofishing surveys in Peace River tributaries***

		Moberly River			Cache Creek			Red Creek			Farrell Creek			Lynx Creek			Maurice			Total		
Group	**Species**	**n**	**%**	**CPUE[1]**	**n**	**%**	**CPUE[1]**	**n**	**%**	**CPUE[1]**	**n**	**%**	**CPUE[1]**	**n**	**%**	**CPUE[1]**	**n**	**%**	**CPUE[1]**	**n**	**%**	**CPUE[1]**
Sportfish	ARGR	3	0.5	0.1																3	0.0	0.0
	BURB	1	0.2	0.0																1	0.0	0.0
	MNWH	3	0.5	0.1	3	0.0	0.2				1	0.0	0.0	18	3.0	0.6	17	3.7	1.0	42	0.2	0.3
	RNTR													4	0.7	0.1	13	2.8	0.7	17	0.1	0.1
	Subtotal	7	1.1	0.1	3	0.0	0.2	0.0	0.0	0.0	1	0.0	0.0	22	3.7	0.7	30	6.5	1.7	63	0.3	0.5
Suckers	LNSC	30	4.8	0.5	1	0.0	0.1				5	0.1	0.2	50	8.3	1.7	4	0.9	0.2	90	0.4	0.6
	LRSC	1	0.2	0.0							5	0.1	0.2	2	0.3	0.1				8	0.0	0.1
	WHSC													1	0.2	0.0				1	0.0	0.0
	YOY Sucker	67	10.6	1.2	1378	11.2	107.1	51	16.5	9.8	2139	23.9	99.6	378	62.8	12.6	130	28.0	6.5	4143	17.8	29.8
	Subtotal	98	15.5	1.8	1379	11.2	107.2	51	16.5	9.8	2149	24.0	100.0	431	71.6	14.4	134	28.8	6.7	4242	18.2	30.5
Minnows	LKCH	22	3.5	0.4	1884	15.3	129.6	62	20.0	11.9	297	3.3	13.8	25	4.2	0.8				2290	9.8	16.5
	LNDC	405	64.2	6.8	3740	30.4	261.3	132	42.6	25.4	2183	24.4	101.6	45	7.5	1.5	171	36.8	8.8	6676	28.7	48.0
	NRPM	3	0.5	0.1							711	7.9	33.1	21	3.5	0.7				735	3.2	5.3
	RDSH	42	6.7	0.8	2741	22.3	145.8	65	21.0	12.5	2194	24.5	102.1	6	1.0	0.2				5048	21.7	36.3
	YOY Minnow				2544	20.7	200.0				1413	15.8	65.8	47	7.8	1.6				4004	17.2	28.8
	Subtotal	472	74.8	8.0	10909	88.8	736.8	259	83.5	49.9	6798	75.9	316.5	144	23.9	4.8	171	36.8	8.8	18753	80.6	134.8
Sculpin	PRSC	5	0.8	0.1							2	0.0	0.1	5	0.8	0.2	38	8.2	2.1	50	0.2	0.4
	SLSC	44	7.0	0.5							4	0.0	0.2				30	6.5	1.6	78	0.3	0.6
	Sculpin	5	0.8	0.1													62	13.3	3.2	67	0.3	0.5
	Subtotal	54	8.6	0.7	0	0.0	0.0	0	0.0	0.0	6	0.1	0.3	5	0.8	0.2	130	28.0	6.8	195	0.8	1.4
Total		631	100.0	10.6	12291	100.0	844.2	310	100.0	59.7	8954	100.0	416.9	602	100.0	20.1	465	100.0	23.9	23253	100.0	167.2

Note: [1] Catch-per-unit-effort (CPUE) is the number of fish captured divided by the elapsed time spent electrofishing; values listed have been multiplied by 100 to give CPUE for 100 seconds of electrofishing.

3.4.2.1 Moberly River

A total of 631 fish, representing 11 species, was captured in the Moberly River during summer electrofishing surveys in 2006 (Table 38). This was the largest number of species captured in any of the seven tributaries sampled. Longnose dace were the most common fish species captured, accounting for 64% of the total catch. Young-of-the-year (YOY) suckers were the next most abundant fish captured (11%), followed by redside shiners (7%), slimy sculpin (7%), and juvenile longnose sucker (5%). No other species represented more than 3% of the total catch and included juvenile burbot, juvenile largescale sucker, juvenile northern pikeminnow, prickly sculpin, and lake chub. Total CPUE in the Moberly River was 10.6 fish/100 sec, the lowest catch rate of any of the tributaries sampled. (Table 39). Average lengths and weights for each species of fish captured in the Moberly River in summer 2006 are provided in Table 40.

Three YOY Arctic grayling and three YOY mountain whitefish were captured in the Moberly River. Two of these YOY Arctic grayling were captured in run habitat in the lower reach while the other was captured in a riffle in the upper reach. These fish were the only YOY Arctic grayling captured in any of the tributaries sampled and indicate that Arctic grayling successfully spawned in the upper and lower reaches of the Moberly River in 2006. All three YOY mountain whitefish were captured in the lower reach and also indicate that mountain whitefish successfully spawned in the Moberly River in fall 2005.

Within the Moberly River, fish were captured in greater numbers in run habitat than in pools or riffles. However, differences in abundance were only significant for longnose dace (F=14.15, p=0.0004) and slimy sculpin (F=5.70, p=0.01) and both of these species were significantly more abundant in riffles than in pools or runs. This difference is not unexpected given that the preferred habitat for both species is fast-flowing riffles with cobble substrates (Scott and Crossman, 1973; Evans et al. 2002). Habitats in the upper reach had a higher abundance of fish than in the lower reaches, however, this was only significant for YOY suckers (F=9.47, p=0.01). Northern pikeminnow, prickly sculpin and lake chub were only captured in the lower reach whereas, longnose dace, longnose suckers and redside shiners were captured in almost every habitat type in both the upper and lower reaches. Slimy sculpin were captured in upper and lower reaches in all habitats except pools.

Table 38: ***Number of fish captured, by habitat type and reach, in the Moberly River during summer electrofishing surveys in 2006***

		Number of fish per site																																		
		Pool									Riffle											Run													Combined	
		Lower					Upper			Sub-	Lower					Upper					Sub-	Lower						Upper					Sub-	Sites	
Group	**Species**	**1**	**2**	**3**	**4**	**Total**	**5**	**6**	**Total**	**total**	**1**	**2**	**3**	**4**	**Total**	**5**	**6**	**7**	**8**	**Total**	**total**	**1**	**2**	**3**	**4**	**5**	**Total**	**6**	**7**	**8**	**9**	**Total**	**total**	**Total**	**% Catch**
Sportfish	ARGR					0			0	0					0		1			1	1			1		1	2					0	2	3	0.5
	BURB					0			0	0					0					0	0	1					1					0	1	1	0.2
	MNWH					0			0	0	1				1					0	1			1		1	2					0	2	3	0.5
	Subtotal	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	1	0	0	1	2	1	0	2	0	2	5	0	0	0	0	0	5	7	1.1
Suckers	LNSC	1		1		2			0	2	1		1		2		2	3		5	7	2		2	1	2	7	3	7		4	14	21	30	4.8
	LRSC			1		1			0	1					0					0	0						0					0	0	1	0.2
	YOY Sucker	1	3			4	2	13	15	19	10	1	2	1	14		2	1	4	7	21			2	1		3	1	10	10	3	24	27	67	10.6
	Subtotal	2	3	2	0	7	2	13	15	22	11	1	3	1	16	0	4	4	4	12	28	2	0	4	2	2	10	4	17	10	7	38	48	98	15.5
Minnows	LKCH	2	1	1		4	2		2	6					0			1		1	1			3			3	1	8	2	1	12	15	22	3.5
	LNDC		6			6	1		1	7	52	21	16	13	102	21	49	49	33	152	254	5	4	6	2	22	39	59	15	8	23	105	144	405	64.2
	NRPM	1				1			0	1					0					0	0			1		1	2					0	2	3	0.5
	RDSH		4	14	2	20	10	1	11	31	1				1					0	1	1		3			4		6			6	10	42	6.7
	Subtotal	3	11	15	2	31	13	1	14	45	53	21	16	13	103	21	49	50	33	153	256	6	4	13	2	23	48	60	29	10	24	123	171	472	74.8
Sculpin	PRSC		3			3			0	3			1		1					0	1	1					1					0	1	5	0.8
	SLSC					0			0	0	2	1	1	1	5	9	7	6	5	27	32			3			3	4			5	9	12	44	7.0
	Sculpin		1			1			0	1					0		1			1	1					3	3					0	3	5	0.8
	Subtotal	0	4	0	0	4	0	0	0	4	2	1	2	1	6	9	8	6	5	28	34	1	0	3	0	3	7	4	0	0	5	9	16	54	8.6
Total		5	18	17	2	42	15	14	29	71	67	23	21	15	126	30	62	60	42	194	320	10	4	22	4	30	70	68	46	20	36	170	240	631	100.0

Table 39: Catch-per-unit-effort (CPUE) of fish captured, by habitat type and reach, in the Moberly River during summer electrofishing surveys in 2006

		Number of fish per 100 seconds																																
		Pool									**Riffle**											**Run**													
		Lower					**Upper**			**Sub-**	**Lower**					**Upper**					**Sub-**	**Lower**						**Upper**					**Sub-**	**Total**
Group	**Species**	**1**	**2**	**3**	**4**	**Mean**	**5**	**6**	**Mean**	**total**	**1**	**2**	**3**	**4**	**Mean**	**5**	**6**	**7**	**8**	**Mean**	**total**	**1**	**2**	**3**	**4**	**5**	**Mean**	**6**	**7**	**8**	**9**	**Mean**	**total**	**Mean**
Sportfish	ARGR					0.0			0.0	0.0					0.0		0.3			0.1	0.0			0.8		0.4	0.2					0.0	0.1	0.1
	BURB					0.0			0.0	0.0					0.0					0.0	0.0	0.3					0.1					0.0	0.0	0.0
	MNWH					0.0			0.0	0.0	0.2				0.1					0.0	0.0			0.8		0.4	0.2					0.0	0.1	0.1
Suckers	LNSC	2.3		0.7		0.3			0.0	0.2	0.2		0.5		0.2		0.6	--		0.2	0.4	0.7		1.5	0.4	0.7	0.6	0.8	3.0		0.9	1.1	0.9	0.5
	LRSC			0.7		0.2			0.0	0.1					0.0					0.0	0.0						0.0					0.0	0.0	0.0
	YOY Sucker	2.3	1.4			0.7	--	5.0	5.0	2.0	1.6	0.4	0.9	0.8	1.1		0.6	--	1.4	0.7	1.0			1.5	0.4		0.3	0.3	4.3	5.1	0.7	1.9	2.2	1.2
Minnows	LKCH	4.7	0.5	0.7		0.7	--		0.0	0.5					0.0			--		0.0	0.0			2.3			0.3	0.3	3.4	1.0	0.2	1.0	0.7	0.4
	LNDC		2.8			1.0	--		0.0	0.7	8.5	7.8	7.3	10.1	8.3	10.0	15.0	--	11.8	12.6	10.0	1.7	2.7	4.6	0.8	7.8	3.6	15.8	6.4	4.1	5.4	8.5	6.2	6.8
	NRPM	2.3				0.2			0.0	0.1					0.0					0.0	0.0			0.8		0.4	0.2					0.0	0.1	0.1
	RDSH		1.9	9.8	1.0	3.3	--	0.4	0.4	2.4	0.2				0.1					0.0	0.0	0.3		2.3			0.4		2.6			0.5	1.1	0.8
Sculpin	PRSC		1.4			0.5			0.0	0.3			0.5		0.1					0.0	0.0	0.3					0.1					0.0	0.2	0.1
	SLSC					0.0			0.0	0.0	0.3	0.4	0.5	0.8	0.4	4.3	2.1	--	1.8	2.6	1.3			2.3			0.3	1.1			1.2	0.7	1.3	0.5
	Sculpin		0.5			0.2			0.0	0.1					0.0		0.3			0.1	0.0					1.1	0.3					0.0	0.2	0.1
Total		11.6	8.4	11.9	1.0	7.0	--	5.4	5.4	6.5	11.0	8.5	9.5	11.6	10.3	14.4	19.0	--	15.0	16.4	12.7	3.3	2.7	16.9	1.7	10.7	6.4	18.2	19.7	10.2	8.4	13.8	10.3	10.6
Elapsed time		43	214	143	200	600	?	259	259	859	610	270	220	129	1229	209	327	?	279	815	2044	300	148	130	238	281	1097	374	234	196	428	1232	2329	5232

Note: The symbol '—' indicates occasions when elapsed time was not recorded and so CPUE estimates could not be calculated

Table 40: ***Mean, minimum, and maximum length and weight of fish captured in the Moberly River during summer electrofishing surveys in 2006***

		Length (mm)					Weight (g)				
Group	**Species**	**n**	**Mean**	**SD**	**Min**	**Max**	**n**	**Mean**	**SD**	**Min**	**Max**
Sportfish	ARGR	3	66	5	62	71	3	2.9	0.5	2.5	3.4
	BURB	1	242				1	74.5			
	MNWH	3	72	7	65	78	3	3.8	1.0	2.8	4.8
Suckers	LNSC	46	75	7	20	170	46	8.2	0.5	0.1	52.7
	LRSC	1	143				1	29.0			
	YOY	50	11		19	51	6	0.0			
Minnows	LKCH	21	83	29	21	138	21	7.7	7.8	0.2	29.0
	LNDC	251	56	14	12	95	247	2.0	14.4	0.1	9.6
	NRPM	3	135	74	61	208	3	14.2	14.0	2.1	29.5
	RDSH	20	84	18	30	105	20	8.0	4.0	0.2	13.1
Sculpin	PRSC	5	91	29	56	128	5	11.5	11.3	1.3	28.7
	SLSC	42	52	21	25	82	42	2.3	2.2	0.2	6.4

3.4.2.2 Wilder Creek

There was very little water in Wilder Creek at the time of sampling and no discernable flow. In Wilder Creek, between the lower reach and the upper reach, natural iron concentrations tinted the water and soil in the stream channel a deep red.

YOY fish were observed in the shallow pools of water present and sample was collected with a siene net. The sample collected contained 33 YOY (16 mm to 24 mm) lake chub and one juvenile (94 mm) lake chub. Electrofishing was not conducted in Wilder Creek because it would not have been as effective in the shallow habitat as the seine. For this reason, CPUE was not calculated for Wilder Creek and can not be compared to the other tributaries sampled.

3.4.2.3 Cache Creek

In total, an estimated 12,291 fish (extrapolated from subsamples) were captured in Cache Creek in summer 2006 (Table 41). This tributary had a CPUE of 844 fish per 100 seconds of electrofishing (Table 42). Only five species were captured in Cache Creek in summer and this was the lowest species diversity of any of the tributaries sampled. These species included, in order of abundance, longnose dace (30% of the total catch), redside shiner (22%), unidentifiable YOY minnows (21%), lake chub (15%), and YOY suckers (11%) which are presumed to be longnose sucker based on the abundance of ripe longnose suckers in Cache Creek in spring (see Section 3.2.2). One juvenile longnose sucker and three YOY mountain whitefish were also captured in Cache Creek in summer 2006. Mean length and weight of fish captured in Cache Creek in summer 2006 is provided in Table 43.

Although not significantly different, the greatest abundance of fish was found in pools while run habitat had the lowest abundance of fish. All habitat units had higher abundances in the lower reach compared with the upper reach and this was mainly due to the greater abundance of longnose dace in the lower reach. Differences in abundance between reaches in Cache Creek were not significant.

A density estimate based on three-pass depletions was calculated for one lower reach riffle and pool in Cache Creek. Density of fish in the riffle and pool was 10624 and 7239 fish per 100 m^2, respectively. Species composition was similar between the upper and lower reaches and, with the exception of mountain whitefish, all species present were found in all habitat types in both upper and lower reaches of Cache Creek. The three YOY mountain whitefish were all found in one pool in the lower reach.

Table 41: Number of fish captured, by habitat type and reach, in Cache Creek by habitat unit during summer electrofishing surveys in 2006

		Number of fish per site																									
		Pool								Riffle								Run								Combined	
		Lower				Upper			Sub-	Lower			Upper				Sub-	Lower			Upper				Sub-	Sites	
Group	**Species**	**1**	**2**	**3**	**Total**	**4**	**5**	**Total**	**total**	**1**	**2**	**Total**	**4**	**5**	**6**	**Total**	**total**	**1**	**2**	**Total**	**4**	**5**	**6**	**Total**	**total**	**Total**	**% Catch**
Sportfish	MNWH	3			3			0	3			0				0	0			0				0	0	3	0.0
	Subtotal	3	0	0	3	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0.0
Suckers	LNSC	1			1			0	1			0				0	0			0				0	0	1	0.0
	YOY Sucker	266	37	756	1059	27	19	46	1105	16	7	23	7	2	2	11	34	8	74	82	70	5	82	157	239	1378	11.2
	Subtotal	267	37	756	1060	27	19	46	1106	16	7	23	7	2	2	11	34	8	74	82	70	5	82	157	239	1379	11.2
Minnows	LKCH	99	209	769	1077	86	61	147	1224	235	27	262	94	24	20	138	400	50	108	158	26	21	55	102	260	1884	15.3
	LNDC	1184	527	1192	2903	5		5	2908	416	45	461	40	10	7	57	518	173	123	296		4	14	18	314	3740	30.4
	RDSH	338	196	684	1218	27	75	102	1320	886	84	970	81	18	1	100	1070		173	173	39	16	123	178	351	2741	22.3
	YOY Minnow	616	478	660	1754			0	1754			0	13			13	13		173	173	201	1	402	604	777	2544	20.7
	Subtotal	2237	1410	3305	6952	118	136	254	7206	1537	156	1693	228	52	28	308	2001	223	577	800	266	42	594	902	1702	10909	88.8
Total		2507	1447	4061	8015	145	155	300	8315	1553	163	1716	235	54	30	319	2035	231	651	882	336	47	676	1059	1941	12291	100.0

Table 42: Catch-per-unit-effort (CPUE) of fish captured in Cache Creek, by habitat type and reach, during summer electrofishing surveys in 2006

		Number of fish per 100 seconds																								
		Pool								**Riffle**								**Run**								
		Lower				**Upper**			**Sub-**	**Lower**			**Upper**				**Sub-**	**Lower**			**Upper**				**Sub-**	**Total**
Group	**Species**	**1**	**2**	**3**	**Mean**	**4**	**5**	**Mean**	**total**	**1**	**2**	**Mean**	**4**	**5**	**6**	**Mean**	**total**	**1**	**2**	**Mean**	**4**	**5**	**6**	**Mean**	**total**	**Mean**
Sportfish	MNWH	1.2			0.5			0.0	0.4			0.0				0.0	0.0			0.0				0.0	0.0	0.2
Suckers	LNSC	0.4			0.2			0.0	0.1			0.0				0.0	0.0			0.0				0.0	0.0	0.1
	YOY Sucker	105.9	14.5	755.8	175.0	44.2	40.9	43.4	155.4	--	21.2	21.2	7.3	4.4	2.5	5.0	7.1	10.9	125.5	65.6	95.6	13.9	111.1	85.8	77.6	107.1
Minnows	LKCH	39.3	82.4	768.8	178.0	143.2	133.0	138.7	172.2	--	77.8	77.8	102.1	52.2	25.0	63.3	65.2	71.1	183.0	126.4	35.9	58.3	74.0	55.7	84.4	129.6
	LNDC	471.8	207.4	1191.7	479.8	8.9		4.7	409.0	--	127.3	127.3	43.8	21.7	8.8	26.1	40.3	247.5	209.2	236.8		11.1	18.5	9.8	101.9	261.3
	RDSH	134.8	77.2	683.8	201.3	44.2	163.6	96.2	185.7	--	240.4	240.4	87.5	39.1	1.3	45.9	72.7		292.8	138.4	53.8	44.4	166.6	97.3	114.0	145.8
	YOY Minnow	245.5	188.1	659.8	289.9			0.0	246.7			0.0	14.6			6.0	5.1		292.8	138.4	274.9	2.8	543.0	330.1	252.3	200.0
Total		999.0	569.5	4060.0	1324.8	240.6	337.5	283.0	1169.5		465.7	465.7	255.2	117.4	37.5	146.3	804.3	329.6	1103.2	705.6	460.1	130.6	913.2	578.7	630.2	844.2
Elapsed time		251	254	100	605	60	46	106	711		35	35.0	92	46	80	218	253	70	59	129	73	36	74	183	312	1276

Note: The symbol '—' indicates occasions when elapsed time was not recorded and so CPUE estimates could not be calculated

Table 43: Mean, minimum, and maximum length and weight of fish captured during summer electrofishing surveys in Cache Creek

		Length (mm)					Weight (g)				
Group	**Species**	**n**	**Mean**	**SD**	**Min**	**Max**	**n**	**Mean**	**SD**	**Min**	**Max**
Sportfish	MNWH	3	57	4	54	61	3	1.8	0.3	1.5	2.1
Suckers	LNSC	1	74				1	4.2			
	YOY suckers	158			12	35	0				
Minnows	LKCH	8	79	19	52	105	8	6.1	4.2	1.5	12.6
	YOY LKCH	285			11	45	0				
	LNDC	6	65	9	59	84	6	2.6	0.7	1.9	3.8
	YOY LNDC	402			12	33	0				
	YOY RDSH	377			12	26	0				

3.4.2.4 Red Creek

In total, 310 fish were captured in Red Creek (Table 44). The average CPUE was 59.7 fish per 100 seconds of electrofishing (Table 45). Only 4 species were captured and included, in order of abundance, longnose dace (43% of the total catch), lake chub (20%), redside shiner (21%), and YOY suckers (17%). Minimum and maximum length of fish captured in Red Creek in summer 2006 is provided in Table 46.

On average, CPUE was higher in run habitats than riffles, however, the difference was not significant. Species composition was identical between riffles and runs as all species captured were found in both habitats. In comparison to Cache Creek downstream of Red Creek, the number of fish captured in Red Creek was much lower. This was likely due to the lower flow, smaller stream size, and lower habitat diversity in Red Creek. The upper reach of Red Creek was not sampled during the current survey and comparison of fish communities from the upper and lower reaches were not possible.

Table 44: Number of fish captured, by habitat type, in Red Creek during summer electrofishing surveys in 2006

		Number of fish per site										
		Riffle				Run				Combined	
		Lower			Sub-	Lower			Sub-	Sites	
Group	**Species**	**1**	**2**	**3**	**total**	**1**	**2**	**3**	**total**	**Total**	**% Catch**
Suckers	YOY Sucker		2		2		49		49	51	16.5
	Subtotal	0	2	0	2	0	49	0	49	51	16.5
Minnows	LKCH	8	7		15	4	32	11	47	62	20.0
	LNDC	9	12	10	31	7	79	15	101	132	42.6
	RDSH	5	6	8	19	2	31	13	46	65	21.0
	Subtotal	22	25	18	65	13	142	39	194	259	83.5
Total		22	27	18	67	13	191	39	243	310	100.0

Table 45: Catch-per-unit-effort (CPUE) of fish captured, by habitat type, in Red Creek during summer electrofishing surveys

		Number of fish per 100 seconds								
		Riffle				Run				
		Lower				Lower				Total
Group	**Species**	**1**	**2**	**3**	**Mean**	**1**	**2**	**3**	**Mean**	**Mean**
Suckers	YOY Sucker		3.7		0.7		36.5		20.7	9.8
Minnows	LKCH	7.8	13.0		5.3	7.4	24.1	22.5	19.8	11.9
	LNDC	8.8	22.2	7.9	11.0	13.0	59.1	30.6	42.6	25.4
	RDSH	4.9	11.1	6.4	6.7	3.7	23.3	26.5	19.4	12.5
Total		21.6	50.0	14.3	23.8	24.1	143.0	79.6	102.5	59.7
Elapsed time		102	54	129	285	54	134	49	237	522

Table 46: Minimum and maximum lengths of fish captured in Red Creek during summer electrofishing surveys in 2006

		Length (mm)		
Group	**Species**	**n**	**Min**	**Max**
Sucker	YOY suckers	16	32	53
Minnow	LKCH	39	15	64
	LNDC	74	15	64
	RDSH	42	20	28

3.4.2.5 Farrell Creek

In total, an estimated 8,954 fish (extrapolated from subsamples) were captured in Farrell Creek in summer 2006 (Table 47). A total of nine fish species was represented in the catch and included, in order of abundance, YOY redside shiner (25%), YOY longnose dace (24%), YOY suckers (24%), unidentifiable YOY minnows (16%), YOY northern pikeminnow (8%), and lake chub (3%). Juvenile longnose sucker, largescale sucker, prickly sculpin, slimy sculpin and YOY mountain whitefish comprised less than 1% of the total catch each. The single YOY mountain whitefish was captured in a pool in the upper reach indicating that mountain whitefish spawned above the zone of inundation in Farrell Creek in fall 2005. Total average CPUE was 417 fish per 100 s of electrofishing in Farrell Creek in summer 2006 (Table 48). Mean, minimum, and maximum length and weight of fish captured in Farrell Creek in summer 2006 is provided in Table 49.

