BC hydro

FOR GENERATIONS

Report Title: *Peace River Fisheries Investigation - Peace River and Pine River Radio Telemetry Study 2007*
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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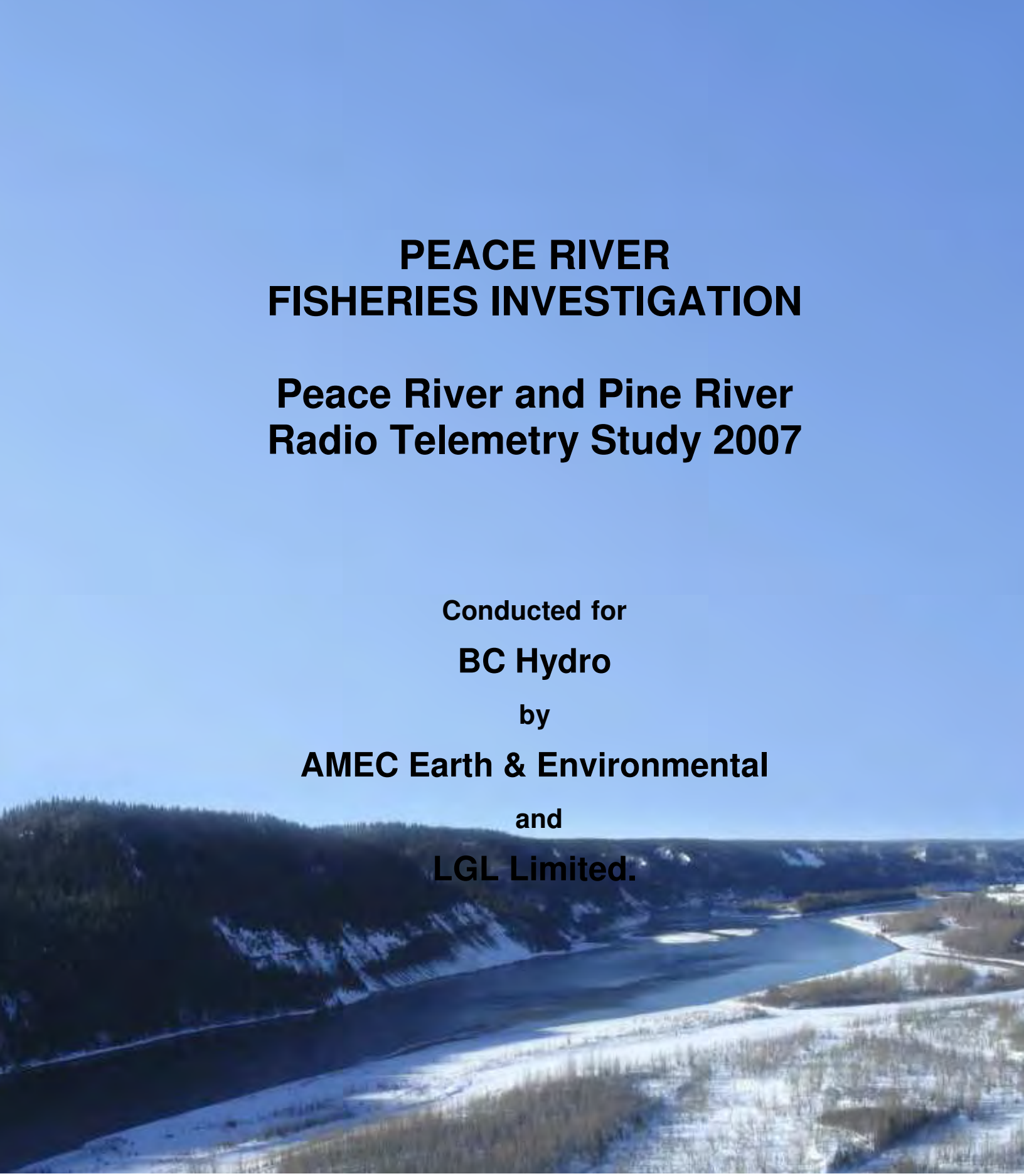
PEACE RIVER
FISHERIES INVESTIGATION

Peace River and Pine River
Radio Telemetry Study 2007



Conducted for

BC Hydro

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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. BC Hydro commissioned AMEC and LGL Ltd. in 2005 to initiate a radio telemetry study on adult large-bodied fish species in the Peace River mainstem and its tributaries. AMEC and LGL continued the radio telemetry program in 2006 and 2007 and have produced interim reports. The present report emphasizes the findings of 2007, compares them to previous results, and provides a synopsis of the results to date. The main objectives of the 2007 Peace River investigation were as follows:

1. Determine the magnitude and direction of fish movements and seasonal variability of movement in Peace River mainstem and its tributaries
2. Determine the magnitude and direction of fish movements and seasonal variability of movement past the proposed Site C location and upstream of the potential zone of inundation in the tributaries
3. Determine the utilization of the Peace River and the tributaries upstream of the Beatton River by bull trout tagged in the Pine River
4. Continue to monitor water temperatures in Peace River tributaries and the mainstem at the proposed Site C location

Between 2005 and 2007, 342 large-bodied fish were tagged in the Peace River drainage below Peace Canyon dam. A total of 116 mountain whitefish, 57 Arctic grayling, 47 rainbow trout, 58 walleye and 64 bull trout were tagged, by AMEC and LGL, Golder and Associates and BC Ministry of Environment, in these years. The majority of the tagged fish were captured, tagged and released into the Peace River mainstem. However in 2006, all of the bull trout and some Arctic grayling (14%) and rainbow trout (32%) were tagged in the Pine River system.

The movements of the radio-tagged fish were monitored from early spring through fall in 2006 and 2007 with a network of fixed-station receivers and mobile tracks. In 2007, a total of ten fixed-stations were strategically located throughout the Peace River drainage. Five fixed-stations were located in the Peace River mainstem between the Peace Canyon Dam and the Beatton River. Another five receivers were placed upstream in the following tributaries: the Halfway River at the Graham River, the Pine River at the Murray and Sukunka rivers, and the Moberly River approximately 10 km upstream from the Peace River, just above the potential zone of inundation.

In addition to monitoring the movements of the radio-tagged populations with the fixed-station receivers, 12 aerial flights were conducted between March and November to determine the location of radio-tagged fish. The flight path typically included: the Peace River mainstem from Peace Canyon Dam to Peace River, Alberta; the Halfway River to the

Graham River; the Beatton River to the Doig River; Moberly River to Moberly Lake; and, the Pine River system to the upper Burnt River. Aerial survey tracks were conducted biweekly in the spring and fall and monthly in the summer.