Species composition was similar among habitat types and between reaches in Farrell Creek and all species, with the exception of mountain whitefish, juvenile longnose and largescale suckers, and prickly and slimy sculpins, were captured in all habitat types in both lower and upper reaches. Catch-per-unit-effort was highest in runs and lowest in riffles in Farrell Creek but this difference was significant only for YOY sucker (F=19.30, p=0.0001), longnose dace (F=7.05, p=0.01), lake chub (F=8.13, p=0.01) and YOY minnows (F=20.08, p=0.0001; Table 48). Young-of-the-year suckers (F=19.76, p=0.001), longnose dace (F=6.90, p=0.02), and northern pikeminnow (F=5.85, p=0.03) were all significantly more abundant in the lower reach than the upper reach. Lake chub were significantly more abundant in the upper reach (F=5.94, p=0.03). Based on three-depletion estimates, the total density of fish in riffle and pool habitats in the lower reach of Farrell Creek was 3754 and 5527 fish per 100 m^2, respectively.

Table 47: Number of fish captured, by habitat type and reach, in Farrell Creek during summer electrofishing surveys in 2006

		Number of fish per site																												
		Pool									Riffle									Run									Combined	
		Lower				Upper				Sub-	Lower				Upper				Sub-	Lower				Upper				Sub-	Sites	
Group	**Species**	**1**	**2**	**3**	**Total**	**4**	**5**	**6**	**Total**	**total**	**1**	**2**	**3**	**Total**	**4**	**5**	**6**	**Total**	**total**	**1**	**2**	**3**	**Total**	**4**	**5**	**6**	**Total**	**total**	**Total**	**% Catch**
Sportfish	MNWH				0	1			1	1				0				0	0				0				0	0	1	0.0
	Subtotal	0	0	0	0	1	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0.0
Suckers	LNSC				0	2	2		4	4				0				0	0				0	1			1	1	5	0.1
	LRSC				0		4	1	5	5				0				0	0				0				0	0	5	0.1
	YOY Sucker	409	123	288	820	123	48	28	199	1019	41	25	34	100		11	5	16	116	219	114	342	675	164	100	65	329	1004	2139	23.9
	Subtotal	409	123	288	820	125	54	29	208	1028	41	25	34	100	0	11	5	16	116	219	114	342	675	165	100	65	330	1005	2149	24.0
Minnows	LKCH			8	8	15	13	49	77	85	3			3	9			9	12		10	37	47	57	30	66	153	200	297	3.3
	LNDC	143	38	219	400	50	67	10	127	527	80	108	147	335	60	115	93	268	603	255	271	292	818	160	52	23	235	1053	2183	24.4
	NRPM	251	79		330			14	14	344	13			13				0	13	123	143	49	315	19	20		39	354	711	7.9
	RDSH	339	49	189	577	70	45	135	250	827	131	15	19	165	55	104	138	297	462	116	171	85	372	122	76	335	533	905	2194	24.5
	YOY Minnow	91		87	178	99	36	87	222	400			8	8	4	7	88	99	107	280	109	280	669	158	79		237	906	1413	15.8
	Subtotal	824	166	503	1493	234	161	295	690	2183	227	123	174	524	128	226	319	673	1197	774	704	743	2221	516	257	424	1197	3418	6798	75.9
Sculpin	PRSC	2			2				0	2				0				0	0				0				0	0	2	0.0
	SLSC				0	2		1	3	3				0				0	0				0			1	1	1	4	0.0
	Subtotal	2	0	0	2	2	0	1	3	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	6	0.1
Total		1235	289	791	2315	362	215	325	902	3217	268	148	208	624	128	237	324	689	1313	993	818	1085	2896	681	357	490	1528	4424	8954	100.0

Table 48: Catch-per-unit-effort (CPUE) of fish captured, by habitat type and reach, in Farrell Creek during summer electrofishing surveys in 2006

		Number of fish per 100 seconds																											
		Pool									**Riffle**									**Run**									
		Lower				**Upper**				**Sub-**	**Lower**				**Upper**				**Sub-**	**Lower**				**Upper**				**Sub-**	**Total**
Group	**Species**	**1**	**2**	**3**	**Mean**	**4**	**5**	**6**	**Mean**	**total**	**1**	**2**	**3**	**Mean**	**4**	**5**	**6**	**Mean**	**total**	**1**	**2**	**3**	**Mean**	**4**	**5**	**6**	**Mean**	**total**	**Mean**
Sportfish	MNWH				0.0		0.6		0.3	0.2				0.0				0.0	0.0				0.0				0.0	0.0	0.0
Suckers	LNSC				0.0	1.2	2.1		1.2	0.6				0.0				0.0	0.0				0.0	1.5			0.5	0.2	0.2
	LRSC				0.0		4.3	1.3	1.4	0.8				0.0				0.0	0.0				0.0				0.0	0.0	0.2
	YOY Sucker	226.0	316.0	306.4	261.1	71.3	50.7	35.1	57.5	154.4	27.0	8.3	13.0	14.0		8.1	3.3	4.3	10.7	223.5	335.4	518.2	340.9	237.7	129.9	111.2	161.3	249.8	99.6
Minnows	LKCH			8.4	2.5	8.9	14.1	62.1	22.3	12.9	2.1			0.4	9.4			2.4	1.1		28.0	55.4	23.7	82.4	38.5	112.9	75.0	49.8	13.8
	LNDC	78.9	98.1	232.7	127.4	29.1	71.5	12.6	36.7	79.8	52.9	35.9	56.7	47.0	63.9	83.0	65.7	71.8	55.5	260.1	796.6	442.9	413.1	231.8	68.1	38.8	115.2	261.9	101.6
	NRPM	138.8	201.6		105.1			17.5	4.0	52.1	8.4			1.8				0.0	1.2	125.5	419.3	73.8	159.1	28.2	25.7		19.1	88.1	33.1
	RDSH	187.3	125.3	201.3	183.8	40.4	47.9	171.0	72.3	125.3	86.1	4.9	7.2	23.1	58.6	75.5	98.1	79.6	42.5	118.6	503.1	129.2	187.9	177.3	98.4	578.0	261.3	225.1	102.1
	YOY Minnow	50.5		92.3	56.7	57.1	38.8	109.6	64.2	60.6			2.9	1.1	4.7	5.4	62.1	26.5	9.9	285.9	321.4	424.4	337.9	229.7	103.0		116.2	225.4	65.8
Sculpin	PRSC	1.1			0.6				0.0	0.3				0.0				0.0	0.0				0.0				0.0	0.0	0.1
	SLSC				0.0	1.2		1.3	0.9	0.5				0.0				0.0	0.0				0.0			1.7	0.5	0.2	0.2
Total		682.5	741.0	841.0	737.3	209.1	229.9	410.3	260.7	487.4	176.4	49.1	79.8	87.5	136.5	172.0	229.2	184.7	120.9	1013.6	2403.7	1643.8	1462.6	988.5	463.6	842.7	749.0	1100.5	416.9
Elapsed Time		181	39	94	314	173	94	79	346	660	152	301	260	713	94	138	141	373	1086	98	34	66	198	69	77	58	204	402	2148

Table 49: Mean, minimum, and maximum length and weight of fish captured during summer electrofishing surveys in Farrell Creek

		Length (mm)					Weight (g)				
Group	**Species**	**n**	**Mean**	**SD**	**Min**	**Max**	**n**	**Mean**	**SD**	**Min**	**Max**
Sportfish	YOY MNWH	1	52				1	1.3			
Suckers	LNSC	13	86	48.1	40	170	13	12.9	16.4	0.6	51.2
	LRSC	5	130	54.4	77	195	5	35	36.6	5.1	84
	YOY suckers	464			12	44	0				
Minnows	LKCH	14	95	17.2	62	128	14	10.3	5.1	2.7	22.5
	LKCH YOY	65			13	51	0				
	LNDC	50	67	10	53	96	50	3.1	1.7	1.2	8.6
	LNDC YOY	506			10	38	0				
	NRPM YOY	154			12	35	0				
	RDSH	9	72	28.1	47	122	9	7.1	8.6	1.2	24.5
	RDSH YOY	489			11	34	0				
Sculpin	PRSC	3	55	7.6	46	60	3	1.8	0.8	0.9	2.5
	SLSC	4	59	27.4	32	85	4	3.6	3.7	0.3	7.8

3.4.2.6 Lynx Creek

In total, 602 fish were captured in Lynx Creek in summer 2006 (Table 50). Total mean CPUE in Lynx Creek was 20.1 fish per 100 second, the second lowest CPUE of all tributaries sampled (Table 51). However, a total of 10 species was captured which was the second highest species diversity of all tributaries sampled. Young-of-the-year suckers, which are presumed to be longnose sucker based on the abundance of ripe longnose suckers in Lynx Creek in spring (see Section 3.2.5) were the most abundant fish captured in Lynx Creek, accounting for 63% of the total catch. No other species comprised more than 9% of the total catch and included juvenile longnose suckers, longnose dace, northern pikeminnow, juvenile largescale sucker, juvenile white sucker, prickly sculpin, and redside shiner. In addition, 18 YOY mountain whitefish were captured in run habitat in the lower reach indicating that mountain whitefish successful spawned in Lynx Creek in fall 2005. Four juvenile rainbow trout were also captured including one in an upper reach pool and three in riffles in the lower reach.

Average lengths and weights for each fish species captured in Lynx Creek is provided in Table 52. Young-of-the-year mountain whitefish had an average weight of 2 g and length of 52 mm. On average, rainbow trout measured 145 mm and weighed 51 g. Young-of-the-year suckers ranged in length from 15 mm to 37 mm and juvenile longnose suckers had an average length and weight of 180 mm and 143 g, respectively.

Catch-per-unit effort was highest in run habitat in Lynx Creek when considering all fish species combined (Table 51). However, juvenile longnose suckers ($F=16.39$, $p=0.0004$) were significantly more abundant in pools than in runs or riffles. Catch-per-unit-effort was higher in the upper reach for all habitat types but was not significantly different. YOY suckers were found in all habitat types in both upper and lower reaches. Density estimates from the triple pass electrofishing surveys for one run, riffle and pool habitat in the lower reach were 67, 11 and 349 fish per 100 m^2, respectively.

Table 50: Number of fish captured in Lynx Creek, by habitat type and reach, during summer electrofishing surveys in 2006

		Number of fish per site																												
		Pool									Riffle									Run									Combined	
		Lower				Upper				Sub-	Lower				Upper				Sub-	Lower				Upper				Sub-	Sites	
Group	**Species**	**1**	**2**	**3**	**Total**	**4**	**5**	**6**	**Total**	**total**	**1**	**2**	**3**	**Total**	**4**	**5**	**6**	**Total**	**total**	**1**	**2**	**3**	**Total**	**4**	**5**	**6**	**Total**	**total**	**Total**	**% Catch**
Sportfish	MNWH				0				0	0				0				0	0	6	12		18				0	18	18	3.0
	RNTR				0		1		1	1	1	2		3				0	3				0				0	0	4	0.7
	Subtotal	0	0	0	0	0	1	0	1	1	1	2	0	3	0	0	0	0	3	6	12	0	18	0	0	0	0	18	22	3.7
Suckers	LNSC	11	6	5	22	13	5	1	19	41		1	3	4				0	4	5			5				0	5	50	8.3
	LRSC	1		1	2				0	2				0				0	0				0				0	0	2	0.3
	WHSC	1			1				0	1				0				0	0				0				0	0	1	0.2
	YOY Sucker	2	28	11	41	17	16	2	35	76		1	3	4	6		10	16	20	5	28	2	35	77	126	44	247	282	378	62.8
	Subtotal	15	34	17	66	30	21	3	54	120	0	2	6	8	6	0	10	16	24	10	28	2	40	77	126	44	247	287	431	71.6
Minnows	LKCH	1			1				0	1				0				0	0	2	1		3		16	5	21	24	25	4.2
	LNDC			1	1		1		1	2		2	3	5	3	4	5	12	17	4	2	4	10	4	10	2	16	26	45	7.5
	NRPM	11	6	1	18	2	1		3	21				0				0	0				0				0	0	21	3.5
	RDSH				0	3	3		6	6				0				0	0				0				0	0	6	1.0
	YOY Minnow				0	3			3	3				0				0	0				0		30	14	44	44	47	7.8
	Subtotal	12	6	2	20	8	5	0	13	33	0	2	3	5	3	4	5	12	17	6	3	4	13	4	56	21	81	94	144	23.9
Sculpin	PRSC				0				0	0				0				0	0	2	3		5				0	5	5	0.8
	Subtotal	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	3	0	5	0	0	0	0	5	5	0.8
Total		27	40	19	86	38	27	3	68	154	1	6	9	16	9	4	15	28	44	24	46	6	76	81	182	65	328	404	602	100.0

Table 51: Catch-per-unit-effort (CPUE) of fish captured in Lynx Creek, by habitat type and reach, during summer electrofishing surveys in 2006

		Number of fish per 100 seconds																											
		Pool									**Riffle**									**Run**									
		Lower				**Upper**				**Sub-**	**Lower**				**Upper**				**Sub-**	**Lower**				**Upper**				**Sub-**	**Total**
Group	**Species**	**1**	**2**	**3**	**Mean**	**4**	**5**	**6**	**Mean**	**total**	**1**	**2**	**3**	**Mean**	**4**	**5**	**6**	**Mean**	**total**	**1**	**2**	**3**	**Mean**	**4**	**5**	**6**	**Mean**	**total**	**Mean**
Sportfish	MNWH				0.0				0.0	0.0				0.0				0.0	0.0	2.0	8.7		2.5				0.0	1.5	0.6
	RNTR				0.0		1.0		0.4	0.1	0.6	0.8		0.5				0.0	0.3				0.0				0.0	0.0	0.1
Suckers	LNSC	7.4	3.4	5.9	5.3	9.8	5.2	2.0	6.8	5.9		0.4	1.4	0.6				0.0	0.4	1.6			0.7				0.0	0.3	1.7
	LRSC	0.7		1.2	0.5				0.0	0.3				0.0				0.0	0.0				0.0				0.0	0.0	0.1
	WHSC	0.7			0.2				0.0	0.1				0.0				0.0	0.0				0.0				0.0	0.0	0.0
	YOY Sucker	1.3	15.6	12.9	9.9	12.8	16.7	3.9	12.5	11.0		0.4	1.4	0.6	4.5		4.9	3.3	1.8	1.6	20.3	0.7	4.8	21.7	221.1	73.3	52.3	23.5	12.6
Minnows	LKCH	0.7			0.2				0.0	0.1				0.0				0.0	0.0	0.7			0.4		28.1	8.3	4.4	2.0	0.8
	LNDC			1.2	0.2		1.0		0.4	0.3		0.8	1.4	0.8	2.2	2.9	2.4	2.5	1.5	1.3	1.5	1.4	1.4	1.1	17.5	3.3	3.4	2.2	1.5
	NRPM	7.4	3.4	1.2	4.4	1.5	1.0		1.1	3.0				0.0				0.0	0.0				0.0				0.0	0.0	0.7
	RDSH				0.0	2.3	3.1		2.1	0.9				0.0				0.0	0.0				0.0				0.0	0.0	0.2
	YOY Minnow				0.0	2.3			1.1	0.0				0.0				0.0	0.0				0.0		52.6	23.3	9.3	3.7	1.6
Sculpin	PRSC				0.0				0.0	0.0				0.0				0.0	0.0	0.7	2.2		0.7				0.0	0.4	0.2
Total		18.1	22.3	22.4	20.8	28.6	28.1	5.9	24.3	22.2	0.6	2.5	4.2	2.6	6.7	2.9	7.3	5.8	4.0	7.9	32.6	2.1	10.5	22.8	319.3	108.3	69.5	33.7	20.1
Elapsed time		149	179	85	413	133	96	51	280	693	171	241	213	625	134	139	206	479	1104	304	138	284	726	355	57	60	472	1198	2995

Table 52: Mean, minimum, and maximum, length and weight of fish captured during summer electrofishing surveys in Lynx Creek

		Length (mm)					Weight (g)				
Group	**Species**	**n**	**Mean**	**SD**	**Min**	**Max**	**n**	**Mean**	**SD**	**Min**	**Max**
Sportfish	MNWH	14	52	6	43	60	14	1.5	0.7	0.4	2.6
	RNTR	4	145	47	108	210	4	50.7	53.5	15.2	129.2
Suckers	LNSC	98	180	48	31	274	98	142.6	97.8	0.2	500
	LRSC	4	201	23	175	230	4	190.5	88.9	61.9	250
	WHSC	1	173				1	150			
	YOY suckers	384			15	37	0				
Minnows	LKCH	10	46	9	25	58	9	1.2	0.4	0.6	1.7
	LNDC	35	62	30	11	151	33	4.7	6.7	0.1	34.5
	NRPM	33	209	24	175	261	33	179.9	63.9	57.6	300
	RDSH	6	92	14	82	116	6	11.2	6.2	6.7	23.1
Sculpin	PRSC	8	49	8	37	63	8	1.4	0.8	0.5	2.9

3.4.2.7 Maurice Creek

A total of 465 fish, representing six species, was captured in Maurice Creek in summer 2006 (Table 53). Total mean CPUE in Maurice Creek was 23.9 fish per 100 seconds, the third lowest catch rate of any of the tributaries sampled during the summer rearing program (Table 54). Longnose dace and YOY suckers were the most common fish captured, accounting for 37% and 28% of the total catch, respectively. Sculpin species accounted for 28% of the total catch. A total of 17 YOY mountain whitefish and 13 juvenile rainbow trout were captured in Maurice Creek. Average lengths and weights for each fish species captured in Maurice Creek are provided in Table 55.

Catch rates for all species combined was highest in run and pool habitat largely due to the abundance of YOY longnose suckers. There was no significant difference in total catch rates between pools, riffles and runs. Juvenile rainbow trout were present in all three habitat types but the majority (62%) were captured in pools. Most (71%) of the YOY mountain whitefish were captured in run habitat.

Density estimates in one run, riffle and pool by three-pass depletions were 177, 98 and 310 fish per 100 m^2, respectively. All sites sampled were above the zone of inundation and comparison between upstream and downstream reaches was not possible.

Table 53: Number of fish captured in Maurice Creek, by habitat type, during summer electrofishing surveys in 2006

		Number of fish per site													
		Pool				Riffle				Run				Combined	
		Upper				Upper				Upper				Sites	
Group	**Species**	**1**	**2**	**3**	**Total**	**1**	**2**	**3**	**Total**	**1**	**2**	**3**	**Total**	**Total**	**% Catch**
Sportfish	MNWH			4	4		1		1	12			12	17	3.7
	RNTR	5		3	8		3		3	1	1		2	13	2.8
	Subtotal	5	0	7	12	0	4	0	4	13	1	0	14	30	6.5
Suckers	LNSC	1	1		2				0	2			2	4	0.9
	YOY Sucker	25	18	1	44	13	2	2	17	16	17	36	69	130	28.0
	Subtotal	26	19	1	46	13	2	2	17	18	17	36	71	134	28.8
Minnows	LNDC	17	50		67	28	6	24	58	21	19	6	46	171	36.8
	Subtotal	17	50	0	67	28	6	24	58	21	19	6	46	171	36.8
Sculpin	PRSC	8	6	2	16	2	4		6	7	2	7	16	38	8.2
	SLSC	2	2	2	6	2	7	4	13	5	3	3	11	30	6.5
	Sculpin	7	17		24	9	8		17	7	7	7	21	62	13.3
	Subtotal	17	25	4	46	13	19	4	36	19	12	17	48	130	28.0
Total		65	94	12	171	54	31	30	115	71	49	59	179	465	100.0

Table 54: ***Catch-per-unit-effort (CPUE) of fish captured in Maurice Creek, by habitat type, during summer electrofishing surveys in 2006***

		Number of fish per 100 seconds												
		Pool				Riffle				Run				
		Upper				Upper				Upper				Total
Group	**Species**	**1**	**2**	**3**	**Mean**	**1**	**2**	**3**	**Mean**	**1**	**2**	**3**	**Mean**	**Mean**
Sportfish	MNWH			3.5	0.5		0.5		0.2	5.9			3.1	1.0
	RNTR	1.0		2.6	1.0		1.5		0.5	0.5	--		0.3	0.7
Suckers	LNSC	0.2	0.7		0.3				0.0	1.0			0.5	0.2
	YOY Sucker	4.9	12.5	0.9	5.7	4.8	1.0	6.7	3.0	7.9	--	18.9	13.3	6.5
Minnows	LNDC	3.3	34.7		8.7	10.3	19.4	23.3	10.1	10.4	--	3.2	6.9	8.8
Sculpin	PRSC	1.6	4.2	1.7	2.1	0.7	2.0		1.0	3.5	--	3.7	3.6	2.1
	SLSC	0.4	1.4	1.7	0.8	0.7	3.5	3.9	2.3	2.5	--	1.6	2.0	1.6
	Sculpin	1.4	11.8		3.1	3.3	4.0		3.0	3.5	--	3.7	3.6	3.2
Total		12.7	65.3	10.4	22.2	19.8	31.9	33.9	20.0	35.1	--	31.1	35.7	23.9
Elapsed time		510	144	115	769	273	200	103	576	202	?	190	392	1737

Note: The symbol '—' indicates occasions when elapsed time was not recorded and so CPUE estimates could not be calculated

Table 55: ***Mean, minimum, and maximum length and weight of fish captured during summer electrofishing surveys in Maurice Creek***

		Length (mm)					Weight (g)				
Group	**Species**	**n**	**Mean**	**SD**	**Min**	**Max**	**n**	**Mean**	**SD**	**Min**	**Max**
Sportfish	MNWH	12	57	10	42	74	9	14.0	34.5	1.3	106.0
	RNTR	16	131	28	94	186	17	32.6	22.5	11.5	92.6
Suckers	LNSC	5	76	12	61	88	5	5.1	1.9	2.5	7.4
	YOY	329			21	45	0				
Minnows	LNDC	27	91	24	25	120	26	10.2	5.3	1.3	19.9
Sculpin	PRSC	43	67	22	41	118	44	4.7	5.1	0.4	20.6
	SLSC	42	72	10	49	93	42	4.5	1.8	1.4	8.6

3.5 Radio Telemetry

3.5.1 Fish Mortality

To date, a total of 10 tagged-fish (3.9% of the total number tagged) has been confirmed dead (Table 56), and the tags of three fish are suspected to be buried in the substrate. Those confirmed dead include three rainbow trout, four walleye, and three mountain whitefish, of which the tags have been returned to LGL Ltd as proof of mortality. The tags of two of these fish (a rainbow trout and mountain whitefish both ~350 mm long) were found in the stomachs of two large bull trout (both were ~1 m in body length) caught by anglers in the Peace mainstem, with the antenna hanging from the mouth of the trout. Three of our tagged fish were caught by anglers, two fish were found dead on the riverbed with the tag intact, and in the remaining three instances the tags were found on the riverbed with no evidence of the fish. The actual mortality is almost certainly greater than that which has been confirmed dead. Some fish have been repeatedly detected in approximately the same location (not > 0.2 km movement between detections) in the mobile tracking surveys. These fish may be holding in preferred areas for prolonged periods, or are dead. The decision on such fish will have to wait till further tracking is completed in 2007 and mortality can then be more rigorously assessed.

Table 56: Radio-tagged fish that have been confirmed dead, Peace River, 2006

Tag No.	Tag Date	Tag Site	Species	FL (mm)	Weight (g)	Disabled Date	Comment
28	21/09/2005	-31	WP	439	1100	31/01/2006	Caught by angler
10	21/09/2005	-31	WP	411	800	10/02/2006	Fish found dead at Pouce Coupe River
113	29/09/2005	-31	WP	441	1050	07/04/2006	Caught by angler
74	26/09/2005	-7	RB	276	300	17/05/2006	Tag found on riverbed
95	28/09/2005	-3	RB	341	450	01/06/2006	Caught by angler
102	29/09/2005	-31	WP	361	575	08/07/2006	Fish found dead, mouth of Beatton River
252	26/06/2006	-5	MW	326	350	15/07/2006	Tag found on riverbed
88	27/09/2005	-9	RB	396	825	28/08/2006	Eaten by bull trout caught by angler
232	27/06/2006	-15	MW	337	425	02/09/2006	Tag found on riverbed
139	24/06/2006	-9	MW	372	575	09/09/2006	Eaten by bull trout caught by angler

Note: Fish measurements were taken on tag date.

3.5.2 Monitoring Fish Movement

Of the total 255 fish tagged, two Arctic grayling, two rainbow trout, three walleye, and two mountain whitefish were never detected either in the mobile tracking surveys or by the fixed station receivers. The sequential detections of each radio-tagged fish by zones and fixed stations over the duration of the study period in 2006 are shown in Appendix C, Tables 25-27, inclusive.

3.5.2.1 Fixed Stations

A plot of the number of detections by species for each of the fixed stations (Figure 54) reveals the following: the number of walleye detections was high at the Beatton River mouth (Station 110; not included in the analysis), and dropped off markedly with distance upstream with none detected at stations upstream of the Moberly River (Station 70). The detections of mountain whitefish were fairly evenly spread among the Peace mainstem fixed stations, with a few fish detected at the mouth of the Graham River (headwater tributary of the Halfway River; Station 44). Relatively few detections were recorded for rainbow trout, with some upstream of the Halfway River (Station 40) to the Peace Canyon Dam (Station 1), and others downstream of the Halfway River to the Beatton River. Detections of Arctic grayling were mainly downstream of the Halfway to the Beatton, with the greatest number occurring at the Moberly River station.