The key findings of the 2007 radio telemetry program, by species, are as follows:

Rainbow trout

Radio-tagged rainbow trout in the Peace River showed limited movement throughout the two-year tracking period. Rainbow trout were distributed mainly between the Peace Canyon Dam and Cache Creek, upstream of Site C, with only 1 fish (3%) moving past the proposed Site C location. The median distance moved by rainbow trout was 9 km and 7 km in 2006 and 2007, respectively. The greatest movement was observed during their spawning season (April-May). One rainbow trout detected in Maurice Creek is the only observed instance of a Peace River rainbow trout using any tributary upstream of the proposed Site C dam location in 2007.

The rainbow trout tagged in the Pine River drainage never moved downstream into the Peace River in 2007. These fish remained in the mainstem of the Pine and Sukunka rivers for the duration of the year, with the exception of 6 rainbow trout that moved into the Burnt River during the summer months.

Mountain whitefish

Throughout the 2006 and 2007 tracking periods, mountain whitefish remained widely distributed in the Peace River mainstem from the Peace Canyon Dam to Dunvegan, Alberta. In 2007, eight of the tagged mountain whitefish (8%) moved past the proposed Site C location. In the present study, the median distance moved by mountain whitefish was 20.3 km and 6.3 km in 2006 and 2007 respectively, with the movement in 2006 being almost exclusively in the downstream direction at a rate of 69 m/d. Their significantly greater displacement in 2006 is most probably related to the short recovery period after tagging (~1 month) before tracking was begun and should not be taken as representative of the movement of the untagged population.

The most mountain whitefish ever detected in the tributaries occurred in October when 11 fish (12% of those detected) were observed in the Halfway and Pine rivers. Throughout fall, a few fish were detected in the lower and upper reaches of the Halfway River and in the lower Pine River, with a slight increase in their numbers in these areas between August and October, the period when they are likely to be spawning.

Arctic grayling

Arctic grayling moved an average of 9 km with the greatest movement observed during spring. In 2007, 10 of the radio-tagged Arctic grayling (24%) moved past the proposed Site C location. The 2007 tracking results show clear evidence of several Arctic grayling moving well upstream of the potential zone of inundation in the Moberly River in spring, and then

retreating back into the Peace River mainstem in June. Arctic grayling were not detected in any of the smaller tributaries (Maurice, Lynx, Farrell, Cache creeks) upstream of Site C. Two fish were detected within the vicinity of the Beatton River mouth and one fish was detected some 20 km upstream from the mouth in May 2007 suggesting that spawning might also occur in this river.

Based on 2007 tracking results, it is very likely that Arctic grayling in the upper Pine River watershed is a resident population that remains there year round. This population showed relatively little movement from March through to October, and all fish remained in the mainstem of the upper Pine and Sukunka rivers. No tagged Arctic grayling moved from the Pine River drainage into the Peace River

Walleye

Two years of tracking has provided strong evidence on the walleye movements in the Peace River study area. This population moves extensively within and between the Peace River mainstem and major tributaries, with a well-defined spawning migration up the Beatton River in May and back out in June. Most walleye that moved up the Beatton River in spring were fish that over-wintered (October-April) within the vicinity of the Beatton River mouth. In contrast, those that did not move up the Beatton River remained mostly downstream in the Peace River mainstem, widely distributed, with some as far as Peace River, Alberta. The median distance moved by walleye was significantly greater than that of all other species in both years, being 80 km in 2006 and 118 km in 2007. Their mean monthly distance moved was sporadic, but clearly highest in spring (April-May) and autumn (September).

After spawning, walleye that were observed in the Beatton River moved from the Beatton River upstream into the Peace River mainstem to as far as the Moberly River. Several fish moved into the Pine River. In 2007, 5 walleye (10%) moved upstream past the proposed Site C location. By late October, the walleye returned to the Beatton River or to the Peace River near the Beatton River mouth.

Bull trout

Bull trout showed considerable variation in movements among radio-tagged fish in 2007. Overall, the median distance moved over the duration of the tracking period in 2007 was 51 km. In general, the mean monthly distance moved by bull trout was low from March through June (~5 km) and increased in the following months to peak in September (~30 km). Two bull trout made extensive migrations of approximately 450 km. These fish moved from the Pine River system to the upper Halfway River drainage in late summer, remained in the Halfway River system until the end of the spawning period, and then returned to the Pine River in late fall. Another two bull trout moved out of the Pine River system and upstream into the Peace River past the proposed Site C location. One of these bull trout moved to just above the mouth of Cache Creek in May and was still detected in that location during the last aerial track (November 1st). The other bull trout in the Peace River mainstem was

detected near the mouth of Tea Creek during the last track and moved towards this location after being tagged in the Wolverine River in mid-September. In total, 4 (7%) of the bull trout tagged in the Pine River drainage moved upstream past the proposed Site C location.

From the results to date, it appears that there may be two populations of bull trout radio-tagged in the Pine River drainage in 2006: one population rears and forages primarily in the Pine River system and spawns in the Burnt River and another population that forages in the Pine River, but spawns and rears (juvenile stages) in the upper Halfway River drainage.

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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

Starting in 2005, BC Hydro commissioned AMEC and LGL Ltd., to initiate long-term baseline fisheries studies to assess both new and ongoing operations. The specific objectives of the 2007 Peace River investigation, were as follows:

1. Determine late winter locations for all radio-tagged species
2. Determine magnitude and direction of fish movements and seasonal variability of these movements in the mainstem and into the tributaries
3. Determine magnitude, direction and seasonal variability of fish movements past the proposed Site C location
4. Determine the utilization of the Peace River and the tributaries upstream of the Beatton River by bull trout tagged in the Pine River
5. Determine the upstream extent of fish movements in relation to the potential zone of inundation in the tributaries with an emphasis on determining spawning locations in the Peace River tributaries
6. Continue to monitor water temperatures in Peace River tributaries and the mainstem at the proposed Site C location

1.2 Background

The proposed Site C dam has the potential to alter upstream and downstream migrations of fish through the Site C area of the Peace River. 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. The inundation of these tributaries has the potential to impact fish using these tributaries by changing the hydraulic habitat and increasing sedimentation, factors that may have an effect on species composition, abundance and distribution.

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 fish community of the Peace River 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, AMEC 2005). Based on these reviews and gap analyses, AMEC (2005) identified fisheries studies that needed to be initiated immediately by BC Hydro to address potential effects that may require long term datasets for appropriate assessment and monitoring. Two of these potential effects include the utilization of upstream tributaries by Peace River fish and the determination of how Site C dam would affect fish migrations in the Peace River mainstem. These long-term studies were initiated by AMEC and LGL in 2005 (AMEC & LGL 2006a, 2007).