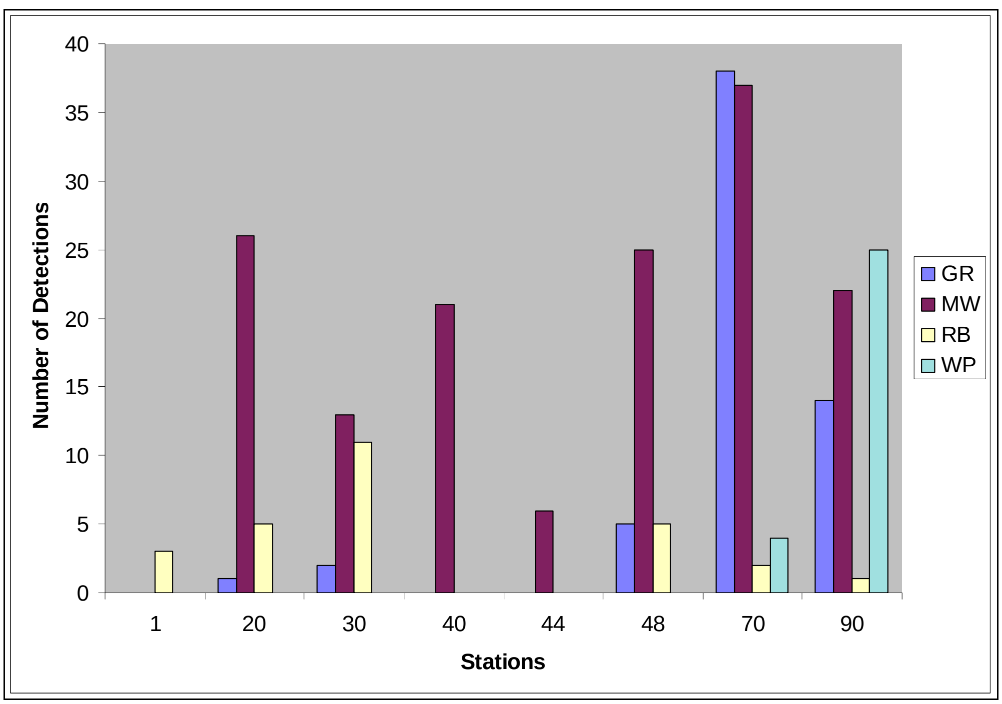


Figure 54: ***Number of individual fish detections for each of the fixed stations (excluding Beatton River; Station 110), Peace River, 2006***

3.5.2.2 Mobile Tracks

The numbers and percentages of the tagged fish detected by mobile tracking in each of the months in 2006 are shown in Table 57.

For the months in which surveys were conducted on more than one day, the total number of unique detections for each species was summed and the percentage value was determined by dividing the summed total by the total number of active tags remaining in the tagged population.

The low percentage of 6.3% (2) of rainbow trout detected in February was low as very few tags had become activated by then due to the 20-week delay from time of implantation in the fish. All tags were activated by the time the March survey had begun, with detections during that month for all species (excluding mountain whitefish as they were not tagged until summer 2006) combined ranging from 57.1 to 67.3%. During the June track, the detections ranged from 49.1 to 53.3% of the tagged populations. In the later months, the detection rate was considerably higher for all species and ranged from 57.1 to 72.2% in August and from 69.0 to 89.5% in October; in both months, the proportion of tagged fish detected was highest for mountain whitefish, the most recently tagged species.

Table 57: Distance tracked, the number and percentage of the tagged fish detected by species by month for the mobile tracking surveys, 2006.

Month	Distance tracked (km)	Arctic grayling		Mountain whitefish		Rainbow trout		Walleye	
		n	**%**	***n***	**%**	***n***	**%**	***n***	**%**
Feb	729	21	42.9	0	0.0	2	6.3	27	47.4
Mar	470	33	67.3	0	0.0	23	71.9	32	57.1
Apr	468	14	28.6	0	0.0	9	28.1	41	74.5
May	981	27	30.6	0	0.0	20	62.5	43	78.2
Jun	696	26	53.1	0	0.0	16	53.3	27	49.1
Aug	353	28	57.1	83	72.2	18	62.1	31	57.4
Oct	900	36	73.5	102	89.5	20	69	47	87.0

Note: The percentages are based on the total number of known active tags remaining in the tagged populations at the time of survey. For months in which surveys were conducted on more than one day, the total number of unique detections was summed.

February Tracks

Prior to the February tracks, none of the fish had moved upstream in the Peace River mainstem from the sites at which they were tagged and released in September 2005.

During the 10 February track (Map 1), only walleye were detected as none of the Arctic grayling and rainbow trout tags had become activated yet. A total of 26 walleye was located, with 14 of them being a short distance (< 2 km) up the Beatton River and the remainder in the Peace River mainstem near the Beatton River confluence and a few in Alberta, with the farthest being near Montagneuse Creek (~60 km from the interprovincial border). One fish (Tag # 10) was found dead in a shallow puddle (covered in ice) on a gravel bar near the mouth of the Pouce Coupe River in Alberta.

During the 12 February track (Map 2), all three species of fish were detected amounting to 20 walleye, 21 Arctic grayling and 2 rainbow trout. Although fewer walleye were located in this track than in the previous one, their overall distribution remained unchanged with most of them being in and around the Beatton River confluence and a few in Alberta. Of the Arctic grayling and rainbow trout detected, all were in the Peace River mainstem except for one Arctic grayling which was approximately 5 km upstream from the mouth in the Pine River. The Arctic grayling in the mainstem were widely scattered from downstream of Cache Creek to the Beatton River, at which a single Arctic grayling was detected amongst the aggregation of tagged walleye. The two rainbow trout detected in this survey were immediately downstream of the Pine River confluence.

March Track

In the March track (Map 3), a good aerial track was achieved with 71% of the fish (34 walleye, 31 Arctic grayling, 23 rainbow trout) detected of the total 124 fish tagged (2 tags disabled from the tag file: 1 fish caught by angler, and 1 fish found dead in 10 February track) assumed to be active and in the river system. The distribution of walleye in March did not differ greatly from the February track, with most of them still aggregated within the vicinity of the mouth of the Beatton River and a few near or in Alberta.

Likewise, the distribution of Arctic grayling in March was similar to the February track, although several tags did not become activated until after the February track. In March, Arctic grayling were detected in the Peace River mainstem from the vicinity of the Cache Creek confluence to downstream of the Beatton River confluence. A comparison of the distribution of tag numbers between the February and March surveys showed no evidence of notable Arctic grayling movement during winter. The exception is the single Arctic grayling in the Pine River, which moved upstream about 4 km (under the ice).

Rainbow trout were widely scattered in the Peace River mainstem from the Peace Canyon Dam to immediately downstream of the Pine River confluence.

Their distribution in March was very similar to that of when they were tagged and released in September 2005 (see Figure 4).

April Track

The distribution of fish in April (Map 4) was similar to that observed in March, although considerably fewer Arctic grayling and rainbow trout were detected in April, possibly as a result of some early movement into the tributaries which went undetected. Walleye, on the other hand, remained aggregated near the Beatton River mouth, although a few fish moved a considerable distance downstream in the Peace mainstem into Alberta. An individual Arctic grayling and a rainbow trout were detected in the Peace mainstem in Alberta, almost as far downstream as the farthest walleye.

May Tracks

The major change in fish distribution in May (Maps 5 and 6) is that a large proportion (~50%) of walleye had moved upstream in the Beatton River as much as 20 km upstream (presumably to spawn). Some walleye were still present at the mouth of the Beatton, and others were widely scattered downstream as far as Dunvegan, Alberta. Three walleye were detected upstream of the Beatton River, one each at the mouths of the Pine and Moberly rivers, and the third approximately 5 km upstream in the Pine River.

The distribution of Arctic grayling in May (Maps 5 and 6) was not greatly different from that observed in April, with most of the fish distributed in the Peace mainstem roughly between Cache Creek and the Beatton River. Three Arctic grayling were detected in tributary streams with one approximately 12 km upstream from the mouth in the Pine River, and two fish between 10 and 15 km upstream from the mouth in the Moberly River. Overall, slightly greater numbers of Arctic grayling and rainbow trout were detected in May than in April. Some fish that were detected in March, but not April, reappeared in May possibly as a result of temporary movement into tributaries (e.g., Maurice, Lynx, Farrell, and others) during spawning.

June Track

With few exceptions, in June (Map 7) most of the detections of the tagged populations were within the Peace River mainstem. Four walleye were detected in the upper reaches of the Beatton River, and two were in the Pine River (one ~ 5 km upstream from the mouth). Several walleye were detected within the vicinity of the Beatton River mouth, and the remainder of detections was quite widespread downstream to as far as near Dunvegan.

A greater number of Arctic grayling was detected in June than May, with the bulk of the detections in the Peace mainstem downstream of Cache Creek to the Beatton River. As for rainbow trout, the numbers detected in June were similar to those in May, although the fish were more widely distributed extending from near the Peace Canyon Dam to past the Pine River.

August Tracks

During August (Maps 8 and 9), with the exception of five walleye in the Pine River (5 to 15 km from the mouth), all detections of the tagged populations were in the Peace mainstem from the Peace Canyon Dam to near the Montagneuse River in Alberta. Walleye were beginning to congregate, with a total of four fish detected at the mouth of the Pine and 11 at the mouth of the Beatton. The remaining walleye detections were widely scattered from downstream of the Pine River to beyond Sneddon Creek. One walleye (most probably dead) was detected in the headwaters of the Beatton River.

Both Arctic grayling and rainbow trout were widely distributed in the Peace mainstem, with a greater number of detections of either species in August than in previous surveys. In general, rainbow trout tended to be distributed more upstream than Arctic grayling in the Peace mainstem, being primarily between the Peace Canyon Dam and the Moberly River, whereas Arctic grayling were mainly between Lynx Creek and the Beatton River.

Mountain whitefish were widely and fairly evenly distributed in the Peace mainstem, with fish detected from Hudson Hope to past Sneddon Creek, Alberta. There is no evidence of this species congregating near the mouths of large rivers. Five mountain whitefish were detected in the Halfway River, two in the lower reach and three some 40-50 km from the mouth. The two fish in the lower reach were tagged between Cache and Tea creeks. Of the three fish further upstream in the Halfway River, one was tagged between Maurice and Lynx, and the other two were tagged between Farrell and Halfway.

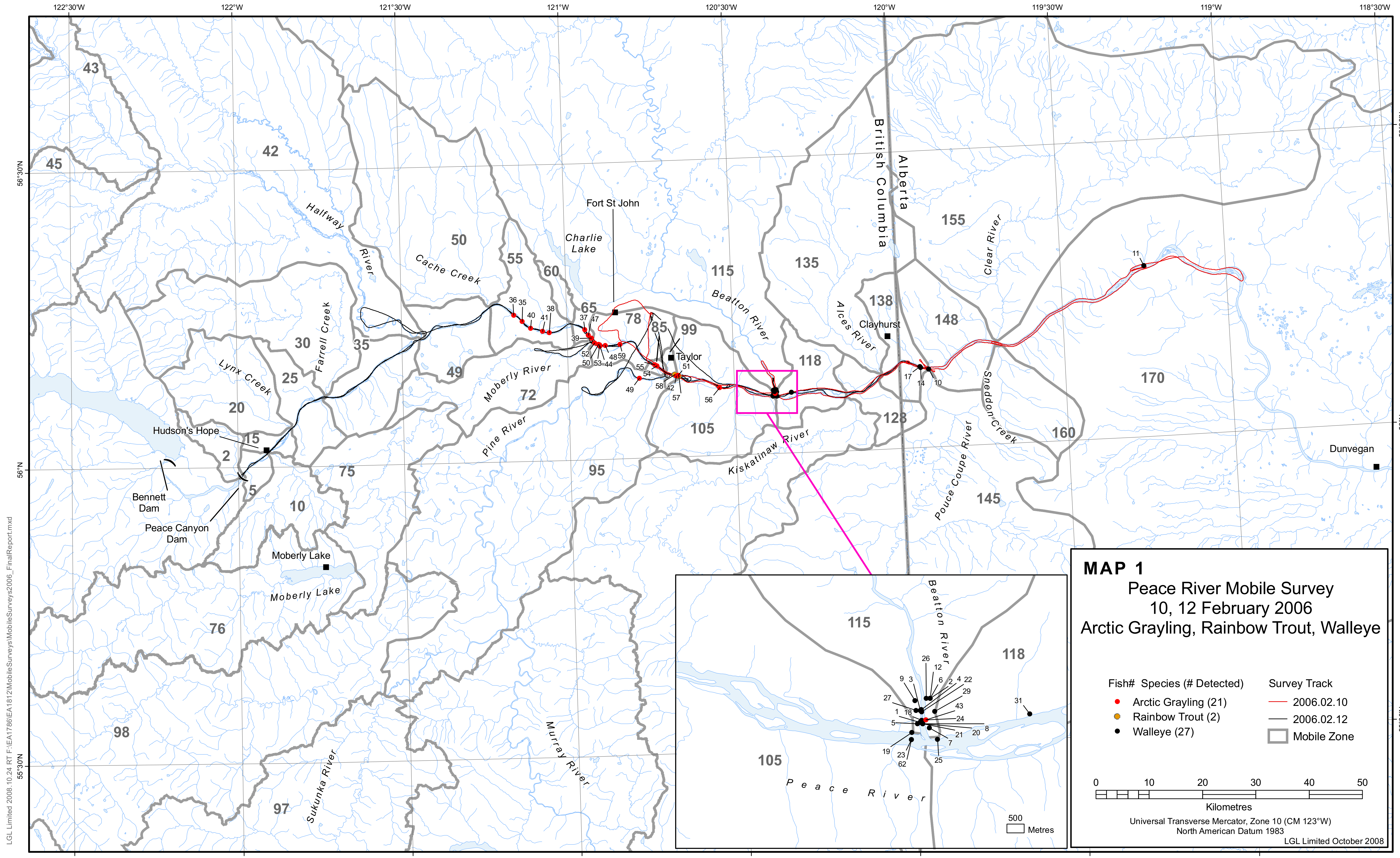
October Tracks

The October tracks (Maps 10-12 inclusive) are indicative of where the fish are likely to be during the winter. Clearly, the bulk of these populations overwinter in the Peace mainstem. Some overwintering occurs in the lower and middle reaches of the Halfway River, and possibly in the lower Pine River, as suggested by the detections of mountain whitefish in these locations. In October, as occurred in February/March, walleye were largely congregated at the mouth of the Beatton River, although several were widely scattered downstream to as far as the Montagnuese River. Minor numbers of walleye were detected upstream of the Beatton River.

Rainbow trout were mainly detected between the Peace Canyon Dam and Cache Creek, with few individuals widely scattered downstream to as far as the Montagnuese River. The individual rainbow trout detected in the vicinity of Moberly Lake was not previously detected anywhere in aerial surveys, but it was detected at the mouth of the Moberly River as well as downstream in the Peace mainstem by fixed-station receivers.

Arctic grayling were primarily detected between Cache Creek and the Beatton River, although like rainbow trout, a few individuals were detected a considerable distance downstream, with two well into Alberta, the farthest being near Dunvegan. A single arctic grayling was detected in the Pine River (near the mouth of the Murray River). This fish was previously detected downstream in the Pine River, as well as in the Peace mainstem as far as the Beatton River mouth.

Mountain whitefish detections were fairly evenly distributed in the Peace River mainstem between Hudson Hope and Taylor, with some scattered variable distances downstream, with a few in Alberta. As in the August survey, a few fish were detected in the Halfway and Pine rivers.


MAP 1
Peace River Mobile Survey
10, 12 February 2006
Arctic Grayling, Rainbow Trout, Walleye
Fish# Species (# Detected)
Arctic Grayling (21)
Rainbow Trout (2)
Walleye (27)
Survey Track
2006.02.10
2006.02.12
Mobile Zone
0 10 20 30 40 50
Kilometres
Universal Transverse Mercator, Zone 10 (CM 123°W)
North American Datum 1983
LGL Limited October 2008
500
Metres
Fort St John
Charlie Lake
Taylor
Clayhurst
Dunvegan
Hudson's Hope
Bennett Dam
Peace Canyon Dam
Moberly Lake
Halfway River
Cache Creek
Lynx Creek
Farrell Creek
Moberly River
Pine River
Beatton River
Alces River
Kiskatinaw River
Clear River
Sneddon Creek
Pouce Coupe River
Murray River
Sukunka River
Peace River
British Columbia
Alberta
122°30'W
122°W
121°30'W
121°W
120°30'W
120°W
119°30'W
119°W
118°30'W
56°30'N
56°N
55°30'N
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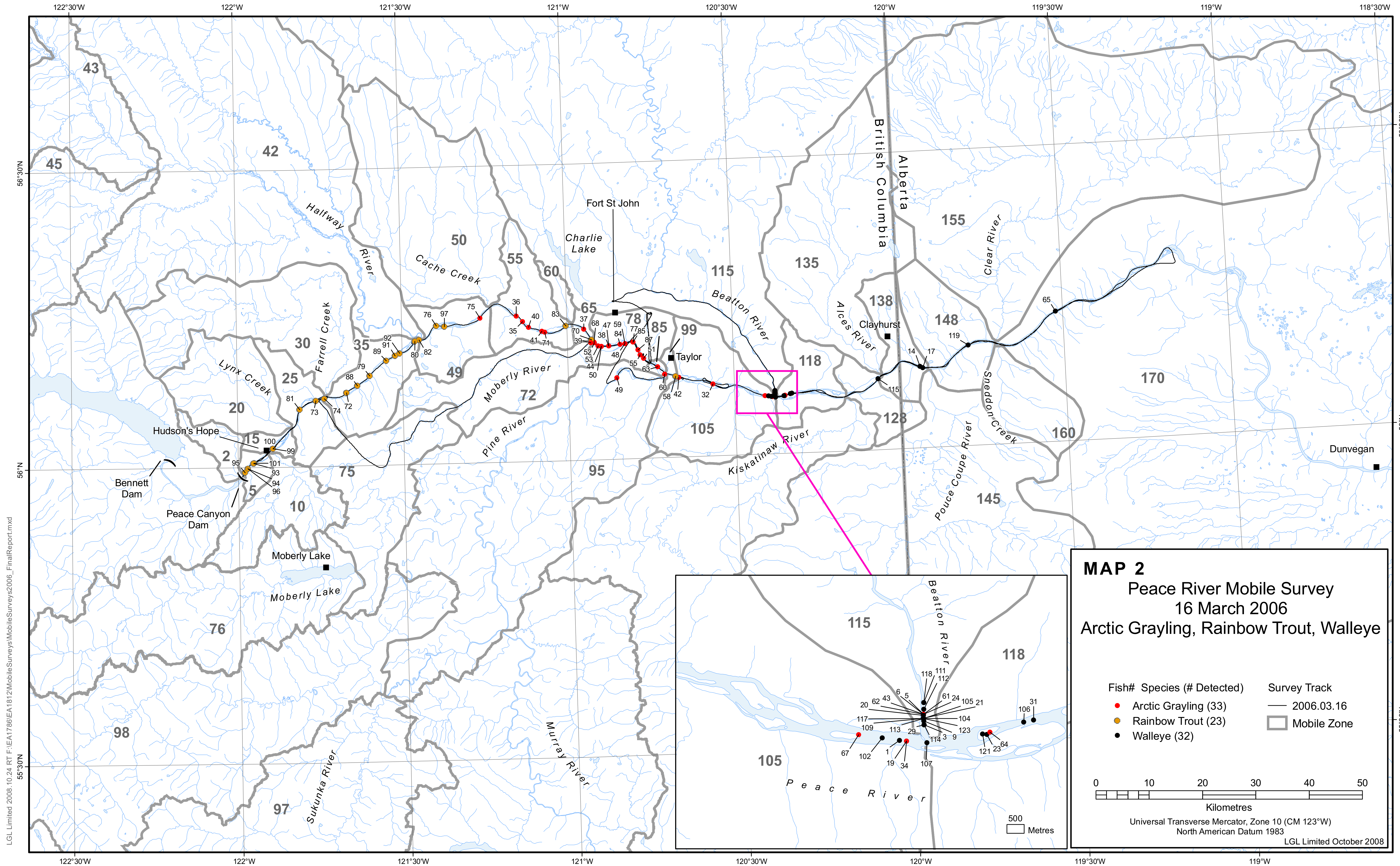
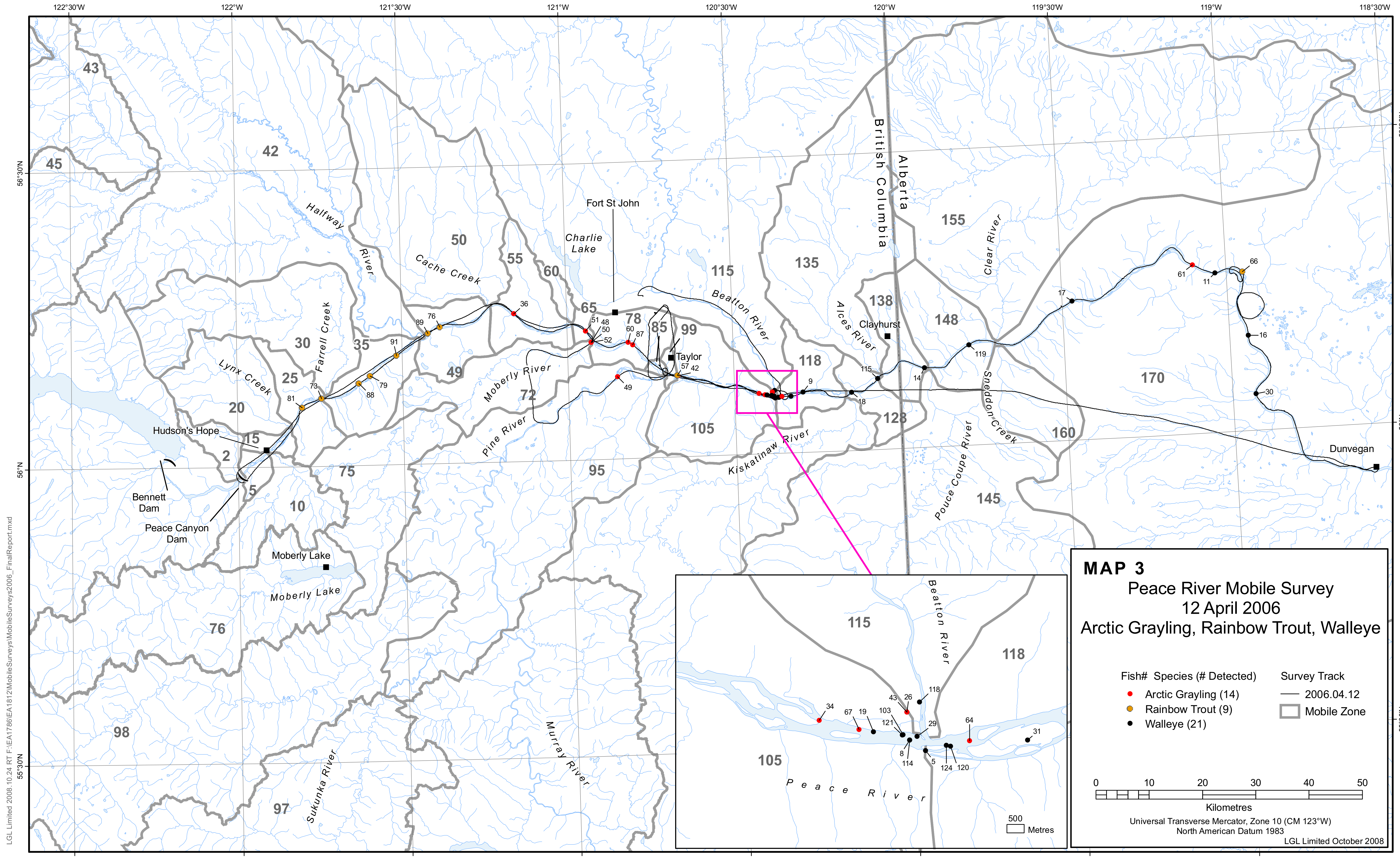
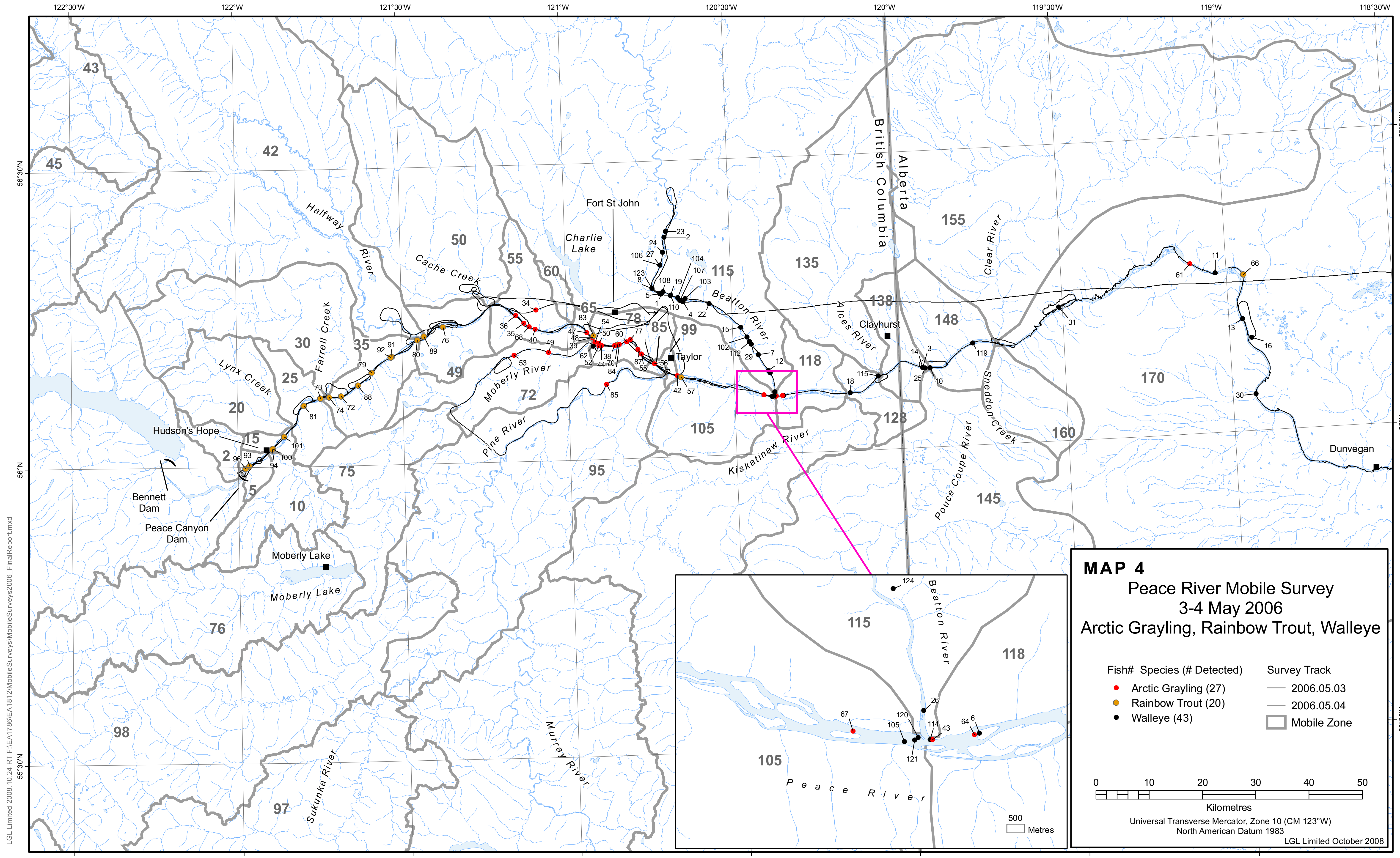