Previous studies have shown that a number of large-bodied fish species in the Peace River, including bull trout (*Salvelinus confluentus*) Arctic grayling (*Thymallus arcticus*), rainbow trout (*Oncorhynchus mykiss*), mountain whitefish (*Prosopium williamsoni*), and longnose sucker (*Catostomus catostomus*), use tributaries upstream of Site C for spawning and rearing (ARL 1991a, 1991b, R.L.&L. 1991a, 1991b). Another study suggested that Peace River tributaries provide most of the annual recruitment for many large-bodied fish species in the river (P & E 2002). Despite these past studies, data gaps exist and additional information was deemed necessary 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. In 2006, AMEC and LGL completed a spring hoop net study and a summer juvenile sampling program to address a portion of these identified knowledge gaps (AMEC & LGL 2007). In addition, Mainstem Aquatics completed a small fish survey in the Peace and Halfway rivers (Mainstem 2007). The 2006 programs provided a thorough investigation of fish presence and utilization in the Peace River tributaries during that year.

Radio telemetry studies were initiated by AMEC and LGL in 2005 to consider the impact that Site C might have on migrations of large-bodied fish in the Peace River (AMEC & LGL 2006a, 2006b, 2006c, 2007). Arctic grayling, walleye, rainbow trout and mountain whitefish were radio-tagged in fall 2005 and early summer 2006.

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 location (AMEC & LGL 2006b). Movement of Pine River bull trout population between the Pine River, the Peace River, and the Halfway River is unknown. In fall 2006, Golder and Associates tagged bull trout in the Pine River system so these fish could be tracked in 2007.

An upstream movement of walleye from the Beatton River to the Moberly River was observed in 1989 and 1990 (R.L.&L. 1991a, 1991b) but the number of migrants was small and the magnitude and importance of this migration past Site C dam remained unclear prior to 2005. In 2006, most radio-tagged walleye remained in the vicinity of the Beatton River or moved downstream into Alberta (AMEC & LGL 2007). However, three walleye (5%) were detected moving past the proposed Site C location to the mouth of the Moberly River in May 2006 (AMEC & LGL 2007).

Mountain whitefish are found throughout the Peace River and are known to use the Halfway River for spawning (R.L. & L. 1991a, 1991b, 2001, P. & E. 2002). An upstream movement of mountain whitefish in the Peace River has been observed through the Large River Fish Indexing Program (P & E, 2002, 2003; Mainstream Aquatics 2004, 2005, 2006). Radio-tagged mountain whitefish in 2006 made localized movements within the Peace River mainstem, with most fish located between Farrell Creek and Beatton River (AMEC & LGL 2007). A total of 38 (34%) tagged mountain whitefish moved in either direction past the proposed Site C location in 2006 (AMEC & LGL 2007).

Arctic grayling are found principally in the reach between the Halfway and Pine rivers which includes the proposed Site C dam site. Radio-tagged Arctic grayling moved very little in the Peace River mainstem in 2006. However, movements were generally concentrated between the Halfway and Pine rivers so 31 (67%) of radio-tagged fish moved past the proposed Site C location (AMEC & LGL 2007). There were concerns that the spring spawning migrations of Arctic grayling were missed in 2006 because spring freshet was early (AMEC & LGL 2007).

Preliminary results from 2006 tracking indicated that radio-tagged rainbow trout moved relatively little in the Peace River and were generally found upstream of the Halfway River with four (15%) of the tagged fish moving past the proposed Site C location (AMEC & LGL 2007).

Movement information collected in 2006 was confounded by an early spring freshet and low flows. It was recommended that movements be confirmed over a normal flow year (AMEC & LGL 2007). In addition, 2006 tracking times limited the determination of spawning locations and the timing of spring and fall spawning movements.

1.3 Study Area

The overall study area includes the Peace River mainstem and its tributaries, extending from Peace Canyon Dam downstream to Peace River, Alberta (Figure 1).

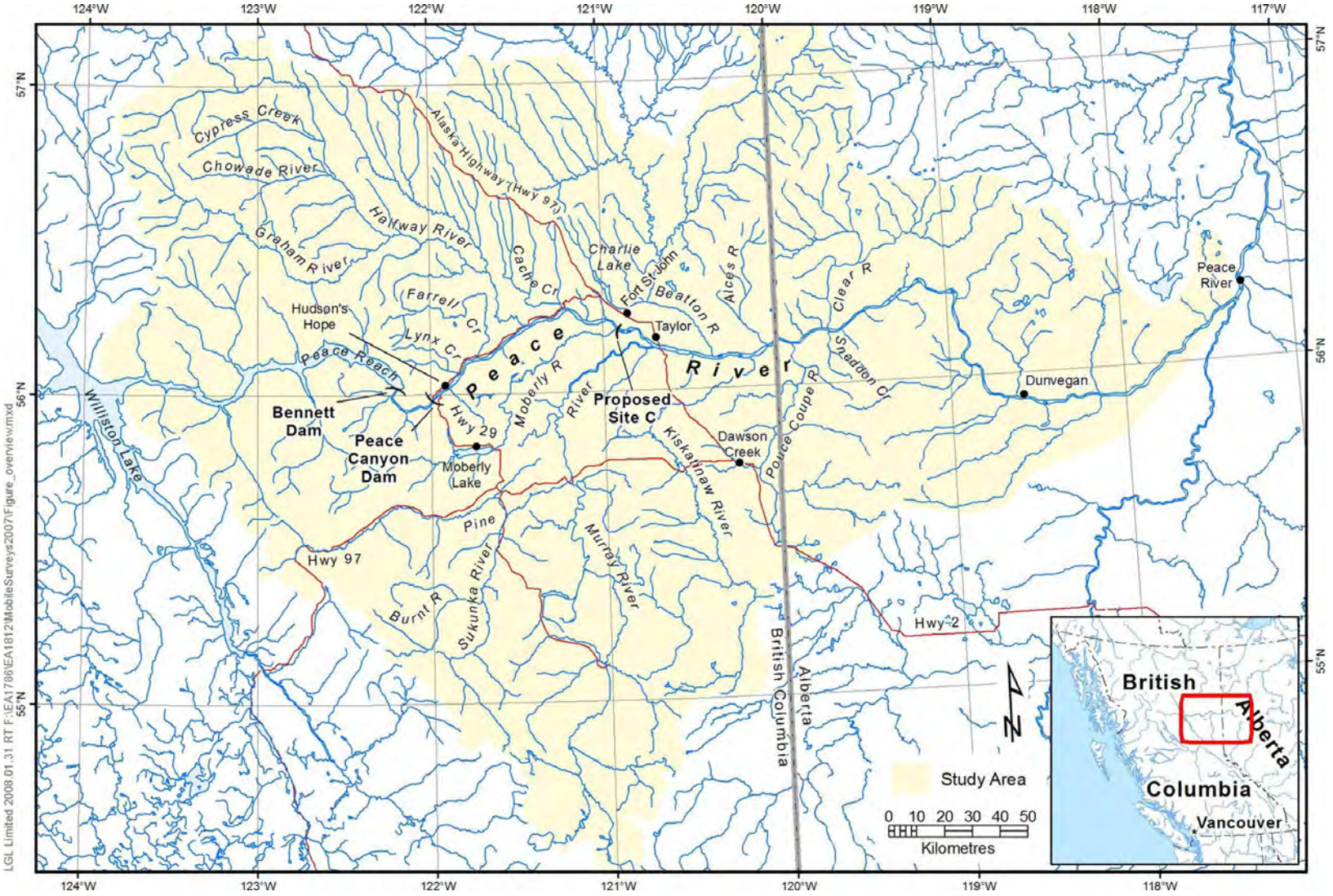


Figure 1: Peace River and its tributaries in northeast British Columbia.