Map 2: Peace River Radio Telemetry Mobile Survey, Mar 16, 2006


MAP 3
Peace River Mobile Survey
12 April 2006
Arctic Grayling, Rainbow Trout, Walleye
Fish# Species (# Detected)
Arctic Grayling (14)
Rainbow Trout (9)
Walleye (21)
Survey Track
2006.04.12
Mobile Zone
0 10 20 30 40 50
Kilometres
Universal Transverse Mercator, Zone 10 (CM 123°W)
North American Datum 1983
LGL Limited October 2008
LGL Limited 2008.10.24 RT F:\EA1786\EA1812\MobileSurveys\MobileSurveys2006_FinalReport.mxd
Fort St John
Charlie Lake
Taylor
Hudson's Hope
Bennett Dam
Peace Canyon Dam
Moberly Lake
Clayhurst
Dunvegan
British Columbia
Alberta
Halfway River
Cache Creek
Farrell Creek
Lynx Creek
Moberly River
Pine River
Beatton River
Alces River
Clear River
Sneddon Creek
Pouce Coupe River
Kiskatinaw River
Murray River
Sukunka River
Moberly Lake
Peace River
500 Metres
122°30'W
122°W
121°30'W
121°W
120°30'W
120°W
119°30'W
119°W
118°30'W
56°30'N
56°N
55°30'N


MAP 4
Peace River Mobile Survey
3-4 May 2006
Arctic Grayling, Rainbow Trout, Walleye
Fish# Species (# Detected)
Arctic Grayling (27)
Rainbow Trout (20)
Walleye (43)
Survey Track
2006.05.03
2006.05.04
Mobile Zone
Kilometres
Universal Transverse Mercator, Zone 10 (CM 123°W)
North American Datum 1983
LGL Limited October 2008
Fort St John
Charlie Lake
Taylor
Clayhurst
Hudson's Hope
Bennett Dam
Peace Canyon Dam
Moberly Lake
Dunvegan
British Columbia
Alberta
Halfway River
Cache Creek
Farrell Creek
Lynx Creek
Moberly River
Pine River
Beatton River
Alces River
Kiskatinaw River
Clear River
Sneddon Creek
Pouce Coupe River
Murray River
Sukunka River
Peace River
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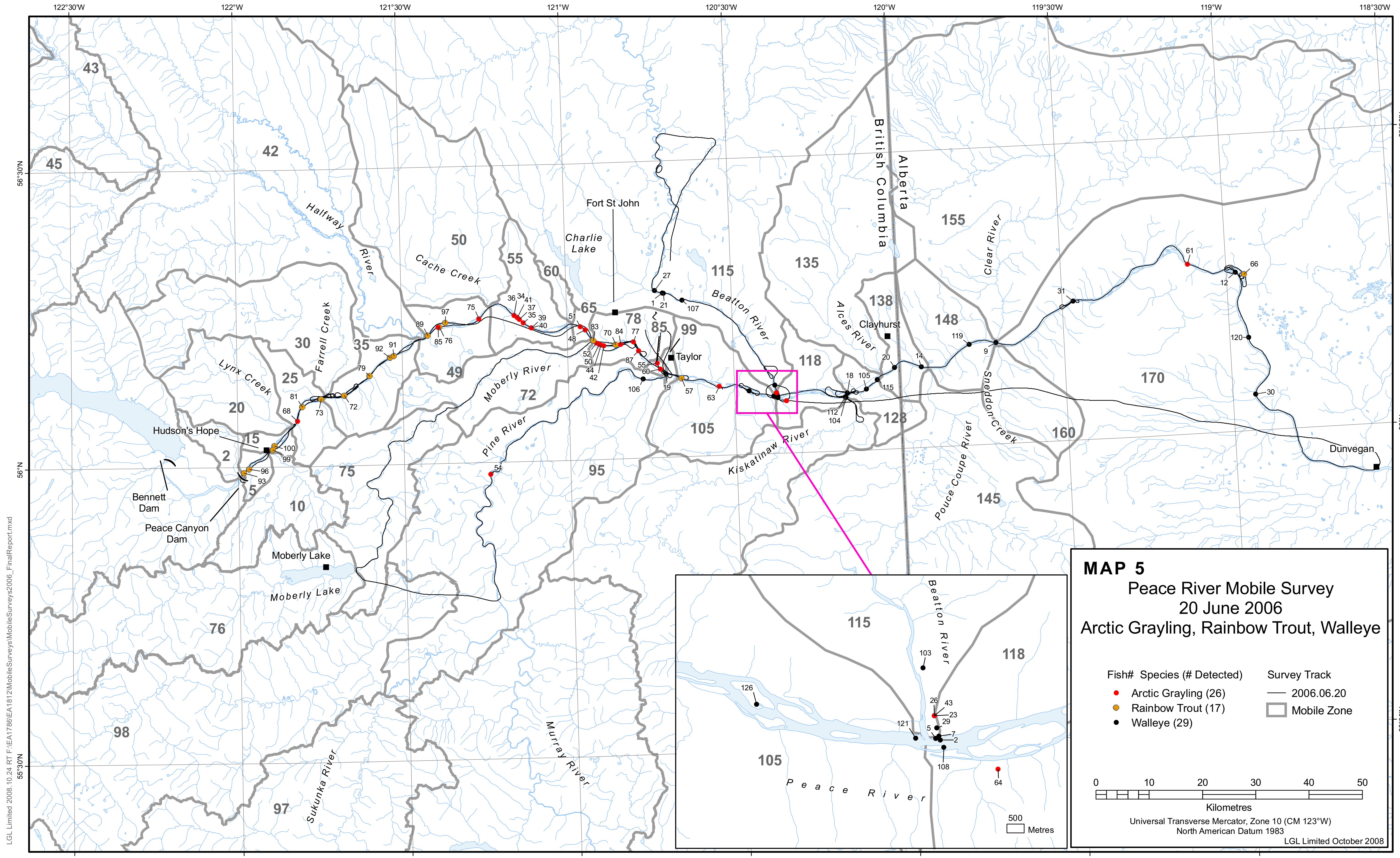
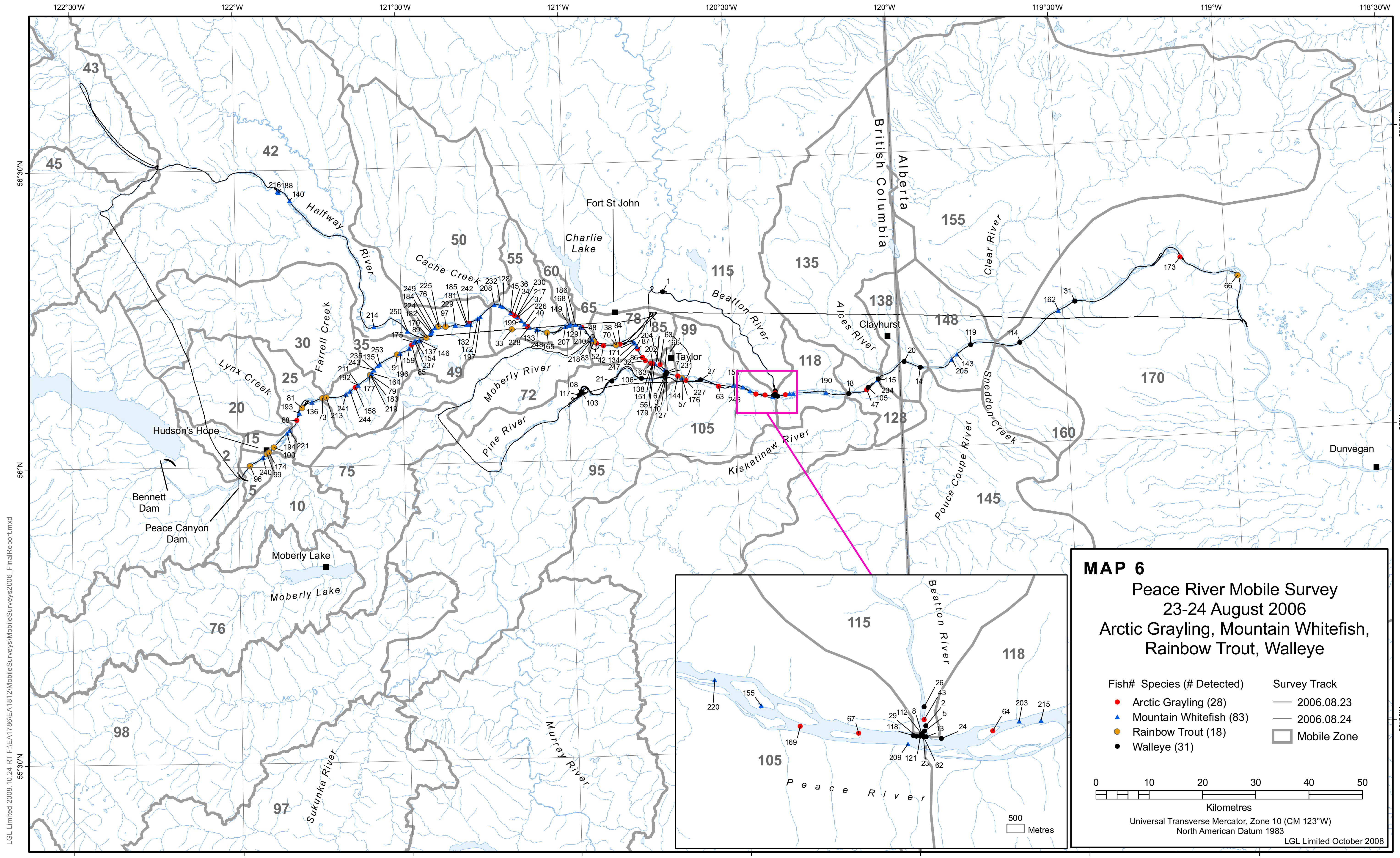
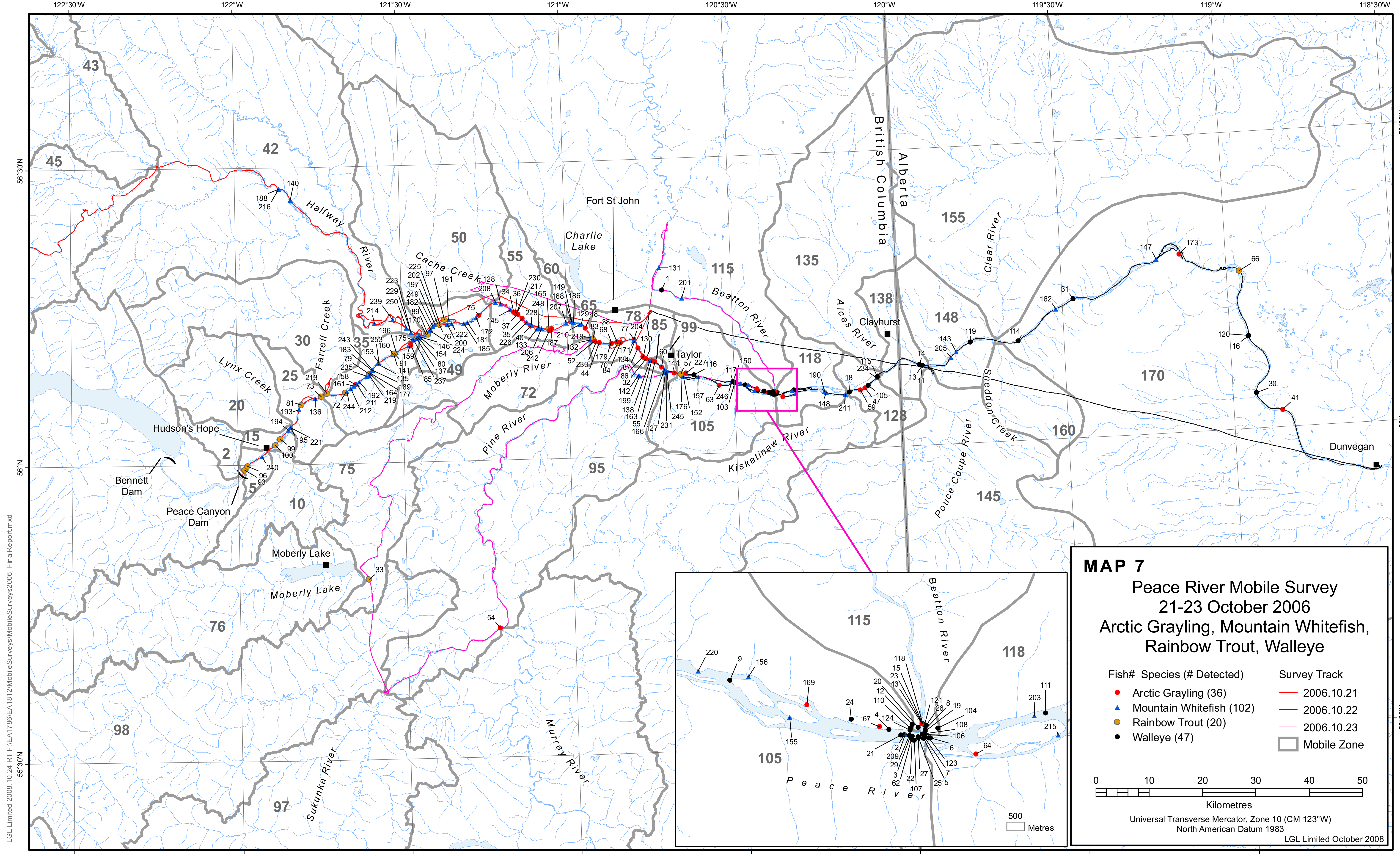

MAP 5
Peace River Mobile Survey
20 June 2006
Arctic Grayling, Rainbow Trout, Walleye
Fish# Species (# Detected)
Arctic Grayling (26)
Rainbow Trout (17)
Walleye (29)
Survey Track
2006.06.20
Mobile Zone
0 10 20 30 40 50
Kilometres
Universal Transverse Mercator, Zone 10 (CM 123°W)
North American Datum 1983
LGL Limited October 2008
Fort St John
Charlie Lake
Taylor
Clayhurst
Dunvegan
Hudson's Hope
Bennett Dam
Peace Canyon Dam
Moberly Lake
British Columbia
Alberta
Halfway River
Cache Creek
Farrell Creek
Lynx Creek
Moberly River
Pine River
Beatton River
Alces River
Kiskatinaw River
Clear River
Sneddon Creek
Pouce Coupe River
Murray River
Sukunka River
Peace River
500 Metres



MAP 6
Peace River Mobile Survey
23-24 August 2006
Arctic Grayling, Mountain Whitefish, Rainbow Trout, Walleye
Fish# Species (# Detected)
Arctic Grayling (28)
Mountain Whitefish (83)
Rainbow Trout (18)
Walleye (31)
Survey Track
2006.08.23
2006.08.24
Mobile Zone
Kilometres
Universal Transverse Mercator, Zone 10 (CM 123°W)
North American Datum 1983
LGL Limited October 2008
Fort St John
Charlie Lake
Hudson's Hope
Bennett Dam
Peace Canyon Dam
Moberly Lake
Taylor
Clayhurst
Dunvegan
British Columbia
Alberta
Halfway River
Cache Creek
Farrell Creek
Lynx Creek
Moberly River
Pine River
Beatton River
Alces River
Kiskatinaw River
Clear River
Sneddon Creek
Pouce Coupe River
Murray River
Sukunka River
Peace River
LGL Limited 2008.10.24 RT F:\EA1786\EA1812\MobileSurveys\MobileSurveys2006_FinalReport.mxd



MAP 7
Peace River Mobile Survey
21-23 October 2006
Arctic Grayling, Mountain Whitefish, Rainbow Trout, Walleye
Fish# Species (# Detected)
Arctic Grayling (36)
Mountain Whitefish (102)
Rainbow Trout (20)
Walleye (47)
Survey Track
2006.10.21
2006.10.22
2006.10.23
Mobile Zone
Kilometres
Universal Transverse Mercator, Zone 10 (CM 123°W)
North American Datum 1983
LGL Limited October 2008
Fort St John
Charlie Lake
Taylor
Clayhurst
Hudson's Hope
Bennett Dam
Peace Canyon Dam
Moberly Lake
Dunvegan
British Columbia
Alberta
Halfway River
Cache Creek
Beatton River
Moberly River
Pine River
Kiskatinaw River
Peace River
Murray River
Sukunka River
Pouce Coupe River
Clear River
Alces River
Farrell Creek
Lynx Creek
Sheddon Creek
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Assessment of Overall Detections (Mobile Tracking)

Spreadsheets of the detections of individual fish of each species from the mobile tracking data by zone and release site (Table 58) show very few detections upstream of the release site for all species. Of the total number of detections for each species, the percentage of those upstream of the release site amounted to 3.9% for walleye, 7.3% for rainbow trout, 9.3% for mountain whitefish, and 10.5% for arctic grayling. With the exception of walleye, the majority of detections for all species were not far downstream from the release site. However, for each species, a few fish were detected a considerable distance downstream from the release site, although more so for walleye than the other species. Some of these extensive movements may represent dead fish drifting downstream, although it is unlikely that they would drift that far. Alternatively, some may have been eaten by large bull trout that have moved downstream with the radio transmitters in their stomachs. Predation by large bull trout on our tagged fish has been confirmed to occur by anglers on two occasions thus far.

Table 58: ***Number of individual fish detections for each species by zone, in relation to release site. For ease of comparison, the release site numbers relate to zone number (i.e., 99 = 1099; 105 = 1105, etc)***

Walleye

	Release Site		
Zone	1099	1105	Totals
78	1		1
95		8	8
99		3	3
105	3	56	59
115	2	145	147
118	4	22	26
125		1	1
128		14	14
138		19	19
148		7	7
170	3	17	20
Totals	13	292	305

Rainbow Trout

	Release Site							
Zone	1005	1015	1025	1035	1049	1055	1099	Totals
5	11	2						13
15	1	10						11
25			7	6				13
35		2	4	23				29
42				1				1
49	4		6	4				14
55				1	3	1		5
65			1	1				2
75						1		1
78			4	3				7
99							2	2
105							7	7
170			5					5
Totals	16	14	27	39	3	2	9	110

Mountain Whitefish

	Release Site						
Zone	1015	1035	1049	1055	1065	1099	Totals
5	2						2
15	5						5
25	4						4
35	19	19			2		40
42	2	6	2	3			13
49		4	23			1	28
55			24	12			36
65		2	2	2	2		8
72			1		1		2
78			4	3	4	1	12
85			3			7	10
95			1	1		2	4
99			4	1		2	7
105		2	12	7		3	24
115			2	2			4
118	1		3	2		2	8
128						2	2
148				4			4
170				1	2		3
Totals	33	33	81	38	11	20	216

Arctic Grayling

	Release Site						
Zone	1025	1035	1055	1065	1099	1105	Totals
25	2						2
35		4					4
49	3	1	1				5
55	2		38				40
65			12				12
72			6				6
78	13	10	32		8		63
85		3			9	1	13
95		1	3		3		7
99			2				2
105	5	4	10	3	1	5	28
115	1		9		1	1	12
118			1			6	7
128			2		1		3
170			1	2	3		6
Totals	26	23	117	5	26	13	210

Note: For each species, detections above the solid line are upstream of the release site

3.5.2.3 Movements of All Fish by Species

Maps showing the movements of all fish for each species based on mobile tracking and fixed station data are presented in Figures 55 to 58, inclusive. Also, for each species, the number of first seen and last seen detections, and all minor and major movements are shown on maps in Appendix C, Figures 1 to 8, inclusive.

The bulk of the movement of mountain whitefish in the Peace River mainstem occurred between Lynx Creek and the Beatton River (Figure 55), with some movement further downstream to as far as Sneddon Creek, Alberta. Movement upstream of Lynx Creek in the Peace mainstem was minor. A few mountain whitefish moved into the Moberly, Pine and Halfway rivers, with a total of six fish detected in the headwaters of the latter (Graham River), although, it is conceivable that these six fish represent predation by large bull trout.

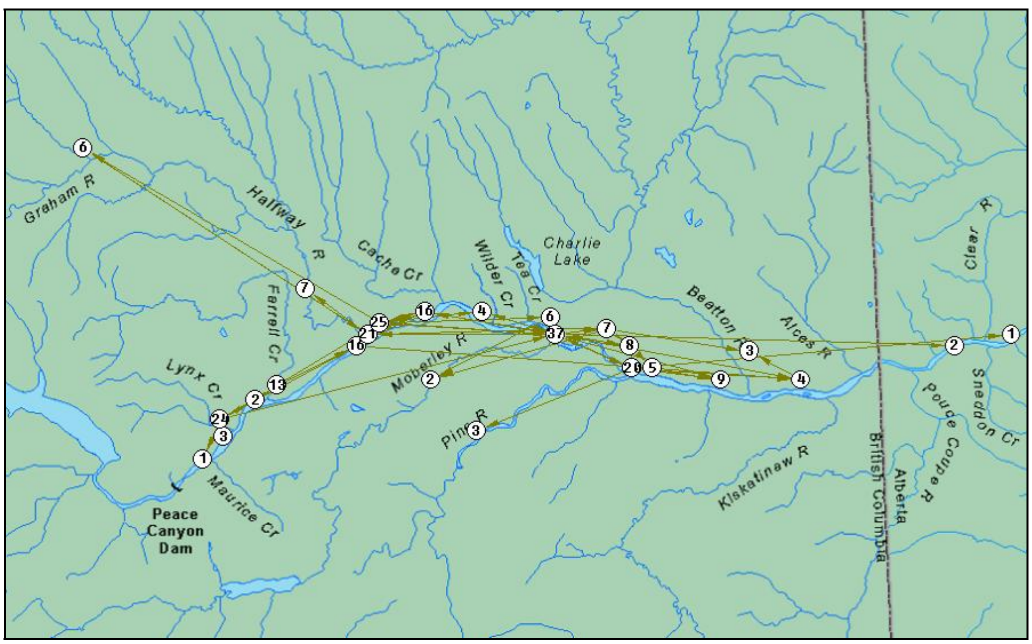

Figure 55: ***Movements of all radio-tagged mountain whitefish, Peace River, 2006. Circles represent the number of fish detected in each location.***

The movement recorded by rainbow trout was almost exclusively in the Peace River mainstem, with only one fish detected in the lower Halfway River and one well upstream in the Moberly River (Figure 56). Movement in the Peace River mainstem was mainly between the Halfway River and Maurice

Creek. Downstream of the Halfway to the Pine River, minor movement was recorded. Beyond the Pine, one fish was detected near the Beatton mouth, and one past Sneddon Creek (see Appendix C, Figure 2).