The distance upstream from the proposed Site C dam site, the length potentially inundated, and the total watershed area of each upstream tributary 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: 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 Flows and Water Temperatures

Information on flow within the Peace (near Taylor, BC; station 07EF001), Pine (station 07FB001), Moberly (station 07FB008), Halfway (station 07FA006) and Beatton (07FC001) rivers was obtained from the Water Survey of Canada (WSC, EC 2007a, 2007 b; Figure 2). For each day in the year, average maximum and minimum flows over a 10 year period (1996-2005) was calculated. This was compared to the 2006 data, and when available, the 2007 flows. Most of the 2007 data was still unavailable at the time of reporting. Any 2007 data obtained from Water Survey of Canada has not been fully evaluated or calibrated by them and should be considered preliminary.

Tidbit® temperature loggers were also 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 (Figure 2). Most of the loggers were located within 1 km of the confluence with Peace River. Water temperatures were recorded every hour between deployment and download. The timing of deployment varied among sites and due to high flows and debris, some loggers were lost or needed to be moved over the course of the study (2005-2007). All temperature loggers were downloaded for the last time in fall 2007.

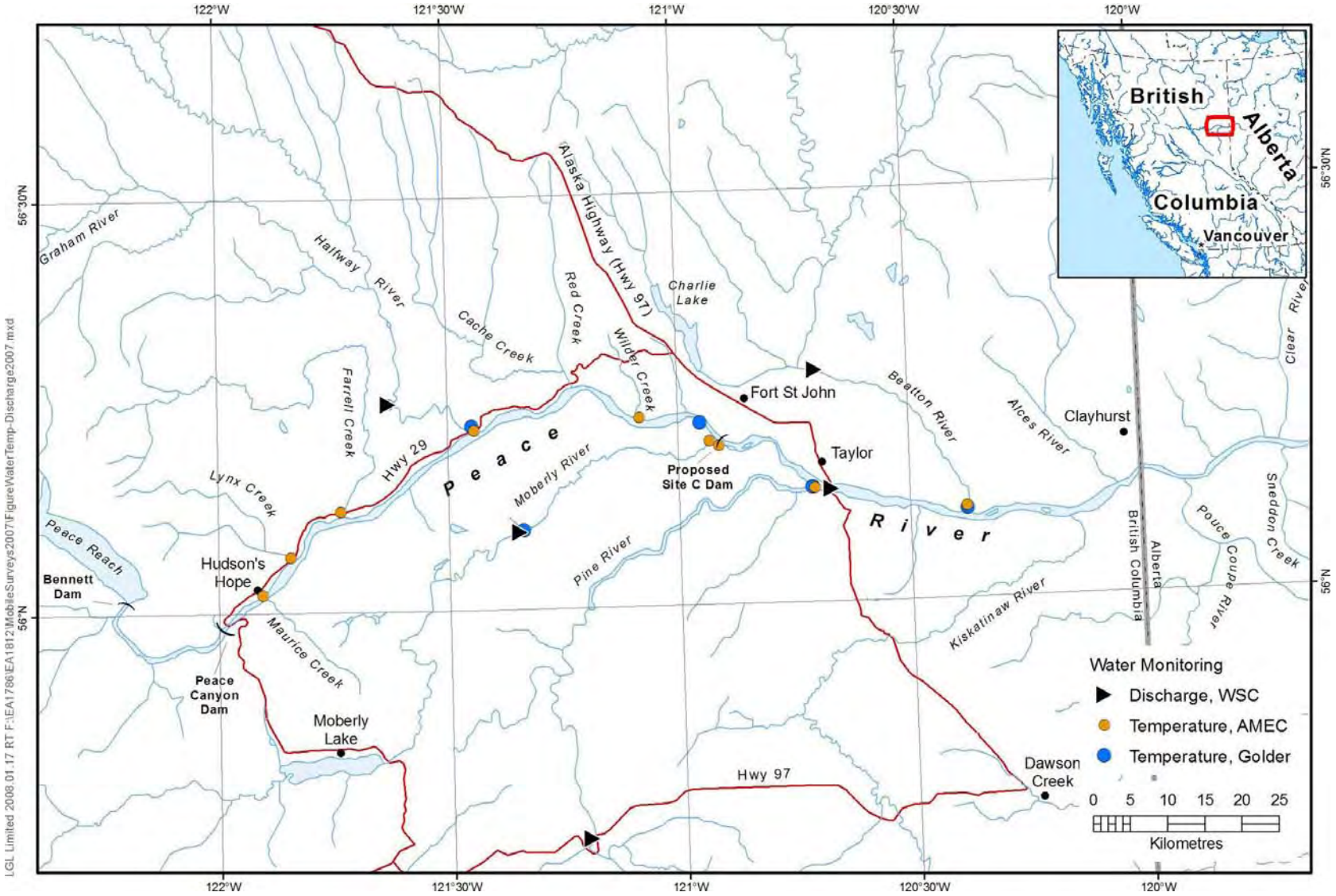


Figure 2: Temperature and discharge monitoring locations in the Peace River and its tributaries.

During high spring flows, temperature loggers in the Peace River mainstem and the Pine, Beatton and Moberly rivers were lost. In addition, our temperature logger in the Halfway River was buried by sediment in the spring and did not reflect water temperatures properly. In order to augment the missing data, Golder and Associates Inc. (Golder) provided temperature data for these locations (Figure 2). Golder deployed Hobo temperature loggers recording temperature every 15 minutes at each of these locations. Golder's loggers were installed in November 2006 or March 2007 and downloaded in spring, summer and fall 2007.

Data from all temperature loggers was carefully reviewed to ensure data quality. Daily mean, minimum and maximum water temperatures were graphed to identify any time periods where the loggers were out of water as a result of desiccation or tampering. Any time periods with suspicious data were eliminate from the data set. Daily means for the remaining data were graphed by day for 2005, 2006 and 2007.

2.2 Radio Telemetry

2.2.1 Radio Transmitters

Pulse-coded microprocessor transmitters fabricated by Lotek Engineering Inc. were used to tag fish in this study. Two transmitter sizes were used depending on the size of the fish, with both tag sizes having a 400 mm long antenna and a 3v battery to transmit a pulsed signal every 5 s (set by the manufacturer); the estimated operational life was 560 and 761 days for the small and large tags, respectively. For the smaller fish (250-400 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). For the fish tagged in 2005, both sizes of transmitters were pre-programmed by the manufacturer to become activated 20 weeks (±1 h) after the tags were implanted. For more details on the tags refer to AMEC and LGL (2007). Overall, the tags performed well over the two-year tracking period, by late September 2007 there were indications of a drop-off in detection rates for Arctic grayling, rainbow trout and walleye as tags from 2005 reached the end of their battery life.

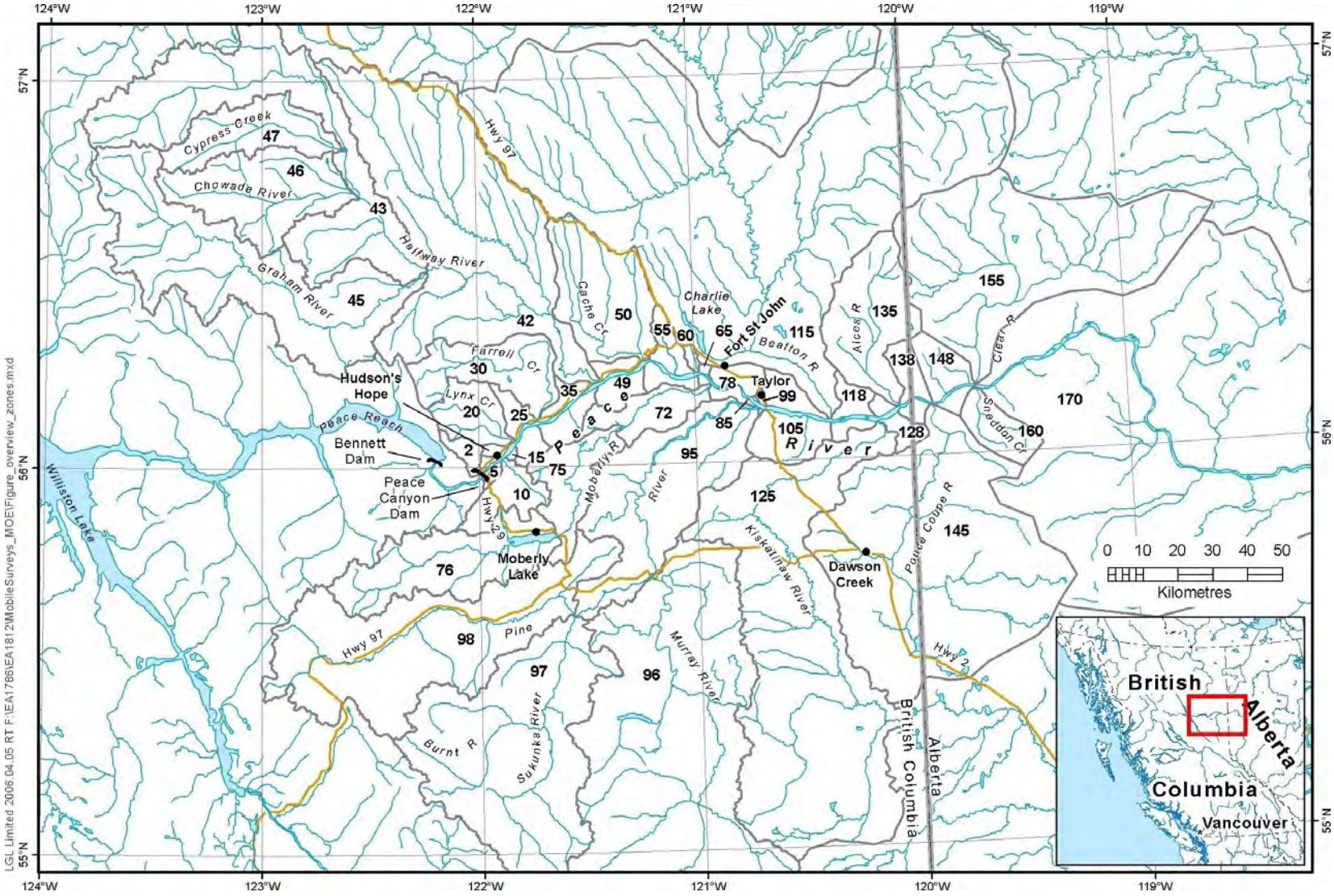


Figure 3: ***Map of upper Peace River system showing the zones of watersheds (numbered) used in fish mobile tracking***

2.2.2 Mobile Zones and Fixed-Stations

A map of the upper Peace River system showing the zones of watersheds used in mobile tracking of fish is shown in, with zones delineated as described by AMEC & LGL (2007). In addition to mobile tracking, several fixed-station receiver sites were installed to monitor fish movements totalling nine stations in 2006 and 10 in 2007. Two of the stations that were operated in 2006 were discontinued in 2007 as their detection capability overlapped with that of adjacent stations (Figure 4). Three new fixed-stations were added in 2007 at the following locations: Moberly River at the inundation line (~10 km upstream from the river mouth); Pine River at the Murray River confluence; and Pine River at the Sukunka River confluence. For details of the components at the fixed-stations and their setting up in spring and decommissioning in late autumn refer to AMEC and LGL (2007).