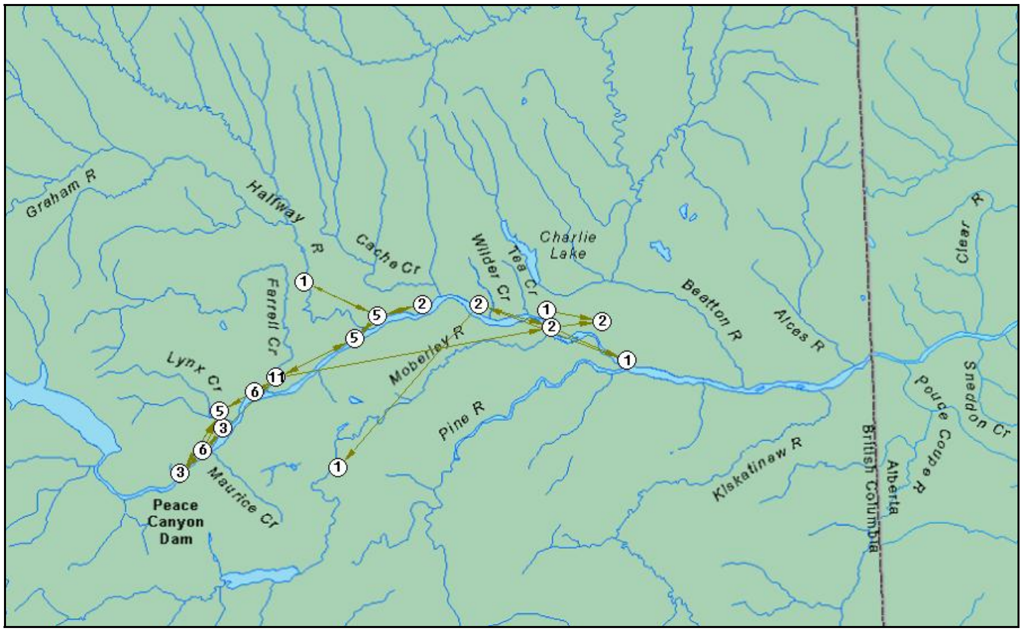

Figure 56: ***Movements of all radio-tagged rainbow trout, Peace River, 2006. Circles represent the number of fish detected in each location.***

The observed movement of Arctic grayling was mainly in the Peace mainstem between the Halfway and Beatton rivers (Figure 57), with relatively few movements recorded both upstream and downstream of this reach. Three Arctic grayling moved in and out of the Moberly River, and four moved into the Pine River, with one of them still there during the 23 October mobile track. A few fish were scattered downstream of the Beatton, with two recorded within the vicinity of Sneddon Creek.

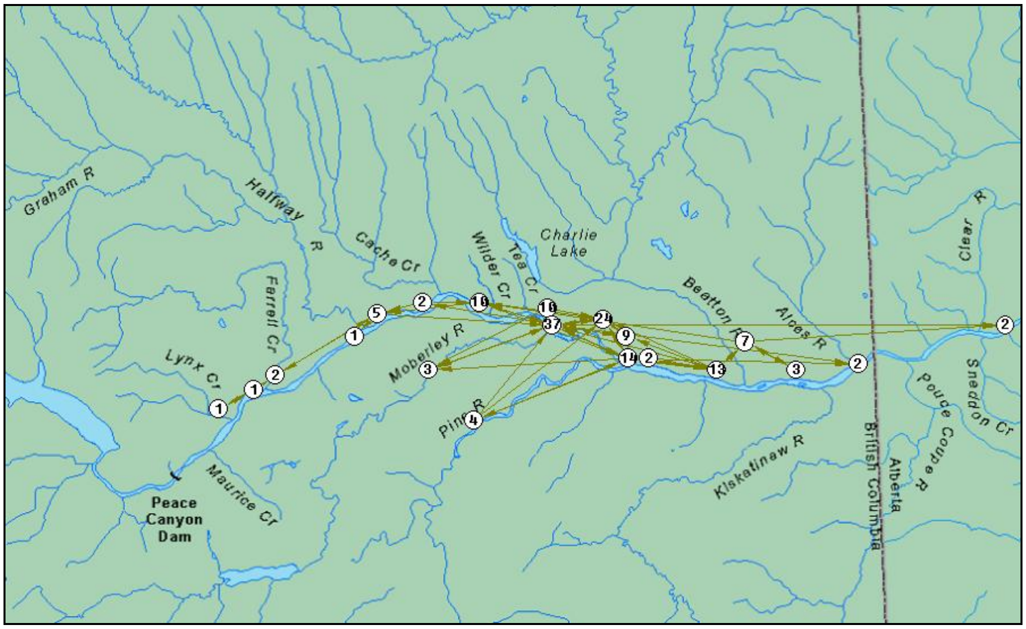

Figure 57: ***Movements of all radio-tagged Arctic grayling, Peace River, 2006. Circles represent the number of fish detected in each location.***

No movement of walleye was detected in the Peace River mainstem upstream of the Moberly River confluence (Figure 58). Overall, movement of the tagged population occurred from the Moberly River to a short distance downstream of Sneddon Creek. More than 30% of the movement recorded consisted of fish moving in and out of the Beatton River, with a similar proportion recorded of fish moving in the Peace mainstem between the mouth of the Beatton and Alces River. Approximately 10-20% of walleye movement in the Peace mainstem was between the Beatton and Pine rivers. Eight walleye were recorded moving in and out of the Pine River in the summer, but none of these fish were still present there on the 23 October track.

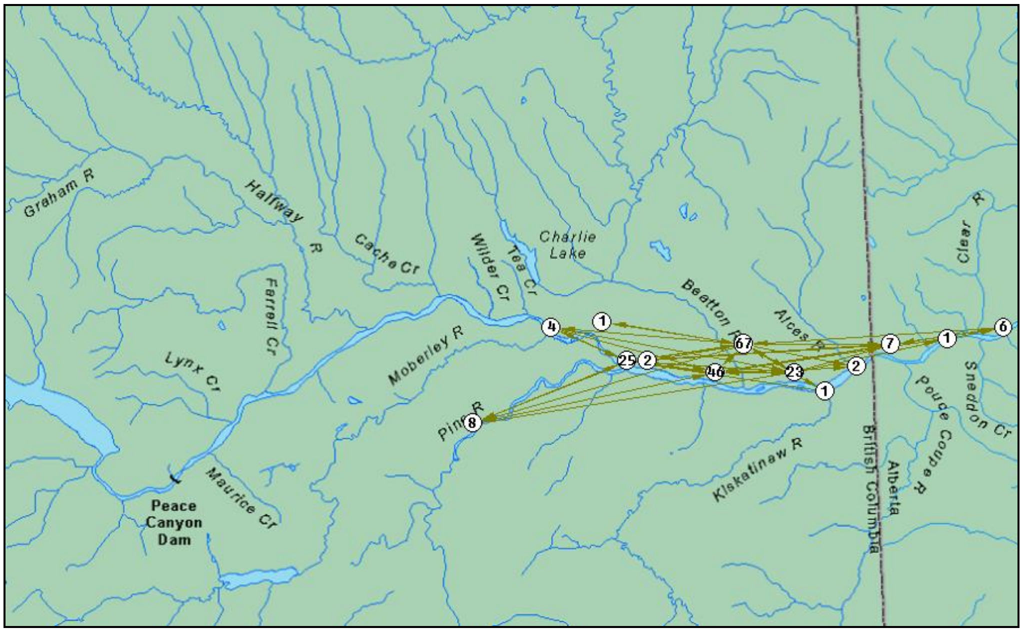

Figure 58: ***Movements of all radio-tagged walleye, Peace River, 2006. Circles represent the number of fish detected in each location.***

3.5.2.4 Movements of Individual Fish

Examples of sequential detections of individual fish (outliers, and others) of each species are shown to provide a visual display movement of individuals of these species (Figures 59 to 66, inclusive).

The mountain whitefish examples include one fish moving upstream in the Peace mainstem from below Tea Creek to past the Halfway River (Figure 59), and of another moving downstream from above Wilder Creek to the Pine River (Figure 60). Both of these fish show greater than average movement of the tagged population, but are not considered as extreme as, those that migrated (or were eaten by bull trout that moved) up to the headwaters of the Halfway River, or those that moved extensively downstream in the Peace mainstem.

The two examples of rainbow trout include mostly Peace mainstem movement, with one fish moving between the Halfway River and Peace Canyon Dam, with repeat movements between Farrell and Lynx creeks (Figure 61). The other is of a rainbow trout that moved between Farrell Creek and Pine River, and subsequently entered the Moberly River and moved a considerable distance upstream (Figure 62). Both of these fish show greater than average movement of the tagged population.

The two Arctic grayling examples include one fish that represents Arctic grayling which moved from Peace mainstem into and out of the Moberly River (Figure 63), and another with quite extensive movement in the Peace mainstem between the Moberly River and Lynx Creek, with repeat movements between Farrell Creek and Halfway River, and subsequently back to the mouth of the Moberly (Figure 64).

The walleye examples include a fish indicative of average movement of the tagged population (Figure 65), showing both upstream and downstream movement in the Peace mainstem between the Moberly River and beyond the Beatton River, with repeat movements between the Beatton and the mainstem. Figure 66 shows a fish that moved both upstream and downstream in the Peace mainstem, but also moved in and out of the Pine River (Figure 66).

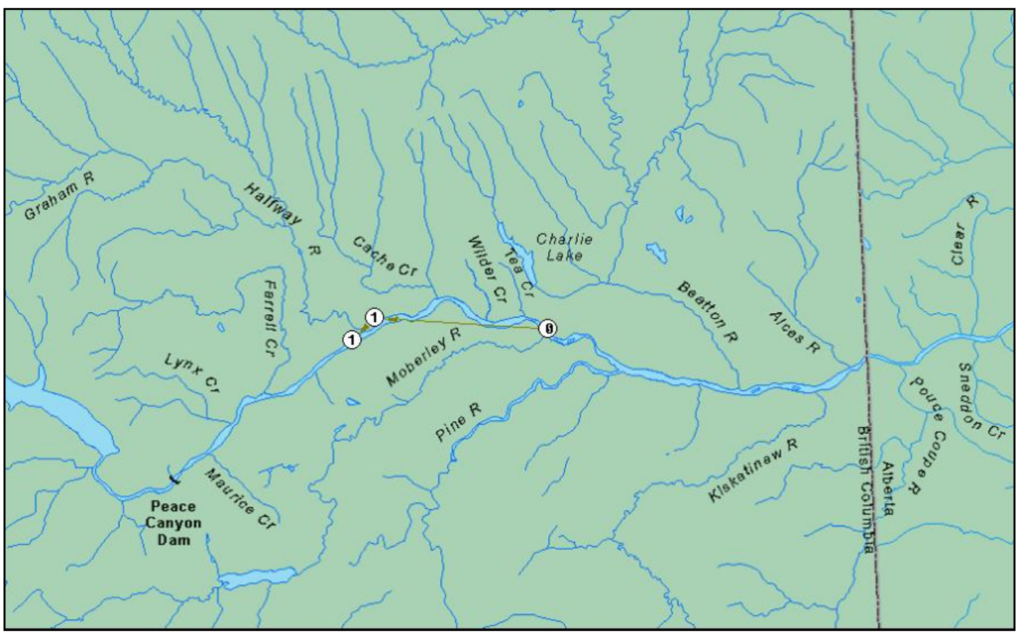

Figure 59: ***Sequential detections by zone of a mountain whitefish (Tag # 159; FL = 355 mm) with the track ending upstream of the Halfway River. The numbers in the circles indicate the number of times the fish was detected in that zone.***

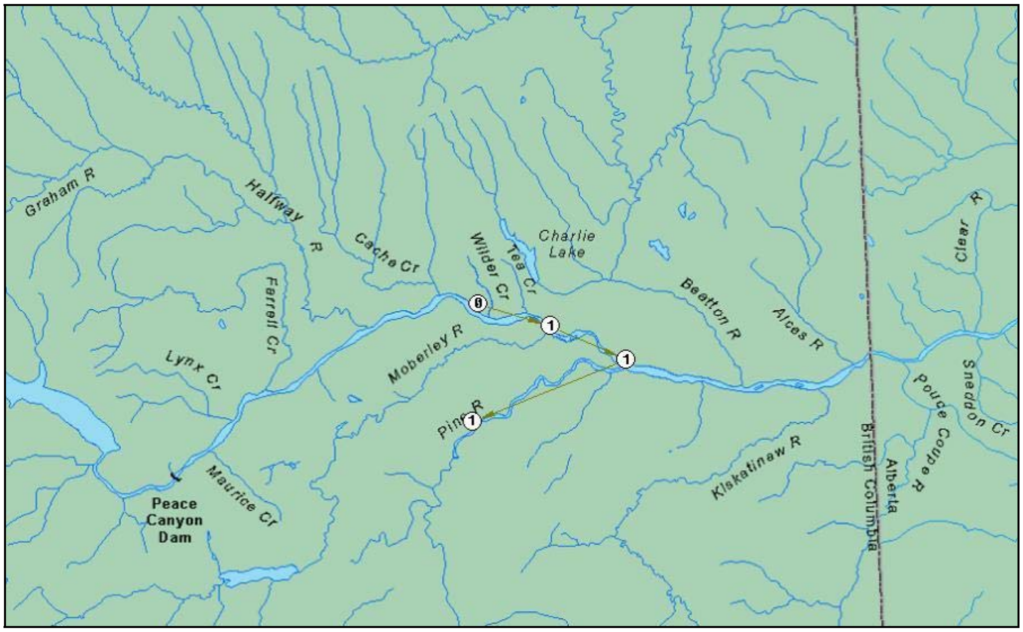

Figure 60: **_Sequential detections by zone of a mountain whitefish (Tag # 199; FL = 355) with the track ending in the Pine River. The numbers in the circles indicate the number of times the fish was detected in that zone._**

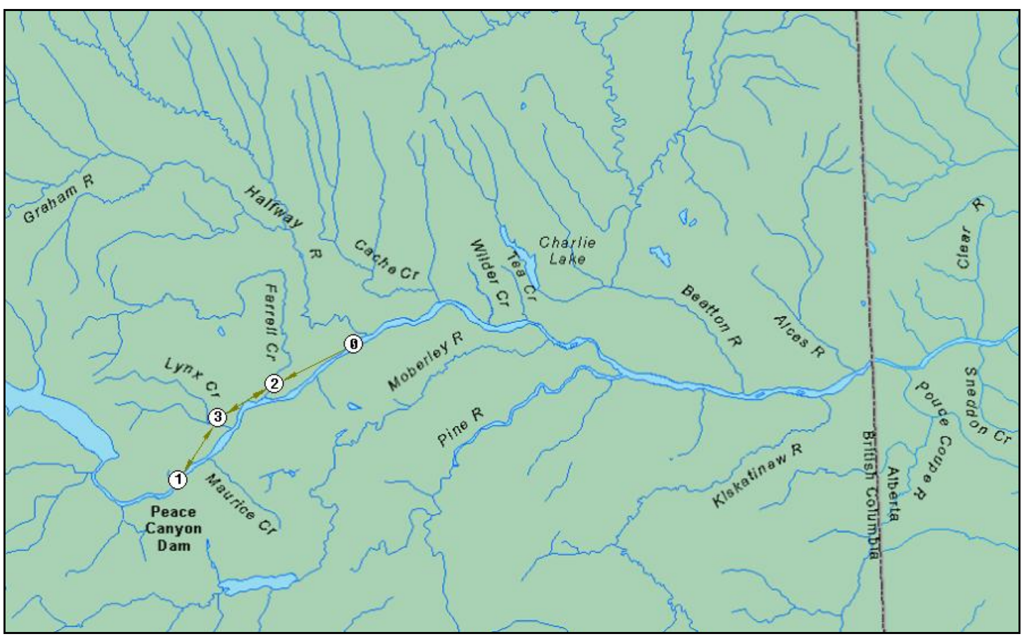

Figure 61: **_Sequential detections by zone of a rainbow trout (Tag # 58; FL = 396) with the track ending in Lynx Creek. The numbers in the circles indicate the number of times the fish was detected in that zone._**

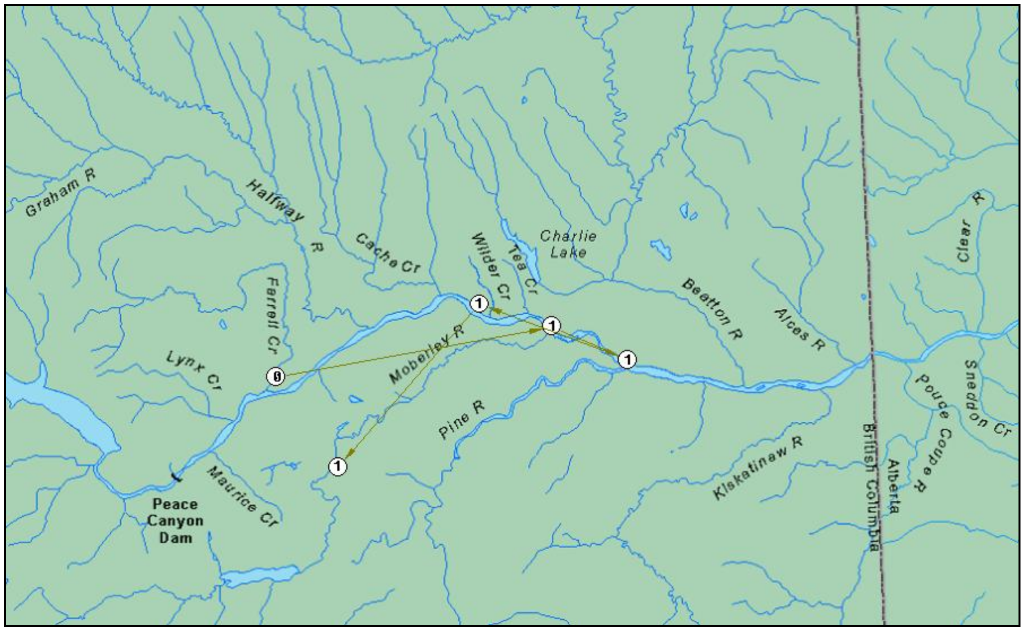

Figure 62: ***Sequential detections by zone of a rainbow trout (Tag # 33; FL = 309)) with the track ending in the Moberly River. The numbers in the circles indicate the number of times the fish was detected in that zone.***

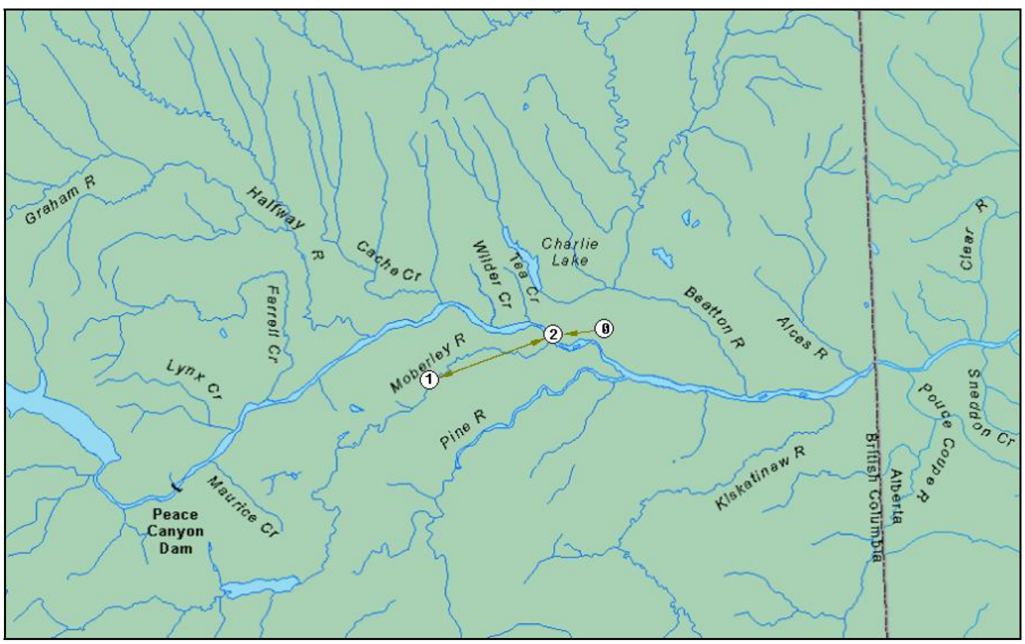

Figure 63: ***Sequential detections by zone of an Arctic grayling (Tag # 53; FL = 350) with the track ending in the Peace River downstream of Tea Creek. The numbers in the circles indicate the number of times the fish was detected in that zone.***

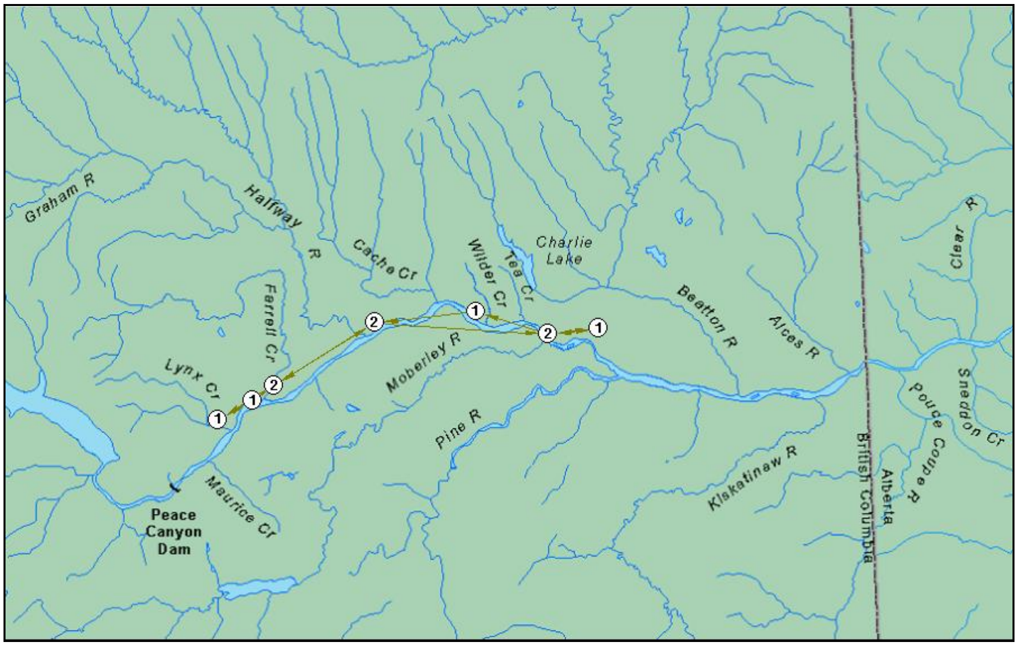

Figure 64: ***Sequential detections by zone of an Arctic grayling (Tag # 68; FL = 311) with the track ending in the Peace River downstream of Tea Creek (same zone where fish first detected). The numbers in the circles indicate the number of times the fish was detected in that zone.***

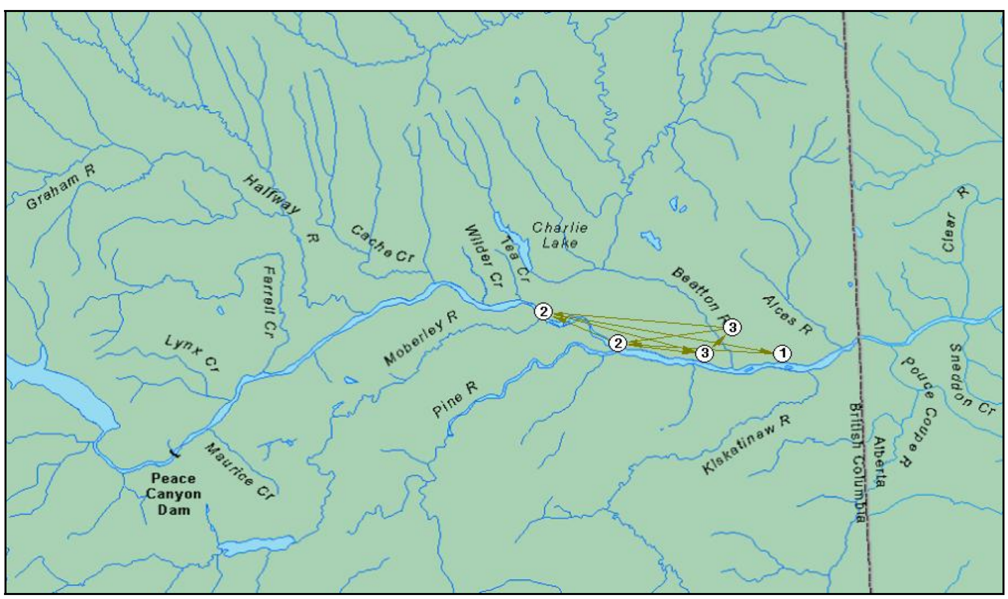

Figure 65: ***Sequential detections by zone of a walleye (Tag # 2; FL = 434) showing several upstream/downstream movements with the track starting and ending in the Beatton River. The numbers in the circles indicate the number of times the fish was detected in that zone.***

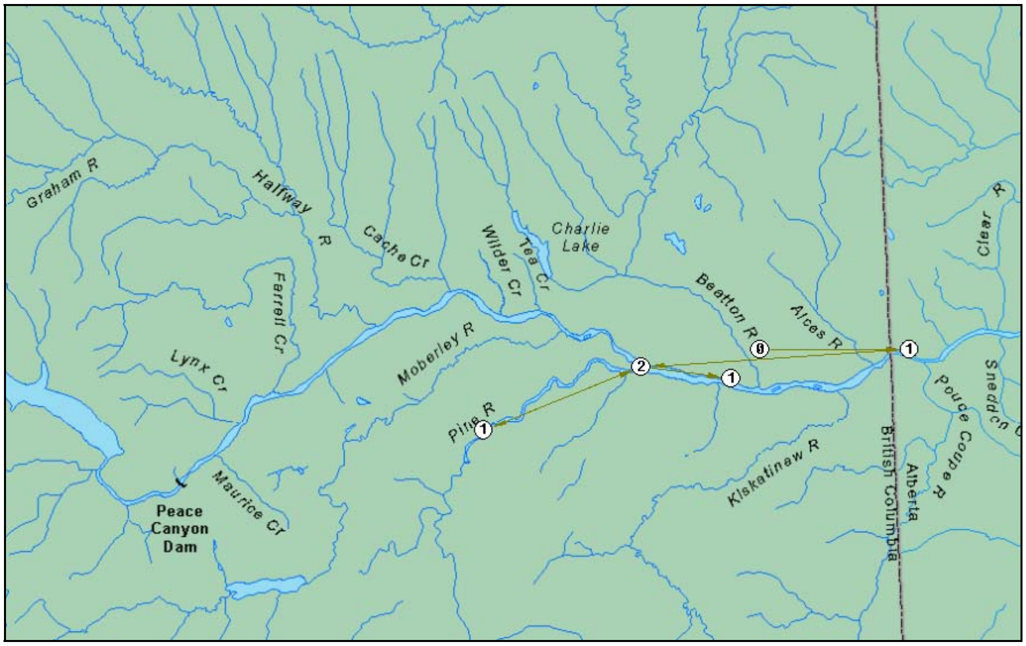

Figure 66: ***Sequential detections by zone of a walleye (Tag # 63; FL = 450) with the track ending at the mouth of the Pine River. The numbers in the circles indicate the number of times the fish was detected in that zone.***

3.5.2.5 Assessment of Fish Movements

A plot of the mean number of movements per fish for each of the tagged populations by month shows a similar seasonal pattern for Arctic grayling, rainbow trout and walleye over the period tracked (Figure 67). All three species show a decline in movement during summer (June-August), with a low in July when temperatures in the Peace mainstem ranged approximately between 13 and 15°C. By September, the mean number of movements detected for these species was similar to that observed in the period preceding summer. The mean number of movements was highest for Arctic grayling, rainbow trout, and walleye in May, September and October, respectively. The movement of mountain whitefish was low in all months for which there are data, but particularly in July and September which are based on fixed-station data only.

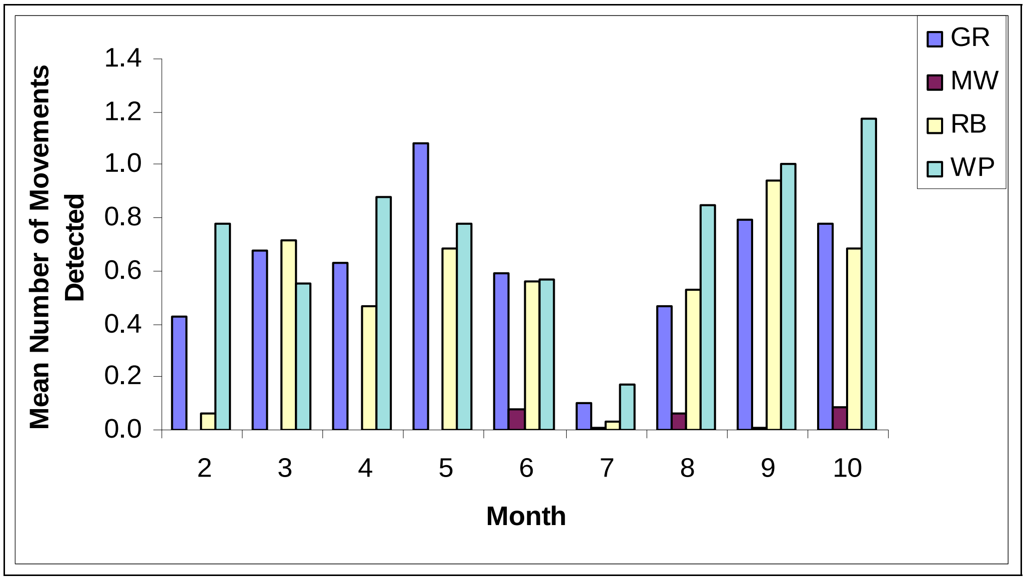

Figure 67: ***Mean number of movements detected per fish by species monthly, Peace River, 2006. The mean values are equal to the monthly total number of detections for each species divided by the total number of fish.***

A plot of the mean distance moved by species monthly (Figure 68) shows that the mountain whitefish population generally moved relatively little, compared with that of the other species. The occurrence of greatest movement may be related to spawning, with the mean distance moved being highest for Arctic grayling in March (~12 km), rainbow trout in March-April (~6-7 km), and walleye in May (~12.5 km). A walleye migration up the Beatton River was detected in the May mobile tracking survey. The movement detected for all species was low in July and September, the months in which no mobile tracking was done. In August and October, the mean distances moved were at similar levels to those recorded in June.

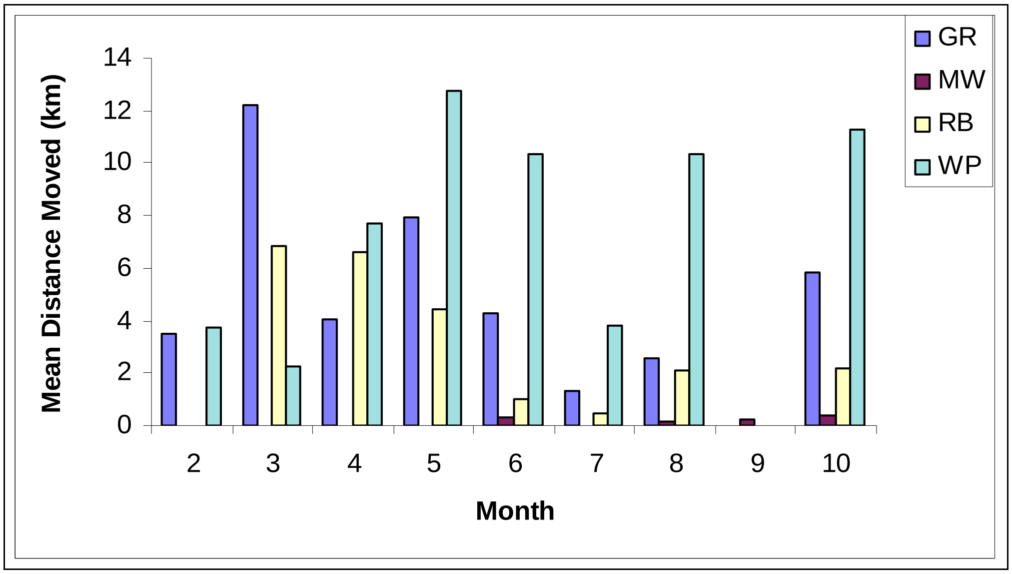

Figure 68: ***Mean distance moved by species monthly, Peace River, 2006***

The range in movement was considerable for all species (Figure 69) although particularly so for mountain whitefish (0 to ~300 km) because of the extensive movement up the Halfway River. Movement of Arctic grayling and rainbow trout ranged from 0 to ~180 km, and walleye from 0 to ~200 km. The median distance moved by each of these tagged populations is lowest for rainbow trout (7.4 km) and highest for walleye (57.9 km), whereas that of mountain whitefish and Arctic grayling are intermediate being 17.1 km and 36.1 km, respectively. Variation in movement was least for rainbow trout, as is evident by the narrow range of the percentile box, intermediate for mountain whitefish, and greatest for Arctic grayling and walleye.

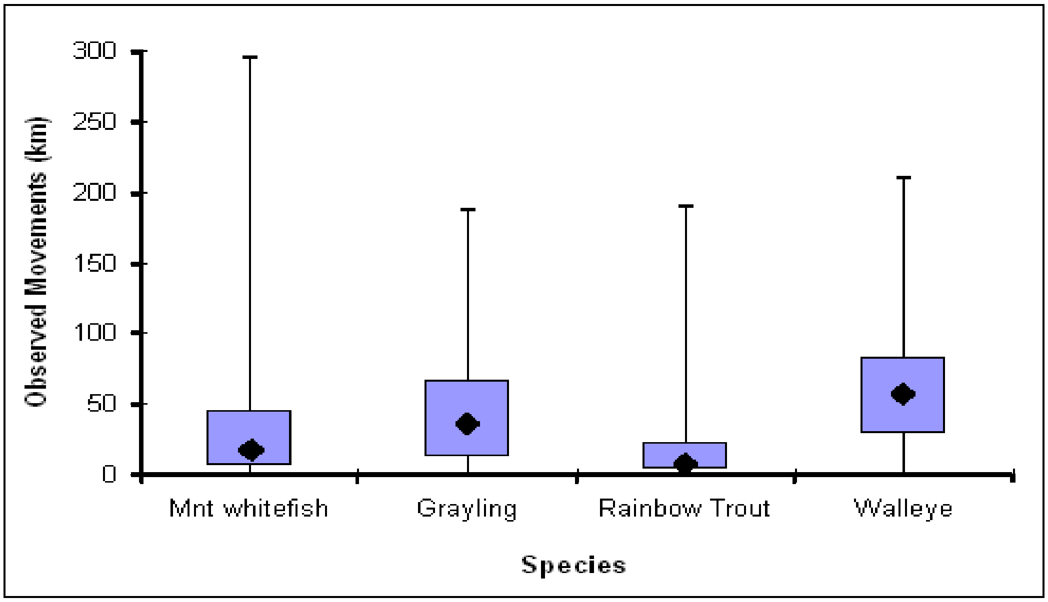

Figure 69: ***Observed distances moved by species, Peace River, 2006. Diamonds indicate medians, boxes enclose the 25th to 75th percentiles, and vertical lines extend from minimum to maximum observed values.***

A plot of movements since last detection by species (Figure 70) clearly shows that movement was not unidirectional; upstream and downstream movements were not recorded in similar proportions for most species. The percentage of fish within each of the tagged populations that only moved downstream amounted to 1.7% for walleye, 5.2% for mountain whitefish, 6.1% for Arctic grayling, and 12.5% for rainbow trout. Overall, movement is least for rainbow trout, with relatively few detections at distances >10 km in either direction. For both Arctic grayling and mountain whitefish, the bulk of movement detected <20 km in either direction, although the range in distance is considerably greater downstream than upstream. The distribution of walleye movement is evenly spread in both upstream and downstream directions, with the range in movement being similar in either direction (~100 km).

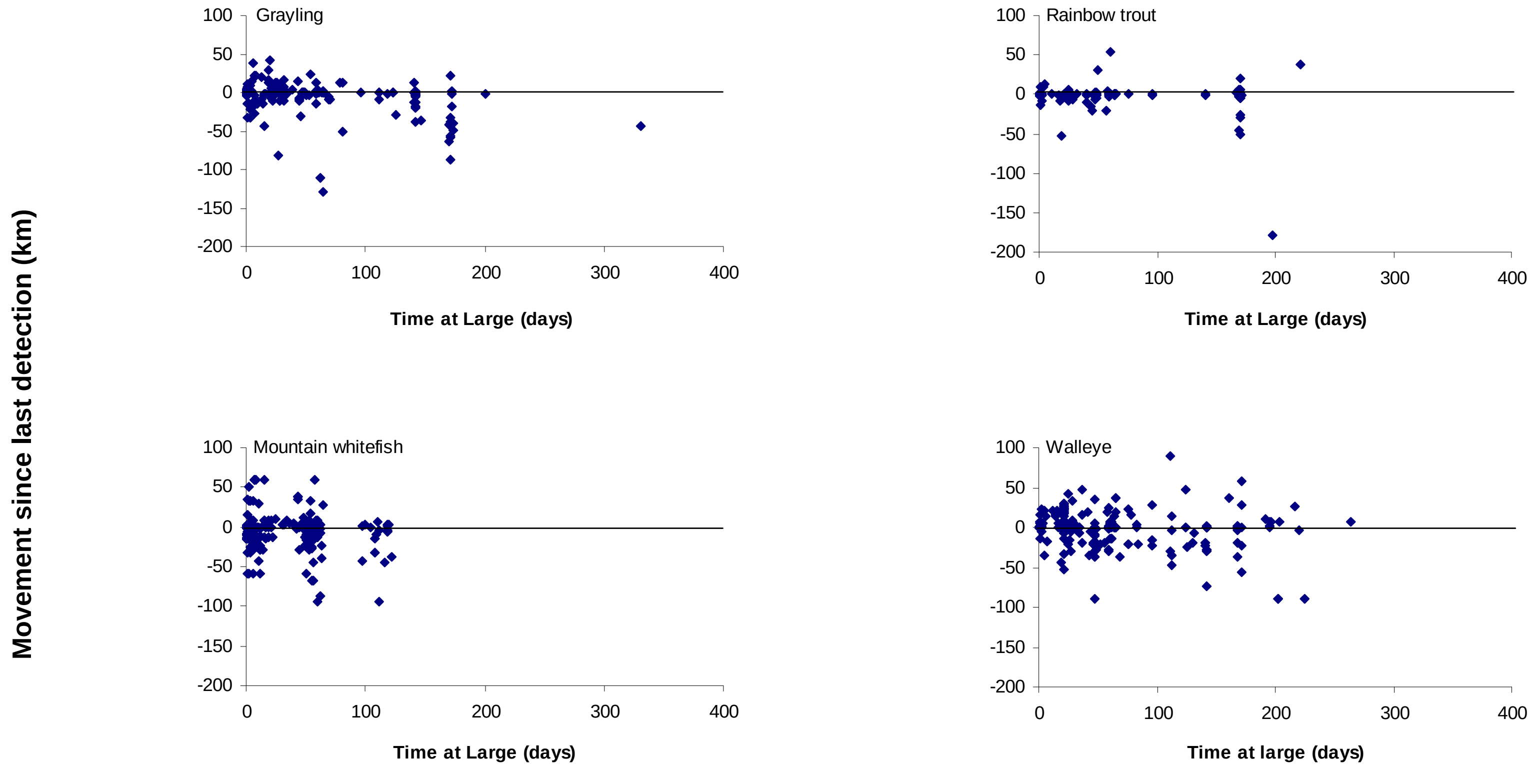

Figure 70: ***Plots of movements since last detection of individual fish by species over the duration of study, Peace River, 2006. Upstream movements are shown as positive, downstream movements as negative, on the Y-axis***

3.5.2.6 Assessment of Fish Movement Past Site C

An estimate of the percentage of each of the tagged populations moving past Site C is presented in Figure 71. The percentage of Arctic grayling (67%) passing Site C is significantly ($P < 0.05$) greater than that of all three other study species. The percentage of mountain whitefish (34%) is significantly greater ($P < 0.05$) than that of both rainbow trout (13%) and walleye (5%). There is no statistical difference in site C passage between rainbow trout and walleye.

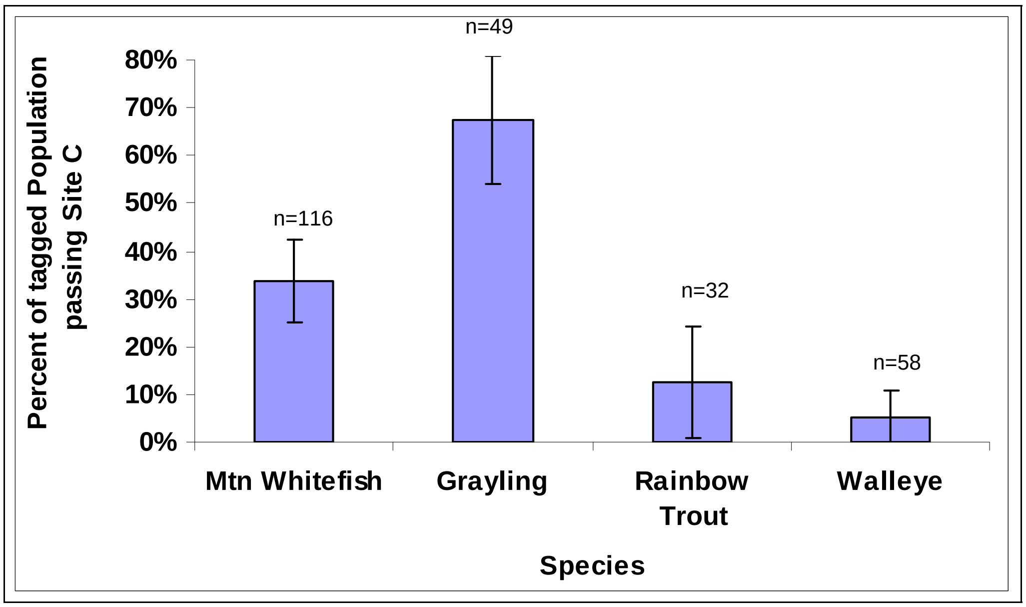

Figure 71: ***Percentage of tagged population by species moving past Site C (based on release, fixed station, and mobile tracking data), Peace River, 2006. The error bars reflect SE of the mean and are not related to the statistical test used***

Some movement of fish past Site C was recorded in all months (Figure 72), although the largest numbers of fish were in the area from May to July. Large numbers of Arctic grayling movements were missed in February and March. These fish were tagged and released upstream of Site C (Cache Creek and Lynx Creek) in September 2005, passed the fixed-station before it was installed, and were first detected downstream of Site C during mobile surveys in the early winter of 2006. Walleye detections were infrequent and limited to the period from May to August. The numbers of rainbow trout detected in the area were similar among months in which movement was detected. The lack of pre-June detections of mountain whitefish is an artefact of the sampling program: all whitefish were released in June 2006, and were therefore not available to be detected in any prior month.

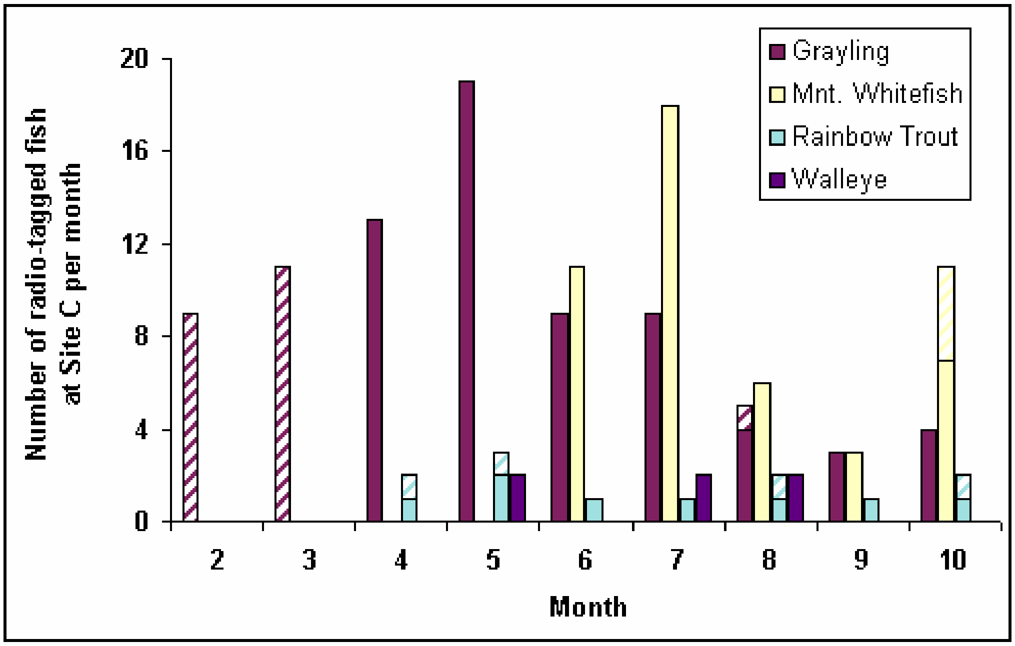

Figure 72 ***Number of radio-tagged fish detected at or moving past the fixed-station receiver near Site C, by species and by month. The hatched areas represent fish that moved past Site C without being detected on the fixed-station receiver.***

4.0 DISCUSSION

The discussion below is divided into five sections. These include:

- A synthesis of the results of the spring hoop netting and summer juvenile rearing surveys, and the first year of tracking of radio-tagged fish in the Peace River to describe what was learned regarding the utilization of Peace River tributaries by Peace River fish.
- A discussion of movements of walleye, mountain whitefish, Arctic grayling, and rainbow trout in the Peace River mainstem based on the first year results of the Peace River radio telemetry program.
- An assessment of the habitat utilization by rearing juveniles in the Peace River tributaries.
- An assessment of the effectiveness of hoop nets to monitor spring spawning runs and the feasibility and likely effectiveness of larval drift nets to help identify critical spawning areas in Peace River tributaries.
- A discussion of the limitations of the 2006 hoop netting, juvenile rearing, and radio telemetry studies.

4.1 Fish Utilization of Peace River Tributaries

4.1.1 Sportfish

4.1.1.1 Arctic Grayling

Arctic grayling spawn and rear in the Moberly River and the Moberly River likely contributes more to the annual recruitment of the Peace River Arctic grayling population than any other tributary upstream of the proposed Site C dam. In 2006, adult and ripe Arctic grayling were captured moving into the Moberly River in spring and young-of-the-year Arctic grayling were captured in summer, albeit in low numbers (< 3 fish). Adult Arctic grayling were not captured in any other tributary in spring 2006 and young-of-the-years were not captured in any other tributary in summer. These results are similar to previous studies which found the largest numbers of Arctic grayling moving into the Moberly River in spring than in any other Peace River tributary (ARL, 1991b; RRCS, 1978). Small upstream movements of Arctic grayling have also been previously observed in Farrell, Lynx, and Maurice creeks (RRCS, 1978). The absence of Arctic grayling in the hoop net catches in spring 2006 may be due to fish moving upstream during the early spring freshet which occurred one month before hoop nets were installed in May. While we cannot say definitively that Arctic grayling spawning did not occur in any of these smaller tributaries in 2006, the absence of adult Arctic grayling in the spring electrofishing surveys and the absence of young-of-the-years in summer suggests strongly that these creeks were not used extensively by the Peace River Arctic grayling population, if they were used at all.

A young-of-the-year Arctic grayling was captured in the upper reach of the Moberly River indicating that some Arctic grayling spawning occurs above the zone of inundation. It is unclear whether this fish was a progeny of upstream migrants from the Peace River or from a resident population that may exist in the Moberly River. However, the movement of two radio-tagged adult Arctic grayling into the upper reach of the Moberly River in May suggests that some portion of the Peace River Arctic grayling population utilizes spawning and rearing habitat in the upper reach of the Moberly River each year. The presence of young-of-the-year Arctic grayling in the lower reach of the Moberly River suggests that Arctic grayling may also spawn below the zone of inundation. Suitable spawning habitat is present in this lower reach (AMEC and LGL, 2006a) but it is also possible that these fish may be spawned in the upper reach then drift downstream before finding suitable rearing habitat. Given that these YOY fish were found approximately 8 km downstream from the line of normal reservoir operation, this seems less likely than if they were spawned in the lower reach.

A resident population of Arctic grayling exists in the upper Halfway River and is known to spawn and rear in upper Halfway River tributaries (ARL 1997). Tracking results from radio-tagged Arctic grayling in the upper Halfway River suggest that most of these fish remain in the upper Halfway River year-round and very few move downstream to the Peace River (AMEC and LGL, 2006b). Although the hoop net in the Halfway River was fishing only a small portion of the river, and was not fishing for the entire spring sampling period, the absence of Arctic grayling in the spring hoop net catch and the observation that no radio-tagged Arctic grayling moved from the Peace River into the Halfway River in 2006 suggests that the Halfway River is probably not an important spawning tributary for Arctic grayling in the Peace River. Initial radio-telemetry data indicate that the Pine River may be utilized more by Peace River Arctic grayling than the Halfway River.

4.1.1.2 Bull Trout

Few bull trout moved into tributaries in spring, which was not unexpected given that bull trout are fall spawners and are generally rare in the Peace River. Most of the bull trout captured (8 of 11 fish) were juveniles moving into Lynx and Maurice creeks, suggesting that both creeks provide rearing habitat for bull trout. The single bull trout in the Halfway River was a large (581 mm) adult. Bull trout have been captured previously in the Halfway River (RRCS, 1978; ARL, 1991; R.L.&L., 1991a,b; AMEC and LGL, 2006b) and as the radio telemetry program conducted by the BC Ministry of Environment (AMEC and LGL, 2006b) has shown, the Halfway River appears to support a population of bull trout that moves between the Halfway and Peace Rivers for spawning and overwintering.

4.1.1.3 Burbot

The movement of 11 burbot into the Halfway River in spring 2006 was surprising given that burbot are relatively rare in the Peace River and because burbot spawn in mid-winter (Scott and Crossman, 1973) and had finished spawning before hoop net were installed. Burbot have been captured previously in the Halfway River as well as in the Moberly River and Lynx Creek (RRCS, 1978; ARL, 1991a; AMEC and LGL, 2006a) but always in low numbers. The upstream movement of burbot observed in the Halfway River in spring 2006 may represent a foraging migration or localized movements of burbot concentrated near the Peace River/Halfway River confluence.