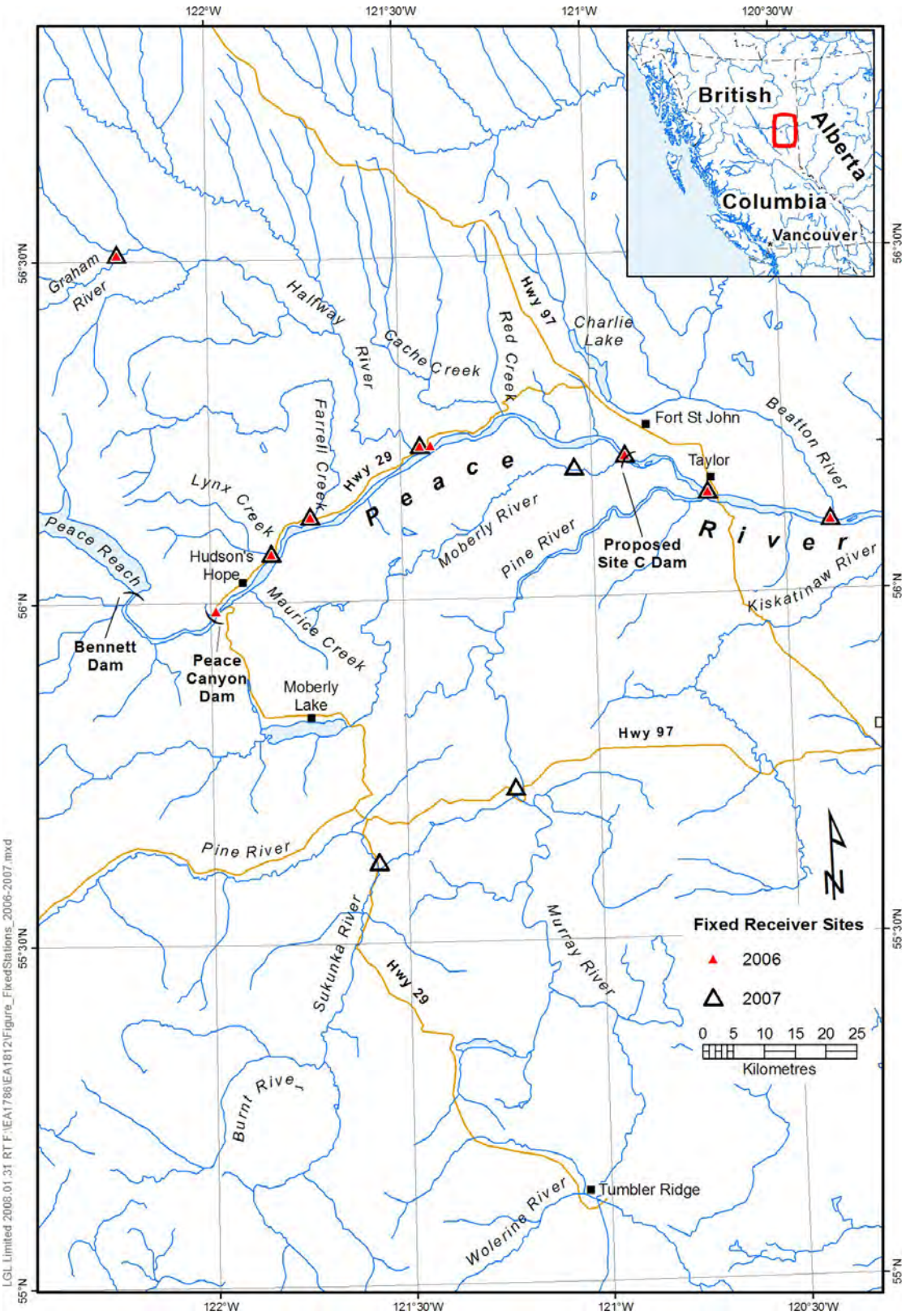


Figure 4: Location of fixed-stations in the Peace River watershed, 2006-2007

2.2.3 Fish Collection, Tagging and Releasing

The fish tracked in 2007 consisted of fish that were radio-tagged by AMEC and LGL in 2005 and 2006, as well as those tagged by Golder Associates in 2006 and MOE in 2007 (Table 2).

Table 2: Summary of all radio-tagged fish released in the upper Peace River system, 2005-2007.

Species	Number of fish			
	2005	2006	2007	Total
Mountain whitefish	0	116	0	116
Arctic grayling	39	10, 8[1]	0	57
Rainbow trout	29	3, 15[1]	0	47
Walleye	58	0	0	58
Bull trout	0	54[1]	10[2]	64
Total	126	206	10	342

Notes: [1] fish tagged by Golder Associates in the Pine River system, August-September, 2006
[2] fish tagged by MOE in Wolverine River (9) and upper Moberly River (1), July-September, 2007

Fish tagged by AMEC and LGL comprised mountain whitefish, Arctic grayling, rainbow trout and walleye, all of which were captured, tagged and released in the Peace River mainstem between the Peace Canyon Dam and the Beatton River confluence. The locations and numbers of these fish releases are shown in Figures 5 and 6; for more details on these releases refer to AMEC & LGL (2007).

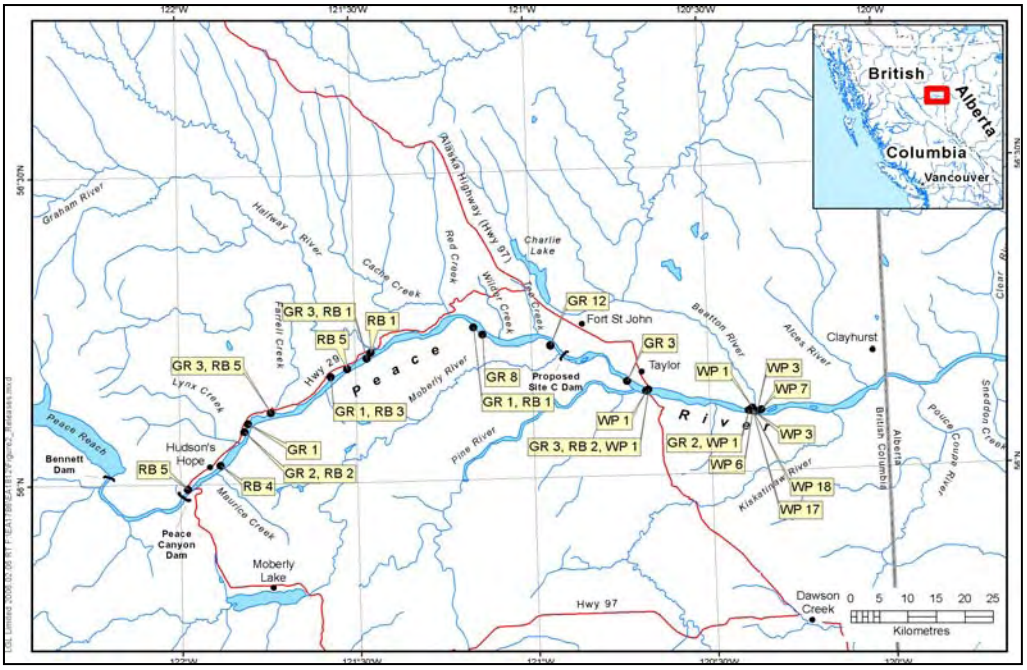


Figure 5: ***Locations and numbers of radio-tagged Arctic grayling, rainbow trout and walleye released in the Peace River mainstem, September 2005.***