4.1.1.4 Mountain Whitefish

Young-of-the-year mountain whitefish were captured in the Moberly River, and in Cache, Farrell, Lynx, and Maurice creeks in summer 2006 indicating that mountain whitefish successfully spawned in each of these tributaries in fall 2005. Young-of-the-year mountain whitefish were captured in greatest numbers in Lynx and Maurice Creeks in 2006. The utilization of these tributaries by spawning mountain whitefish is supported by previous studies which found mountain whitefish to be the most common large-bodied fish species observed in fall in the Moberly River, the Halfway River, Cache Creek, Lynx Creek, and Maurice Creek in fall 2005 (AMEC and LGL, 2006a) and in the Moberly River in fall of 1989 (ARL, 1991a) and in Farrell and Lynx creeks in fall 1974 (RRCS, 1978). The purpose of the movement of adult mountain whitefish into the Moberly River in spring 2006 is unclear but may be movement of foraging fish.

Mountain whitefish YOY were captured in the lower reach, below the line of inundation, in Lynx, and Maurice creeks and in the Moberly River in 2006. These fish could have been spawned in the lower reach or may have drifted downstream after hatching in the upper reach of each of these tributaries. This is less likely to have occurred in the Moberly River given that the lower reach sampling sites were located approximately 8 km downstream from the line of inundation. The only YOY mountain whitefish captured in Farrell Creek was found in the upper reach indicating that some portion of the mountain whitefish population spawn above the potential upstream limit of the proposed Site C reservoir in that creek.

The contribution of smaller Peace River tributaries (i.e., Lynx, Farrell, Maurice, and Cache) to the annual recruitment of the Peace River mountain whitefish population is likely to be highly dependent on flow conditions. In July 2006, most of the YOY mountain whitefish captured in the smaller creeks were found in isolated pools and were unable to drift downstream to the Peace River. Water temperatures in these pools were often well above 20°C in July and, although none of these creeks were monitored after the end of July, it is highly probable that most, if not all, of these fish died due to high water temperatures and continued entrapment in the pools due to low water levels until freeze-up (based on hydrographs in the Moberly and Halfway Rivers). It is unknown what percentage of the total number of YOY mountain whitefish in each creek drifted downstream before low flows precluded out-migration to the Peace River in 2006.

The Halfway River is used by mountain whitefish for spawning and may contribute substantially to the annual recruitment to the Peace River population. Large numbers of spawning mountain whitefish were found in the Halfway River in fall 1989 and the highest numbers of larval mountain whitefish were found downstream of the Halfway River in the Peace River the following spring/summer (R.L. & L., 1991a, b). Low numbers of larval mountain whitefish were found throughout the Peace River mainstem in summer and fall during small fish surveys conducted in 2000 (R.L. & L., 2001). Despite these low numbers, mountain whitefish continue to be the most abundant sportfish in the Peace River. This suggests strongly that mountain whitefish in the Peace River rely heavily on recruitment from tributaries (R.L., & L., 2001) and in particular, the Halfway River. Preliminary tracking data from radio-tagged fish supports the importance of the Halfway River to mountain whitefish. Although based on a short tracking period, a large number (62) of detections of radio-tagged mountain whitefish occurred near the mouth of the Halfway River and 13 detections were made in the Halfway River itself, including the detection of five fish as far as 50 km upstream at the confluence of the Graham River (possible movement of predatory bull trout). These data suggest that mountain whitefish use the upper tributaries of the Halfway River for spawning although capture of young-of-the-year fish has yet to confirm this contention. It is currently unknown what contribution the Pine River makes to the Peace River mountain whitefish population. Three radio-tagged mountain whitefish moved into the Pine River in 2006.

4.1.1.5 Rainbow Trout

In spring 2006, rainbow trout were the second most common sportfish captured in the tributaries and were found almost exclusively in Maurice, Lynx, and Farrell creeks, the three creeks closest to the Peace Canyon Dam. Although no young-of-the-year rainbow trout were captured in summer 2006, spent rainbow trout have been previously captured in Lynx Creek and in Maurice Creek (ARL, 1991b) indicating that both creeks are used by rainbow trout for spawning. Juvenile (1+) rainbow trout were captured in Lynx and Maurice Creeks in summer 2006. This concentration of rainbow trout in the upper Peace River is supported by the first year of radio-tagging data which found that most tagged rainbow trout remained upstream of the Halfway River throughout 2006.

The 2006 data are similar to previous surveys which found rainbow trout to be most abundant in Lynx and Maurice Creeks where they were often found to be the most abundant large-bodied fish species captured. Most (90%) of rainbow trout captured in fall 2005 were found in Lynx and Maurice Creeks (AMEC and LGL, 2006a). Similarly, large numbers of young-of-the-year and juvenile rainbow trout were found in Lynx and Maurice Creeks in fall of 1989 (ARL, 1991a). Density of juvenile rainbow trout was higher in Maurice Creek (30 fish/100 m^2) than in Lynx Creek (7 fish/100 m^2) but absolute numbers were higher in Lynx Creek (86 fish) than in Maurice Creek (34 fish) (ARL, 1991a). A resident population of rainbow trout is believed to be present in Lynx Creek above the canyon section approximately 4 km upstream from the creek mouth and in Brenot Creek, a Lynx Creek tributary (RRCS, 1978).

4.1.1.6 Walleye

Walleye were not captured in any Peace River tributary during spring and summer sampling in 2006. This result is not unexpected because walleye are known to be found primarily downstream of the Pine River confluence (R.L. & L., 1991a, b; R.L. & L., 2001; P & E, 2002; Mainstream Aquatics 2004, 2005, 2006) and become increasingly more abundant in moving downstream into Alberta (Hillebrand, 1990; R.L. & L., 2000). Walleye were not captured in any of the tributaries sampled upstream of the Pine River in fall 2005 (AMEC and LGL, 2006a), or between 1974 and 1977 (RRCS, 1978). A pair of spawned out adult walleye were captured in Farrell Creek in spring 1989 (ARL 1991a) but it is unclear where these fish spawned. Based on evidence from all other surveys and the current radio telemetry program, it is far more likely that these fish spawned in the Beatton River and then moved upstream to Farrell Creek rather than actually spawning in Farrell Creek.

The Beatton River appears to be the primary spawning location for walleye in the Peace River upstream of the BC/Alberta border. Approximately half of the radio-tagged walleye had moved into the Beatton River in May, presumably to spawn, and some of these walleye had moved as much as 20 km upstream. Most of these fish had moved back to the Peace River by June and were either located at the mouth or had moved downstream of the Beatton River, some as far downstream as Dunvegan, Alberta.

4.1.2 Non-Sportfish

4.1.2.1 Longnose Sucker

In 2006, longnose sucker were the most common fish captured moving into all of the Peace River tributaries sampled with the exception of the Moberly River where it was second only to northern pikeminnow. Most of these fish were mature or ripe adults and these data, combined with the presence of large numbers of young-of-the-year longnose sucker in summer, indicate that longnose sucker spawn in all tributaries upstream of the proposed Site C dam. The current findings are similar to previous studies which also found spawning longnose sucker to be the most abundant fish species captured in Lynx and Maurice creek fish fences in spring 1990 (ARL, 1991b) and in all tributaries sampled between 1974 and 1977 (RRCS, 1978). Juvenile longnose sucker were typically the first or second most abundant fish captured in spring and fall electrofishing and beach seine surveys in 1989 and 1990 (ARL, 1991a, b).

Young-of-the-year longnose suckers were found in all habitat types in the upper and lower reaches of the Moberly River in summer of 2006 but were found in significantly higher abundance in the upper reach. These data indicate that longnose sucker spawn above and below the normal proposed operating level of the Site C reservoir. While the difference in abundance between upper and lower reaches may be confounded by slight but potentially important differences in habitat sampled (e.g., greater pool depth in the lower reach), the greater abundance of YOY longnose sucker in the upper reach suggests that more longnose sucker spawning occurs above the zone of inundation. This argument is made stronger when the effect of downstream drift of larval fish should increase the abundance of YOY longnose sucker in downstream reaches. Additional years of juvenile rearing sampling are needed to confirm this contention. A larval drift survey with drift traps located at different locations in the Moberly River would be best to determine the most likely spawning locations.

Young-of-the-year longnose sucker were also captured above the normal operating level of Site C reservoir in Cache, Farrell, Lynx, and Maurice Creeks. This included the presence of YOY longnose sucker in Red Creek, an upstream tributary of Cache Creek. Much greater numbers of YOY longnose suckers were captured in Cache and Farrell creeks than in Lynx or Maurice creeks. High numbers of YOY and juvenile longnose sucker were captured in Lynx and Maurice creeks in June 1990 (ARL, 1991b).

Despite high numbers of YOY captured, it is likely that the contribution of smaller Peace River tributaries, especially Farrell and Cache, to the annual recruitment of the Peace River for longnose sucker population is highly dependent on flow conditions. In July 2006, most of the YOY longnose suckers captured in the smaller creeks were found in isolated pools and were unable to drift downstream to the Peace River. Water temperatures in these pools were often well above 20°C in July and, although none of these creeks were monitored after the end of July, it is highly probable that many of these fish died due to extreme water temperatures and continued entrapment in the pools due to low water levels until freeze-up (based on hydrographs in the Moberly and Halfway Rivers). It is unknown what percentage of the total number of YOY longnose suckers in each creek drifted downstream before low flows precluded out-migration to the Peace River in 2006.

4.1.2.2 Northern Pikeminnow

In spring, northern pikeminnow move into all the study tributaries to spawn. The number was highest (>25) in the Moberly River, Halfway River, and Farrell Creek. Many of the fish captured in these tributaries in spring 2006 were ripe adults suggesting that the hoop netting survey was conducted near the peak of the spawning runs. Young-of-the-year northern pikeminnow were captured only in Farrell Creek during summer juvenile surveys and provide the only positive confirmation that northern pikeminnow successfully spawned in any of the Peace River tributaries. Smaller movements of northern pikeminnow occurred in Cache and Lynx creeks in spring 2006.

Northern pikeminnow (formerly northern squawfish) were previously captured moving upstream in Lynx Creek in spring 1990 (ARL, 1991b) and in similar numbers to that observed during the current study. Northern pikeminnow were not captured in Maurice Creek in spring 1990 (ARL, 1991b).

4.1.2.3 Redside Shiner

Upstream migrations of redside shiner in Cache, Lynx, and Farrell creeks and in the Halfway River were observed in spring 2006. Many of these fish were in spawning colors and the timing of their movements coincided with water temperatures appropriate to initiate spawning. In addition, YOY redside shiners were captured in Farrell and Cache creeks. Redside shiners were captured in Cache Farrell, Lynx, and Maurice creeks in spring 1989 (ARL, 1991a) and were the most abundant minnow species captured in the Moberly River and in Farrell Creek in fall 1989 (ARL, 1991a). Only two redside shiners were captured in Lynx creek in spring 1990 (ARL, 1991b).

4.1.2.4 Spottail Shiner

A single spottail shiner was captured in the Halfway River in 2006. Spottail shiner is a red listed species in British Columbia meaning they are at risk of extirpation and/or critically imperiled. This species has not been recorded in the Halfway River or any other Peace River tributaries in previous studies (AMEC & LGL 2006a, ARL 1991a, b; R.L. & L., 1991a, b; RRSC 1978). They were also absent from the Peace River mainstem in 1989 and 1990 (R.L. & L., 1991a, b). However, spottail shiner were found in all four zones of the Peace River mainstem (upstream of Maurice Creek; between Lynx Creek and Farrell Creek; between the Halfway River and Cache Creek; and between the Beatton and Kiskatinaw Rivers) sampled in 1999 (R.L. & L., 2001).

4.2 Fish Movements in the Peace River

It is premature to draw any firm conclusions about the movements of the tagged sportfish populations in the Peace River system with only one year of radio-tagged fish tracking completed. However, some generalities can be made with reasonable confidence for those movements which are similar to movements found in previous studies.

Rainbow trout moved relatively little overall in the Peace River and were generally found upstream of the Halfway River. A small number of tagged rainbow trout moved downstream as far as the Beatton River but it is unclear at this time whether these fish represented a real downstream migration or were dead fish drifting downstream or fish eaten by another species. Similar to rainbow trout, Arctic grayling moved very little in the Peace River mainstem and movements were generally concentrated between the Halfway and Pine rivers. Our findings to date on the movement of rainbow trout and Arctic grayling in the Peace River are similar to those of R.L. & L (1991a, 1991b), who reported that the rainbow trout and Arctic grayling populations appeared to make only localized movements and were generally located in similar reaches of the river.

R.L. & L. (1991a, b) reported that a portion of the mountain whitefish population underwent a spawning migration from the Peace River mainstem into the Halfway River in autumn. To date we have only four months of tracking of radio-tagged mountain whitefish in the Peace River and more definitive results will not be available until next year. However, five mountain whitefish tagged in the Peace River moved into the Halfway River in August, some as far as 50 km upstream to the confluence of the Graham River. While it is possible that these fish were eaten by bull trout that are known to migrate to headwater tributaries of the Halfway River in fall to spawn, these fish corroborate R.L. & L.'s (1991a, b) earlier results and suggest strongly that a portion of the Peace River mountain whitefish population use the Halfway River for spawning.

Mountain whitefish appear to move less than walleye, rainbow trout, or Arctic grayling in the Peace River. This species appears to make only localized movements (mean of 2 km) within the Peace River mainstem with most fish located between Farrell Creek and Beatton River. Ongoing mark and recapture studies of the Peace River mountain whitefish population during late summer for the Large River Fish Indexing Program (P & E, 2002; Mainstream Aquatics 2004, 2005, 2006) also suggest that mountain whitefish do not move considerable distances between years (B Gazey, pers. comm.).

Preliminary radio telemetry results appear to corroborate the previously documented upstream movement of walleye from the mouth of the Beatton River to the mouth of the Moberly River in summer. Most of the radio-tagged walleye remained in the vicinity of the Beatton River or moved downstream to Alberta. However, three walleye were detected at the mouth of the Moberly River in May 2006 and had moved upstream sometime between fall 2005 when they were tagged and spring 2006 when they were detected. A similar upstream movement of walleye was observed in 1989 when four Floy-tagged walleye were recaptured in the mouth of the Moberly River in summer (R.L. & L., 1991a). All walleye which exhibited upstream movement in 1989 and 1990 were originally tagged at the mouth of the Beatton River and the average distance traveled by these fish was 30 km (R.L. & L., 1991b). The two spawned-out walleye found in Farrell Creek in 1989 (ARL, 1991a) suggests that some walleye migrate up to 100 km in the Peace River. This migration appears to reverse in fall as a number of walleye tagged at the Moberly River and at Farrell Creek in summer were then recaptured at the Beatton in fall (R.L. & L., 1991a, b). The purpose of this upstream migration is unclear but is likely a foraging migration of post-spawned fish moving to the

Moberly River mouth to feed on congregations of spawning Arctic grayling, longnose sucker, and smaller minnows. Regardless of its purpose, these data confirm that a small portion of the walleye population at the Beatton River move upstream past the proposed Site C dam and it is very likely that this movement occurs every year. The current radio telemetry data provide no evidence of walleye migrating upstream further than the Moberly River.

Radio telemetry results from February tracking indicate that none of the walleye, Arctic grayling, or rainbow trout moved upstream from where they were tagged in September 2005. With the exceptions of a single Arctic grayling in the Pine River, and several walleye in the Beatton River near the mouth, all fish remained in the Peace River mainstem during the winter. Most of the tagged fish were still in the Peace River mainstem in March and April, which is expected because the tributaries were still frozen over in March. The only exception is an Arctic grayling that moved into the Pine River between the February and March tracks and this fish was followed by two more Arctic grayling into the Pine River in May, one as far upstream as the Murray River confluence. Spawning Arctic grayling move soon after ice-out and the movement of these fish suggest that some Arctic grayling that overwinter in the Peace River use the Pine River and its tributaries for spawning. It remains unclear what portion of the Arctic grayling population that overwinter in the Peace River is comprised of Pine River migrants and whether genetically discrete populations of Arctic grayling exist in the Peace and Pine Rivers.

The most notable movement detected in spring was walleye moving into the Beatton River in early May. These fish were captured, tagged and released mainly within the vicinity of the Beatton River mouth in September 2005 where they appear to remain congregated until their migration upstream to spawn. By June, most walleye had returned to the Peace mainstem with a large proportion (50% of detected individuals on June 20) found moving out of the Beatton and some as far downstream as Dunvegan, Alberta, a distance of 115 km. Walleye begin to congregate again at the Beatton River mouth by August and by late October, many of the walleye that have moved downstream as far as Alberta returned, presumably to overwinter. From autumn through to spring, a large proportion of the radio-tagged walleye population was found holding in the vicinity of the Beatton River mouth. Most of the walleye tagged in 1989 and 1990 were recovered from the mouth of the Beatton River (71% of tag returns) which reflects the importance of this habitat to walleye, and also to the high degree of sampling intensity in this area (R.L. & L., 1991b). Similarly, 94% of all walleye captured for tagging in fall 2005, were found in the Peace River reach between the Pine and Beatton rivers (AMEC and LGL, 2006a).

Besides the three Arctic grayling that moved into the Moberly River and the four Arctic grayling that moved into the Pine River in spring, we are currently not able to say where most of the tagged Arctic grayling spawn. Most of the radio-tagged population remained in the Peace mainstem but were not observed congregating in any particular location in spring. Some of these tagged fish may have moved into other tributaries to spawn as fewer tagged Arctic grayling were detected in the Peace River mainstem in May and June than in earlier and later surveys. These movements may have gone undetected because our mobile tracking surveys occurred only once a month in spring and because installation of the fixed station receivers did not occur until the second week of April. Arctic grayling are known to move soon after ice break-up in some systems (Tripp and McCart 1974, Blackman 2002, and others). Therefore, because the initial spring run-off began in late March in 2006, it is entirely possible that a number of these tagged fish moved into the tributaries, spawned, and moved back to the Peace River between mobile tracking flights and before fixed stations were installed. It is also possible that these fish did not spawn in spring 2006 due to the stress of being implanted with radio-tags the previous fall.

4.3 Larval Drift Netting Feasibility

Larval drift netting could be an important part of future fish utilization studies in the Peace River tributaries because it can provide more conclusive evidence regarding the location of spawning areas than can the capture of adults in hoop nets and juvenile electrofishing in summer. However, larval drift netting can be very labour intensive if the amount of drifting debris and the species diversity of drifting fish in the tributaries is high. High debris loads substantially increase the amount of time necessary to sort through the debris to find larval fish. The amount of debris captured in the nets can be minimized by reducing the net soak times but this also reduces the probability of catching fish. Most larval fish drift at night so it is optimal to set nets overnight or at least during the early evening or early morning. Large numbers of different species can make identification and enumeration of fish difficult and time consuming. This is especially true if there are numerous species from different families of fish (e.g., suckers and minnows) present and spawning in the streams. For these reasons, one of the objectives of the 2006 study was to determine the level of effort required, the feasibility, and likely effectiveness of running a spring larval drift program in the Peace River tributaries.

Although based on relatively few individual net sets, results from the 2006 pilot study indicate that larval drift nets were effective at catching larval fish in the Peace River tributaries and that the time required to sort through debris and find larval fish was relatively short. Larval fish were only found in Maurice and Farrell creeks but the absence of larval fish in the drift nets set in Lynx and Cache creeks and in the Halfway River does not necessarily, indicate that the nets were ineffective in these other tributaries. Nets were set only twice in these tributaries, usually for less than 6 hours, and never overnight. Therefore, the probability of catching fish in these tributaries was very small. In the Halfway River, this probability was even smaller as it was not possible to set nets in the thalweg of the river. Fishing multiple nets over the duration of the spring freshet recession would increase the probability of catching fish considerably.

Debris levels were lowest in Maurice Creek and nets could be fished efficiently overnight. Debris levels were higher in the other four tributaries and it is less likely that drift nets could be set overnight in these tributaries without nets blowing out or, at a minimum, significantly reducing fishing efficiency. As with any larval drift program, the duration of soak times in all of the tributaries would need to be monitored continuously and adjusted as necessary to balance fishing efficiency with logistical constraints posed by increasing net check frequency.

The Halfway River and the Moberly River pose additional constraints to a larval drift program due to their greater depth and width and higher discharges. While it may be impossible to ever fish larval drift nets in the thalweg of either river in spring, this net still may capture larval fish and gather important information regarding the species of fish using this tributaries for spawning, the timing of outmigrations, and the location of spawning sites. This is because the number of larval fish drifting downstream is typically very large and the likelihood of fish being captured in nets even along the periphery of the rivers is high.

Drift nets in 2006 were set at the end of the hoop netting program on the receding limb of the spring freshet. Spring flows in 2006 were lower than the 10 year average. Drift nets could be set earlier as water levels rose and peaked in future years but the ability to fish nets in the thalweg, where larval fish are most likely to drift, throughout the spring freshet in higher flow years is likely to be challenging. As mentioned above for the Halfway and Moberly rivers, higher flows will limit the proportion of the channel and the locations that can be sampled with larval drift nets. Although difficult to maintain nets in the thalweg, larval drift nets remain a useful method for Peace River tributary studies in higher flow years because larval drift nets provide the best indication of spawning success and spawning site locations for different species using the tributaries for spawning. Larval fish tend to drift in high numbers once hatched and, even if fishing efficiency is lower than optimal, the presence of even small numbers of larval fish can provide information that answers both of these objectives.

In summary, based on 2006 flows, larval drift netting is a feasible and effective method that has the potential to determine the spawning success and spawning locations for species utilizing Peace River tributaries. Most importantly however, larval drift nets, if used at different locations in each tributary, can provide much more definitive evidence regarding the spawning site locations. This will be particularly important for the impact assessment for Site C dam because the dam has the potential to inundate the lower reaches of tributaries known to be used by Peace River fish for spawning.

4.4 Juvenile Rearing Habitat

Two objectives of the summer juvenile rearing program were to determine if there were any differences in the density of juvenile fish in different habitat types (e.g, runs, riffles, pools) and to determine if there were any differences in the density of juvenile fish above and below the proposed normal operating water level of the Site C reservoir in each upstream tributary.

Initially, triple pass electrofishing surveys were proposed to compare the density of juveniles among habitat types and locations. However in the field, flow conditions and the incredibly high number of YOY minnows and cyprinids made triple-pass surveys challenging. During analysis of the triple pass data, it was determined that the assumptions of the triple pass density estimates were often violated (Zippin 1958), so habitat and site comparisons in this study were mostly based on the catch-per-unit-effort abundance estimates from single pass electrofishing.

In general, fish were more abundant in runs and least abundant in riffles, although habitat use by species varied among tributaries. In Farrell Creek, the abundance of fish was consistently highest in runs for all the sucker and minnow species. In Lynx Creek, juvenile longnose suckers and northern pikeminnow were significantly more abundant in pools than in runs or riffles. In contrast, there were no significant differences in the abundance of any species by habitat type or reach in Cache and Maurice creeks. In the Moberly River, longnose dace and slimy sculpin were significantly more abundant in riffles than in pools or runs. Most notably, young-of-the-year longnose sucker were found in all tributaries sampled and in those tributaries where their density was highest (i.e., Cache Creek, Farrell Creek), YOY suckers were found in all three habitat types in relatively equal abundance. Water levels in Cache and Farrell creeks were so low that fish were highly concentrations in any available habitat.

In most tributaries, there was no significant difference in the abundance of fish captured between upper and lower reaches. The only exceptions to this were, in Moberly River, where habitats in the abundance of YOY suckers was significantly higher in the upper reach than in the lower reach, and in Farrell Creek, where YOY suckers, longnose dace, lake chub and northern pikeminnow were all significantly more abundant in the lower reach than in the upper reach. Sample sizes for the sportfish and sculpin species were too small to draw meaningful comparison among habitat types, between reaches, and among tributaries.

The abundance of juvenile fish in the Moberly River was lower than the other tributaries and was primarily due to the relative paucity of YOY suckers and minnows in comparison to the other creeks. There are three probable reasons for this difference in summer CPUE between the Moberly River and the smaller creeks. First, and probably most important, all of the sites sampled in the Moberly River had flow and, unlike many of the sites sampled in the smaller tributaries, did not include isolated pools which tended to concentrate fish in summer. Second, the Moberly River is much larger than any of the other creeks sampled and, therefore, its pools were deeper and its runs and riffles had higher velocities making sampling less effective. Third, the deeper, faster flowing water precluded the use of block nets. For these reasons, it is not surprising that CPUE was lower in the Moberly River than in the smaller creeks and a comparison between the Moberly River and the other creeks may be misleading.