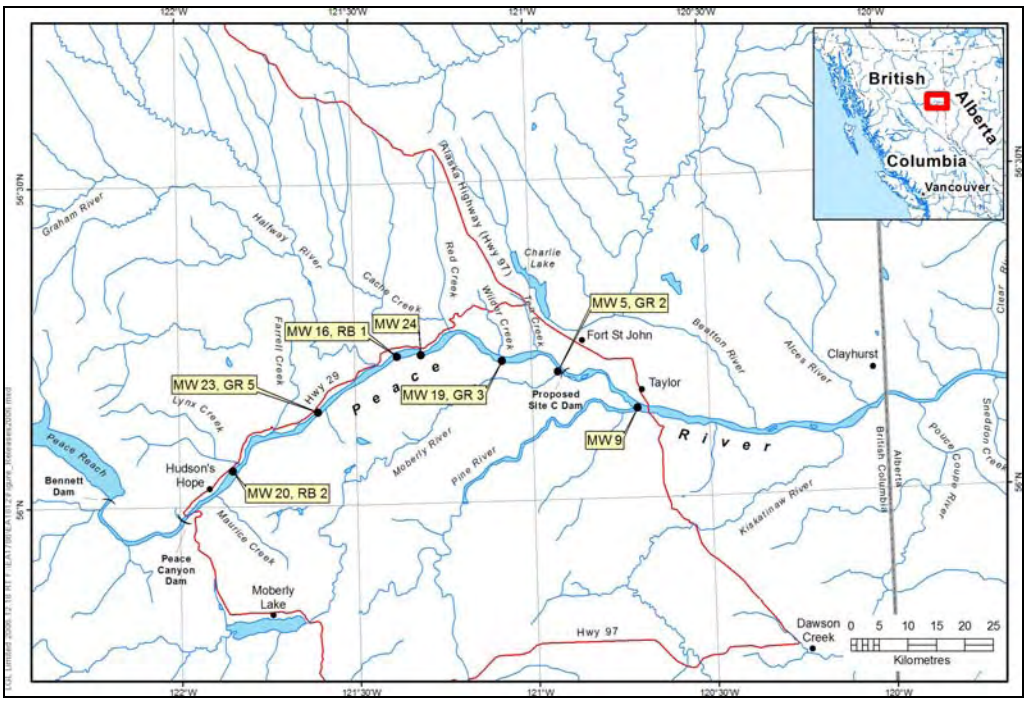


Figure 6: ***Locations and numbers of radio-tagged mountain whitefish, Arctic grayling and rainbow trout released in the Peace River mainstem, June 2006.***

Fish tagged by Golder Associates consisted of 8 Arctic grayling, 15 rainbow trout, and 54 bull trout, all of which were released in the Pine River mainstem and Burnt River (tributary to Sukunka River). Fish tagged by MOE amounted to one and nine bull trout respectively in the Moberly and Wolverine (tributary to Murray River) rivers. However, only eight of the fish in the Wolverine River could be tracked as the tag code and frequency of one fish were not recorded at the time of tagging. The locations and numbers of the fish tagged by Golder and MOE are shown in Figure 7.

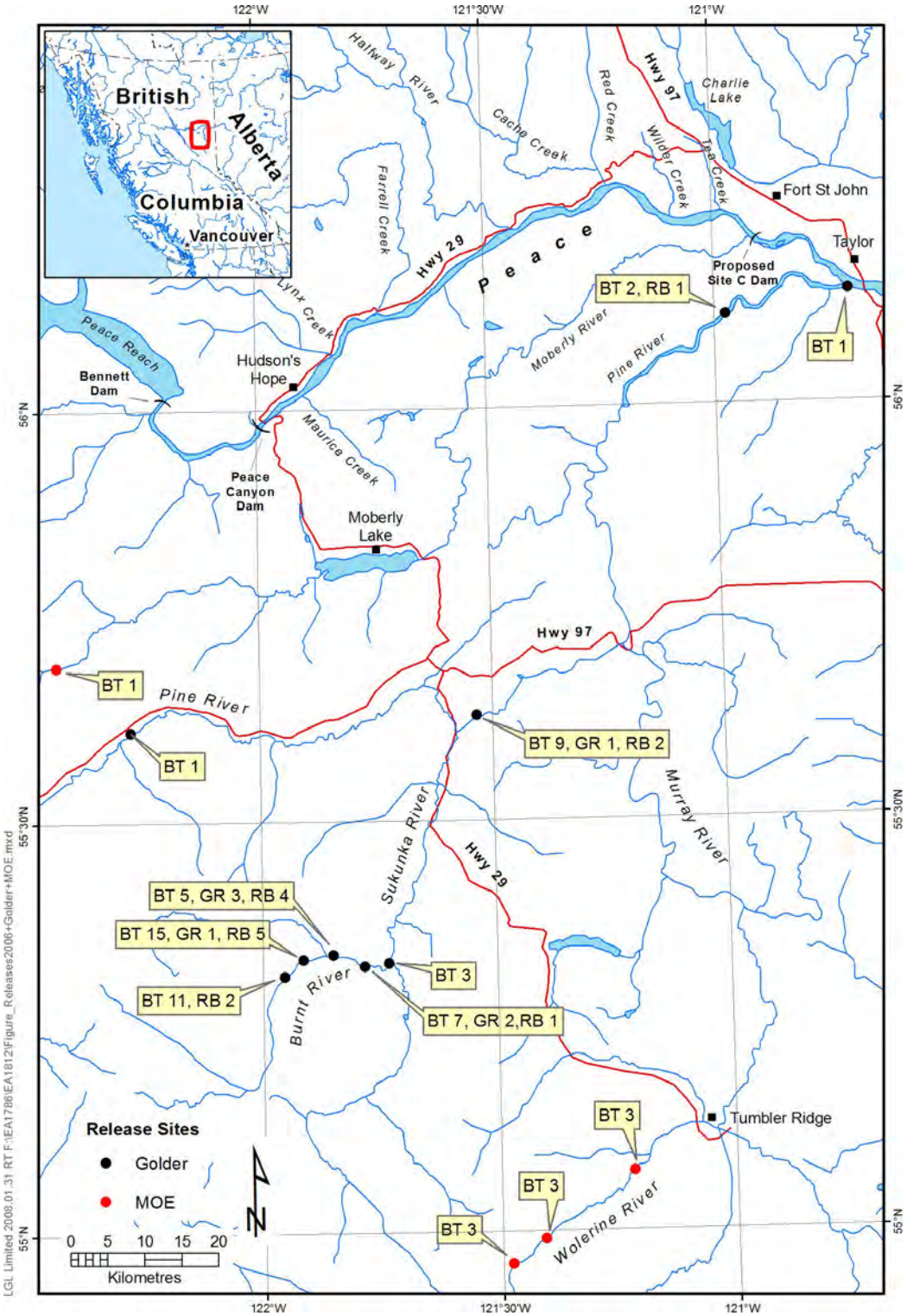


Figure 7: ***Locations and numbers of radio-tagged bull trout, Arctic grayling and rainbow trout released in the Pine River watershed and the Upper Moberly River in 2006 and 2007.***

All of the fish tagged by AMEC and LGL and Golder Associates were collected with the use of a Smith-Root electrofisher operated from a jet boat, whereas those tagged by MOE were collected by angling. Each fish was measured and implanted with a radio transmitter in the peritoneal cavity while under anaesthesia, with the antenna exiting ventrally in the caudal peduncle area and trailing posteriorly. The transmitters used by AMEC and LGL in 2005 and by Golder in 2006 had a factory-built 20-week delay after they were first activated, so that they remained inactive during the first winter; all the other tags were activated at implant. For more details on collection, tagging and releasing procedures for fish tagged in 2005 and 2006 refer to AMEC & LGL (2006a, 2007). With the exception of mountain whitefish, for which mortality during tagging operations was approximately 30%, there was no mortality. Information on tagging procedures used by MOE is not included in this report.