The Moberly River had the highest species diversity of any tributary sampled. This higher diversity is likely related to differences in flow between the Moberly River and the creeks in two ways. First, the large size and flow of the Moberly River likely creates a greater diversity of habitats, including a number of unique habitats (i.e. backwaters and sidechannels) that are not present in the smaller tributaries. Summer flows in the Moberly River maintains, or only slightly reduces, this diversity of habitats. In 2006, the availability of different habitats was severely restricted in the smaller creeks and it was often difficult or impossible to find enough sites of each habitat type to sample. Second, water temperatures in the isolated pools and runs in the creeks were generally always greater than 25°C during the July survey and these temperatures (and associated oxygen concentrations) were likely too high for many species, particularly juvenile salmonids such as Arctic grayling or mountain whitefish. Water temperatures were high (>20°C) in the Moberly River in summer 2006 as well, but the ability of fish to find refuge in deeper pools and runs was greater. Flow conditions in the spring and summer of 2006 were particularly low in comparison to the past 10 years and it is possible that habitat diversity may be greater and the frequency of isolated pools with extreme water temperatures may be lower in the creeks in wetter years.

Young-of-the-year lake chub were the only species found in the isolated pools of Wilder Creek in summer 2006. It is unlikely that many of these fish would have survived the summer as water temperatures likely exceeded 25°C in these pools and water levels only continued to recede until freeze-up preventing downstream escapement.

Large numbers of adults moving upstream in spring coupled with the huge numbers of YOY fish observed in summer provide clear evidence that Cache Creek provides important spawning and rearing habitat for longnose suckers and many minnow species, primarily redside shiner, northern pikeminnow, and longnose dace. The habitat in this tributary is not well suited for salmonid spawning because clean gravel is rare (AMEC & LGL 2006a) so it is not surprising that salmonids were not captured moving upstream to spawn during the spring. However, small numbers of YOY mountain whitefish were collected in the lower reach of Cache Creek in spring and summer. All of these YOY fish were collected in the lower reach suggesting they either drifted downstream from the upper reach to the lower reach, they were spawned in the lower reach or they moved into Cache Creek from the Peace River mainstem.

Cache Creek had extremely low flow at the time of the summer survey and most of these fish were captured in isolated pools. It is expected that the overall recruitment of YOY from Cache Creek is limited by high water temperatures and low flow. The percentage of the total 2006 year class in Cache Creek that moved downstream to the Peace River before or after the low water period in July is unknown.

It was not possible to access areas of Red Creek above the inundation level because of the presence of a very large beaver dam. However, given the size and obvious longevity of the dam, it is likely that this dam is and has been acting as a temporary barrier to upstream movement of fish in Red Creek. Below the beaver dam, Red Creek had a lower abundance of fish than in upper Cache Creek however the species composition was similar. Young-of-the-year suckers were captured in Red Creek which indicates that adult suckers moved at least 4 km up Cache Creek to spawn in Red Creek.

Like Cache Creek, Farrell Creek had large numbers of YOY suckers and minnows suggesting that it is an important tributary for the production of these species in the Peace River. Significantly more fish were captured in the lower reach of Farrell Creek than the upper reach for most species present. However, one mountain whitefish was captured in a pool in the upper reach indicating that some mountain whitefish spawn in Farrell Creek above the potential zone of inundation. The abundance of YOY suckers was significantly higher in the lower reach of Farrell Creek than in the upper reach and this suggests that adults prefer to spawn closer to the mouth of Farrell Creek or that YOY suckers are drifting downstream and prefer to rear in the lower reach. Farrell Creek had extremely low flow at the time of the summer survey and many of these fish were captured in isolated pools. It is unknown what percentage of the total 2006 year class of fish spawning in Farrell Creek managed to escape downstream to the Peace River before July.

In Lynx Creek, YOY longnose suckers and northern pikeminnow were significantly more abundant in pools than in other habitat types and longnose suckers were similarly abundant in upper and lower reaches. There were no significant differences in abundance of any other species present between habitat types. Three of the four juvenile rainbow trout captured in Lynx Creek were in riffle habitats in the lower reach while the fourth was found in an upper reach pool. None of these fish were young-of-the-year (at least 1+) so it is unclear where in Lynx Creek rainbow trout spawned in the spring. All 18 YOY mountain whitefish were captured in the lower reach. While it is unknown if any of these fish drifted downstream from the upstream reach or moved upstream from the Peace River, the absence of YOY mountain whitefish from the upper reach suggests that most mountain whitefish spawning occurs within the lower reach of Lynx Creek.

In Maurice Creek, there were no significant differences in habitat utilization for any species. All species were captured in all habitat types sampled. Young-of-the-year mountain whitefish were captured but, despite the presence of ripe rainbow trout moving into Maurice Creek in spring, no young-of-the-year rainbow trout were captured in summer (only juveniles >94 mm were found). The construction and operation of Site C dam would not inundate any habitat in Maurice Creek not already affected by fluctuating water levels in the Peace River due to operation of Peace Canyon Dam.

4.5 Limitations of the 2006 Study

4.5.1 Flow Conditions

Flow conditions in 2006 were abnormal and this may have influenced the abundance, distribution, and species composition of fish utilizing the Peace River tributaries for spawning and rearing. Based on comparison of hydrographs in the Moberly River, spring and summer flows in the tributaries were similar to the last decade’s lowest flow year. Species composition and abundance of adult spawning runs in spring and abundance and distribution of juveniles in the tributaries in summer should, therefore, be considered representative of a low water year. The effect of the low spring freshet on the abundance of juveniles in the tributaries in summer may also be significant.

4.5.2 Hoop Nets

Hoop nets were used for the first time to capture spring spawning fish in the Peace River tributaries in 2006. This technique captured a high diversity of species and additional backpack electrofishing demonstrated that the hoop nets did not miss any upstream migrations of any large-bodied spring spawning fishes in any of the tributaries, at least during May when the hoop nets were installed. Differences in the hoop net and electrofishing catches in spring were mostly related to gear selectivity.

In the smaller creeks, hoop nets covered the entire stream channel for most of the spring sampling period and there were few days when the nets could not be checked or nets were blown out due to high water. As a result, hoop netting data in the creeks represents, as closely as possible, the species composition and magnitude of the 2006 spring spawning migrations during the period nets were fished. In contrast, hoop nets in the Moberly and Halfway rivers typically covered less than 25% of the stream channel and nets could never be set in the thalweg where most fish are likely to swim. High spring flows in the Moberly and Halfway rivers also caused nets to blow out or go unchecked for a number of days until water levels receded or until an additional net could be installed. As a result of these limitations, many fish may have swum upstream undetected in both rivers. It was never believed that hoop nets would be able to sample the entire channel in either the Halfway or Moberly rivers and the passing of a high proportion of the upstream migrations was expected. Instead, hoop nets were installed only to provide an indication of the timing, species composition, and relative magnitude of the runs, not absolute numbers. This limitation of hoop netting in these rivers is only mentioned here to provide the reader with context if making comparisons between tributaries and to past studies and future sampling in the Peace River tributaries.

Despite these limitations, hoop nets were an effective sampling technique in the Peace River tributaries in 2006 and are probably the best sampling option for enumeration of spring and fall spawning runs in the Peace River tributaries upstream of Site C dam. In the past, fish fences and beach seines were used in Peace River tributaries to determine fish spawning populations (ARL 1991a, b). Hoop net sampling has the advantage over both of these techniques because hoop nets can be easily maintained and moved in comparison to fish fences which blew out repeatedly on Lynx and Maurice creeks in 1990 due to high debris and silt loads (ARL 1991b) and can provide an indication of the direction and magnitude of spawning migrations which beach seining or backpack electrofishing generally cannot.

4.5.3 Electrofishing

Limitations of the summer electrofishing surveys in the Peace River tributaries were primarily related to the low flow levels during sampling. As mentioned previously, low flows in the smaller tributaries limited the availability of habitat and caused YOY fish to become trapped in isolated pools in many of the creeks sampled. These fish may have been concentrated in much higher densities than would occur in these creeks in years with higher flows. If so, CPUE of many species captured in these creeks may be aberrantly high. The high numbers of YOY fish also made Zippin depletion estimates in each habitat type difficult in the creeks because it was never apparent if depletion had been achieved for a particular species in the field until samples were analyzed in the laboratory. Finally, low flows may have also forced juvenile fish to distribute themselves within the available habitat rather than in their preferred rearing habitat. Habitat utilizations observed in 2006 may, therefore, be biased.

4.5.4 Radio Telemetry

All radio telemetry programs have a number of inherent limitations and assumptions, which typically include:

- The limitation of realistically tagging only a small number of adult fish which are then assumed to represent the movements of the greater untagged population.
- The assumption that tagged fish are behaving in a similar manner to untagged fish (i.e., capture, surgeries and holding procedures impart only a short-term [one week to one month] behavioural change).
- The potentially confounding effect of noise from other sources of radio waves can be filtered (e.g., hydroelectric facilities, other tagged wildlife).
- The assumption that mortalities can be detected over time and filtered out of the data set to avoid biasing data interpretation.
- The assumption that the species tagged actually make movements of sufficient length, magnitude (i.e., numbers of fish), and duration to be detected on the spatial and temporal scales of the tracking program design.
- The limitation of radio signals to be detected from fish in greater than 10 m of water.

The effect of most assumptions and limitations of radio telemetry on data quality and interpretation can be minimized by having clear objectives, a well thought-out study design, and a rigorous data quality control and assurance protocol. All of these factors have been adequately addressed for the Peace River radio telemetry study. For the Peace River study, the objectives of the radio telemetry program were clear: 1) determine the timing, direction, distance traveled, and relative magnitude of migrations of rainbow trout, Arctic grayling, mountain whitefish, and walleye in the Peace River; 2) determine if any of these species move into Peace River tributaries at any time during the year; and 3) determine if any migrations involve obligatory movements past the proposed Site C dam site.

Study design aspects to meet these objectives and to reduce the effect of these limitations and assumption for the current Peace River radio telemetry program included: 1) tagging and tracking the four fish species most likely to make migrations in the Peace River past Site C dam (excluding bull trout); 2) maximizing the number of tags implanted in each of the four species in approximate proportion to their abundance in the river; 3) distributing tags in approximate proportion to the natural distribution of each fish species in the river; 4) tagging fish when river conditions maximized survival rates (with the exception of July 2006 when water temperatures were high); 5) using only highly experienced personnel for tag implantation; 6) holding tagged fish for a minimum of 20 minutes before release; and 7) combining monthly aerial tracks of the entire Peace River and its major tributaries from Peace Canyon Dam to Dunvegan, Alberta with data from strategically placed fixed stations on the Peace River to monitor spatial and temporal movements of tagged fish. The Peace River is rarely greater than 4 m deep and radio-tags were determined to be appropriate for use in the Peace River.

Quality control and assurance measures used during the study included biweekly downloading of fixed stations and rigorous data filtering for noise and mortalities using LGL's proven "Telemetry Manager" software.

Despite these measures, some limitations to the 2006 radio telemetry program remain. First and foremost, the 2006 data represents only the first year of tracking. Movements of tagged fish are assumed to represent movements of untagged fish and for Arctic grayling, walleye, and rainbow trout, species that had at least eight months to recover from tagging, there is little reason to believe they do not. Second, mountain whitefish were not tagged until June 2006 and have been only tracked for four months to date. Movements of mountain whitefish based on 2006 should be viewed only as preliminary until further tracking can be conducted in 2007. Third, small localized movements may have been missed if they occurred temporally between mobile tracking events and spatially between fixed stations. The effect of this limitation on assessing movements past Site C was eliminated by having a fixed station at the mouth of the Moberly River, approximately 500 m upstream from the proposed dam site. Fourth, the rate of fish movements upstream or downstream in the river could not be determined because fish were generally not making unidirectional movements (as do Pacific salmon). This limitation is not seen as important however because determining the rate of movement in the river was not a program objective nor does it contribute information to meeting any of the program objectives. Finally, the monthly mobile tracks during the spring and the installation of fixed stations after the initial spring freshet may have precluded the detection of early movements of Arctic grayling and rainbow trout into the Peace River tributaries.

While the possibility exists that some of these limitations and assumption may have effected our interpretation of the 2006 data, it is our view that no important results drawn from the 2006 study are erroneous or biased. We would caution readers however that all conclusions regarding the movement of Arctic grayling, walleye, rainbow trout, and particularly mountain whitefish, in the Peace River will not be finalized until data from the second year of tracking has been collected and analyzed.

5.0 SUMMARY

5.1 Spring Spawning Migrations

Longnose sucker were the most abundant large-bodied fish species captured in all tributaries sampled in spring 2006, with the exception of the Moberly River where it was second. Arctic grayling were captured only in the Moberly River and included ripe adults. The presence of these fish, along with the presence of YOY Arctic grayling in the upper and lower reaches, suggests that the Moberly River is the most important spawning tributary for the Peace River Arctic grayling population. Small numbers of rainbow trout were captured moving into Maurice, Lynx, and Farrell creeks in spring. No young-of-the-year rainbow trout were captured in any of these creeks in summer but rainbow trout have been captured migrating into these creeks in previous surveys suggesting strongly that these may be the primary spawning sites for rainbow trout in this section of the Peace River. Spring spawning runs of northern pikeminnow were observed in the Moberly River, Farrell Creek, Cache Creek, and the Halfway River. A large upstream migration of redside shiner was observed in Cache Creek.

5.2 Summer Juvenile Rearing

Juvenile rearing surveys were conducted in tributaries upstream of the proposed Site C dam site between July 25 and August 2 in 2006. Young-of-the-year longnose sucker were found in all tributaries sampled and typically were the most, or second most, abundant species found. Young-of-the-year minnows were extremely abundant in Farrell and Cache creeks and were most likely redside shiners and northern pikeminnow. Young-of-the-year mountain whitefish were found the Moberly River and Farrell, Lynx, Cache, and Maurice creeks indicating that mountain whitefish successfully spawned in each of these tributaries in fall 2005. Mountain whitefish YOY were found in greatest abundance (>17 fish) in Lynx and Maurice creeks compared to the other creeks (<5).

In most tributaries, there was no significant difference in the abundance of fish captured between upper and lower reaches. The only exceptions to this were in Moberly River, where the abundance of YOY suckers was significantly higher in the upper reach than in the lower reach, and in Farrell Creek, where YOY suckers, longnose dace, and northern pikeminnow were all significantly more abundant in the lower reach than in the upper reach.

One young-of-the-year mountain whitefish was found in the upper reach of Farrell Creek. The presence of YOY mountain whitefish only in the lower reaches of the other tributaries does not confirm that mountain whitefish spawning occurs exclusively in their lower reaches. Some of these YOY mountain whitefish may have drifted downstream from spawning sites in the upper reaches. However, the presence of this one YOY mountain whitefish in Farrell Creek does confirm that mountain whitefish do spawn above the potential zone of inundation in Farrell Creek.

In general, fish were more abundant in runs and least abundant in riffles, although habitat use by species varied among tributaries. In Farrell Creek, the abundance of suckers and minnows was consistently highest in runs. In Lynx Creek, juvenile longnose suckers were significantly more abundant in pools than in runs or riffles. In contrast, there were no significant differences in the abundance of any species by habitat type or reach in Cache and Maurice creeks. Young-of-the-year longnose sucker were found in all three habitat types in relatively equal abundance in Cache and Farrell creeks, the tributaries where their abundance was greatest.

Density of juveniles was lower but species diversity was higher in the Moberly River than in the smaller tributaries in summer 2006. The lower density in the Moberly River is likely due to lower sampling efficiency in the larger water of Moberly River and to the abundance of juvenile fish trapped in the isolated pools sampled in the smaller tributaries. The higher number of species in the Moberly River is likely due to its larger size, greater diversity of habitat, and sustained summer flows.

5.3 Fish Movements in the Peace River Mainstem

A total of 49 Arctic grayling, 58 walleye, 32 rainbow trout and 116 mountain whitefish were radio-tagged in fall 2005 and spring 2006.

Most rainbow trout made only small (<10 km), localized movements and were generally located upstream of the Halfway River. Median distance moved by Arctic grayling was 17 km and most of the movements were confined to the reach between the Halfway and Pine rivers. As a result of these movements and distribution, 67% of tagged Arctic grayling past by the proposed Site C dam site during the 2006 tracking period, the most of any of the four tagged fish species. Similar distribution and movements of rainbow trout and Arctic grayling were documented in previous studies.

Six mountain whitefish moved up the Halfway River in August and three of these fish moved as far as 50 km upstream to the confluence of the Graham River. While these results are based on only four months of tracking data, the use of the Halfway River by mountain whitefish for spawning has been previously documented and the movement of radio-tagged fish moving into the Halfway River in late summer 2006 suggests that these fish were likely part of the Peace River mountain whitefish population that uses the Halfway River for spawning.

Tagged walleye were generally limited to the Peace River downstream of the Pine River confluence, primarily in the vicinity of the Beatton River. Tagged walleye migrated into the Beatton River in May to spawn and returned to the Peace River by June. Most walleye spent the summer in the Peace River between Beatton and Pine confluences but portions of tagged walleye migrated into the Pine River (14%) or moved downstream to Alberta (9%), some as far as Dunvegan. Three walleye (5% of the tagged population) moved upstream to the mouth of the Moberly River in the summer of 2006. Similar upstream movements of walleye from the Beatton River to the mouth of the Moberly River past Site C have been documented previously and the movement of these fish likely represent a post-spawn foraging migration. Tagged walleye began to congregating back at the mouth of the Beatton River by August and included upstream and downstream migrants.

Almost all tagged Arctic grayling, rainbow trout, walleye, and mountain whitefish overwintered in the Peace River mainstem.

5.4 Evaluation of Larval Drift Nets and Hoop Nets

Hoop nets proved to be an effective method for capturing large-bodied fish species moving into the tributaries to spawn. These nets can be easily adjusted and moved to optimize catch efficiency as needed and are much less susceptible to blowing out in high waters than fish fences. In 2006, the entire stream channel could be blocked by the hoop nets for most of the spring sampling period in each of the smaller creeks. This allowed for almost uninterrupted capture of all upstream migrants during the spring sampling period. Significantly less stream channel could be covered in the Moberly and Halfway rivers but catch efficiencies were generally high enough to monitor the species composition and timing of runs in each river. Multiple upstream hoop nets in these rivers would improve catch efficiency without a substantial increase in labour requirements.

The pilot larval drift program proved that larval drift nets can be an effective and efficient technique in the Peace River tributaries. These nets can be fished for different soak times, without compromising catch efficiencies, in order to minimize sorting times depending on the debris load in each tributary. The benefit of these larval drift nets is that they provide the best indication of spawning success and spawning locations if used in multiple at different locations in the tributaries.

In years with higher water flow, fishing efficiency for both the hoop net and larval drift nets would be reduced because nets would have to be moved out of the thalweg and less of the overall stream channel would be sampled. However, these techniques would still provide useful information about species composition and general timing of spawning runs and larval drifting.

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7.0 CLOSURE

Recommendations presented herein are based on an evaluation of the findings of the fish and aquatic investigations described. If conditions other than those reported are noted during subsequent phases of the study, AMEC and/or LGL Ltd. should be notified and be given the opportunity to review and revise the current recommendations, if necessary.

This report has been prepared for the exclusive use of BC Hydro for specific application to the area within this report. Any use which a third party makes of this report, or any reliance on or decisions made based on it, are the responsibility of such third parties. AMEC and LGL Ltd. accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report. It has been prepared in accordance with generally accepted practices. No other warranty, expressed or implied, is made.

AMEC and LGL Ltd. appreciates the opportunity to assist BC Hydro with this project. If you have any questions, or require further assistance, please do not hesitate to contact the undersigned.

Respectfully Submitted,

AMEC Earth & Environmental, **a division of AMEC Americas Limited**	**LGL Limited**
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8.0 REFERENCES

Adams, N.S., D.W. Rondorf, S.D. Evans and J.E. Kelly. 1998. Effects of surgically and gastrically implanted radio transmitters on growth and feeding behaviour of juvenile chinook salmon. Trans. Am. Fish. Soc. 127:128-136.

AMEC Earth & Environmental and LGL Limited (AMEC & LGL). 2006a. Peace River fish and aquatic Investigations, 2005. A report prepared for BC Hydro Environmental Resources, Vancouver, BC.

AMEC Earth & Environmental and LGL Limited (AMEC & LGL). 2006b. Movements of radio-tagged bull trout and Arctic grayling in the upper Peace River system, 1996-99. A report prepared for BC Hydro Environmental Resources, Vancouver, BC.

Aquatic Resources Ltd (ARL). 1991a. Peace River Site C Development: Fisheries Habitat and Tributary Surveys Year 1. A report prepared for BC Hydro Environmental Resources, Vancouver, BC.

Aquatic Resources Ltd (ARL). 1991b. Peace River Site C Development: Fisheries Habitat and Tributary Surveys Year 2. A report prepared for BC Hydro Environmental Resources, Vancouver, BC.

Aquatic Resources Ltd (ARL). 1997. Bull Trout/Grayling Distribution/Temperature Synoptic Survey Peace River. A report prepared for Ministry of Environment Lands and Parks, Fort St. John, BC.

Beauchamp, D. A. 1990. Movements, Habitat Use and Spawning Strategies of Arctic Grayling in a SubAlpine Lake Tributary. Northwest Sci. 64:195-207.

Blackman, B.G. 2002. Radio telemetry studies of Arctic grayling (Thymallus arcticus) to overwinter, spawning and summer feeding areas in the Parsnip River watershed 1996-1997. Peace Williston Fish and Wildlife Compensation Program Report No. 254.

Government of British Columbia; Ministry of the Environment (BC MOE). 2006. BC species and ecosystems explorer. Website: http://srmapps.gov.bc.ca/apps/eswp/. Accessed November, 2006.

Hildebrand, L. 1990. Investigations of fish and habitat resources of the Peace River in Alberta – Volume I. Prepared for Alberta Environment, Planning Division and Alberta Fish and Wildlife Division by R. L. & L. Environmental Services Ltd., Edmonton, Alberta.

Mainstream Aquatics Ltd. 2004. Peace River Fish Community Indexing Program – Phase 3 Studies (2003). A report prepared for BC Hydro Power Supply Environmental Services, Burnaby, BC.

Mainstream Aquatics Ltd. 2005. Peace River Fish Community Indexing Program – Phase 4 Studies. A report prepared for BC Hydro.

Mainstream Aquatics Ltd. 2006. Peace River Fish Community Indexing Program – Phase 5 Studies. A report prepared for BC Hydro.

McPhail, J. D. and C.C. Lindsay. 1970. The freshwater fishes of British Columbia. The University of Alberta Press. Edmonton, AB.

Meador, M.R., J.P. McIntyre, and K.H. Pollack. 2003. Assessing the efficacy of single-pass backpack electrofishing to characterize fish community structure. Trans. Am. Fish. Soc. 132:39-46.

Lockwood, R.N. and J.C. Schneider. 2000. Stream fish population estimates by mark-and-recaptured and depletion methods. Chapter 7 in Manual of Fisheries Survey Methods II: with periodic updates (J.C. Schneider editor). Michigan Department of Natural Resources, Fisheries Division. Special Report No. 25.

P & E Environmental Consultants Ltd. 2002. Peace River Fish Community Indexing Program – Phase 1 Studies (2001). A report prepared for BC Hydro Power Supply Environmental Services, Burnaby, BC.

P & E Environmental Consultants Ltd. 2003. Peace River Fish Community Indexing Program – Phase 2 Studies (2002). A report prepared for BC Hydro Power Supply Environmental Services, Burnaby, BC.

Pottinger Gaherty Environmental Consultants Ltd. 2001. Peace River Water Use Plan. Environmental and Social Data Summary and Gap Analysis. A report prepared for BC Hydro. 135 p. + appendices.

R. L. & L. 1991a. Peace River Site C Hydroelectric Development Pre-construction fisheries studies. Fish Movements and Population Status. 1989 studies. A report prepared for BC Hydro, Environmental Resources, Vancouver, BC

R. L. & L. 1991b. Peace River Site C Hydroelectric Development Pre-construction fisheries studies. Fish Movements and Population Status. 1990 studies. A report prepared for BC Hydro, Environmental Resources, Vancouver, BC

RL & L Environmental Services Ltd. 2000 Dunvegan Hydroelectric Project Fish and Habitat Inventory Comprehensive Report Dunvegan Study Area, Peace River. A report prepared for Glacier Power Ltd.

RL & L Environmental Services Ltd. 2001. Peace River Fish Habitat Utilization Study. A report prepared for BC Hydro.

Renewable Resources Consulting Services Ltd (RRSCL). 1978. Peace River Site C Hydroelectric Development. Fish and Aquatic Environment. A report prepared for Thurber Consultants Ltd., Victoria, BC.

Scott, W.B. and E.J. Crossman. 1973. Freshwater Fishes of Canada. Fisheries Research Board of Canada. Ottawa, ON.

Tripp, D.B. and P.J. McCart. 1974. Life histories of grayling (*Thymallus arcticus*) and longnose suckers (*Catostomus catostomus*) in the Donnelly River system, Northwest Territories. Arctic Gas Biol. Rept. Ser. Volume 20, Chapter 1.

Valenius, M. 2001. Summary of Environmental and Socio-Economic Studies for the Proposed Peace River Site C Hydroelectric Project 1970-2001. A report prepared for BC Hydro. 94 p.

Water Survey of Canada, Environment Canada (WSC, EC). 2006a. Archived hydrometric data. Website:http://www.wsc.ec.gc.ca/hydat/H2O/index_e.cfm?cname=main_e.cfm. Accessed: November, 2006.

Water Survey of Canada, Environment Canada (WSC, EC). 2006b. Real-time hydrometric data. Received from Lynne Campo. November, 2006.

Zippin, C. 1958. The removal method of population estimation. Journal of Wildlife Management 22:82-90.