Fish length and weight details of the radio-tagged fish are summarized by species in Table 3. Among the five species tagged, Arctic grayling were the smallest fish tagged in terms of body length and weight.

Table 3: Summary of lengths and weights of radio-tagged fish released in the upper Peace River system, 2005-2007.

Species	N	Fork Length (mm)		Mean Weight (g)[1]
		Mean	Range	
Mountain whitefish	116	336	252-480	476
Arctic grayling	57	314	251-377	462
Rainbow trout	47	328	256-452	488
Walleye	58	416	275-574	919
Bull trout	64	456	348-684	981
Total	342			

Note: [1]Golder-tagged Arctic grayling and rainbow trout and MOE-tagged bull trout were not weighed.

2.2.4 Monitoring Fish Movement

2.2.4.1 Fixed-stations

For the 2007 monitoring period, all fixed-stations were set up in late March. As in 2006, a Lotek SRX600 receiver was installed at the Beatton River mouth (Station 110) to handle the greater number of detections expected at this location due to fish tending to congregate within this area, particularly walleye. An SRX 600 receiver was also used at Moberly River mouth (Station 70) while all other fixed-stations utilized SRX400 receivers. With the exception of the more remotely located stations (i.e, Stations 44, 720, 960

and 970), the receivers at each of the other stations were downloaded at approximately bi-weekly intervals from the beginning of April to end of October.

The downloading procedure was the same as the previous year (AMEC & LGL 2007). 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 downloaded file to ensure that all of the data had been transferred, the file was readable, and both the receiver and antennae had been operating properly. Generally, all was in good working order at all of the stations throughout the monitoring period. During 2007, on one occasion strong winds blew down the tree on which the receiver and antenna were mounted (no serious damage to equipment or loss of data were incurred) and on another occasion the antenna was blown off the tree. At all stations, the battery was checked regularly and replaced with a fully charged one as necessary.

2.2.4.2 Mobile Tracks

During 2007, a total of 12 aerial tracks of the Peace River mainstem (from the Peace Canyon Dam to Peace River, Alberta) and various tributaries were conducted from late March to early November. To improve our understanding of the movements of both spring-spawners (Arctic grayling, rainbow trout, walleye) and autumn-spawners (mountain whitefish, bull trout), mobile tracking was conducted approximately biweekly in the April-May period and September-early November period. For all other months (i.e., June, July, August), mobile tracking was conducted once monthly.

Initially, two Lotek SRX400 receivers were used in mobile tracking (as in 2006), but from 22 April onward three receivers were used on each of the flights as it was confirmed that the total number of unique detections was slightly greater (~2.5%) with the use of a third receiver. Also, improvements were made to the antennae arrangements on both the fixed wing and helicopter from those used in the previous year to maximize detection capability in fish tracking. 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 fish distribution maps. Most of the mobile surveys were done with a combination of helicopter and fixed-wing aircraft. The fixed-wing generally used for 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. The helicopter was used to track the Peace River mainstem

from the Peace Canyon Dam to the mouth of the Beatton River because this area had a high concentration of radio-tagged fish and the helicopter was able to slow down or hover over the river. To improve mobile tracks, field maps were provided of fish detections in the previous survey showing receiver channel and tag code information for each of the detections. The numbers and percentages of the tags detected for each of the 12 mobile tracks were summarized in tables. For tracks that were completed over several days, the total number of detections was combined to give a single percentage value of detections by species for each of the 12 tracks.

Typically, mobile surveys were conducted along the Peace River mainstem from the Peace Canyon Dam to Peace River, Alberta. As for the tributaries, variable distances were tracked up the Halfway, Moberly, Beatton and Pine rivers and the lower reaches of several creeks (Maurice, Lynx, Farrell, Cache). Frequently, the mobile tracks up the Halfway River extended into the headwaters to check for the presence of tagged fish in the upper reaches of this major tributary system. 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.

2.2.5 Data Processing

Telemetry Data Processing

The data from mobile tracks and fixed-station downloads were processed and analyzed using LGL's custom database software, "*Telemetry Manager*". *Telemetry Manager* facilitates data organization, record validation, and analysis through the systematic application of user-defined criteria. Raw data were archived so that the temporal or spatial resolution and noise filtering criteria could be changed by the user at any time without altering the raw data. An important aspect of radio telemetry is the removal of false records in receiver files, for example, those that arise from electronic noise. In this study, the following criteria were set for records to be considered valid:

- power levels had to be greater than 50 (on a 1 to 232 scale);
- for fixed-station data, multiple detections had to be recorded within a single zone, within 20 minutes of each other, and with no records at other zones interspersed (i.e., single records, or records separated by more than 20 minutes were rejected); and
- detections had to be recorded at zones that were geographically located between the locations of previous and subsequent valid detections.

Once false records were removed, *Telemetry Manager* created a compressed "operational" database of sequential detections for each fish. Each record included the tag number, zone number (antenna number, fixed-station number, or a general location), the first and last time and date for sequential detections in a specific zone, and the maximum power for all detections in that interval. The compressed operational database was used for all subsequent analyses of fish behaviour and survival.

Movement Calculations and Data Cleanup

The result of data processing was an operational database file containing a summary of all release and recovery information, with all valid fixed-station and mobile track detections in chronological order for each fish. For each location record in the database, UTM co-ordinates were appended. For mobile detections, the position of the fish was assumed to be that of the aircraft (downloaded from the GPS unit) at the time of the most powerful detection event. Fish detections recorded by fixed-station receivers were assigned the co-ordinates of the receiver, with the direction of movement determined from the antenna number containing the detection information. From the dataset containing sequential positions for each fish, movements, displacements and travel speeds could be calculated.

Movement distances were estimated using a Foxpro script, which either connected sequential UTM co-ordinates with a straight line, or, when sequential positions were in different zones, via a series of nodes thereby forcing the movements to approximately follow the geography of the river system. For each movement event, the start and end timestamps were used to determine the "time at large" (i.e., the duration) of the movement event. Also, the start and end positions of each movement event were used to determine if the direction of movement was upstream or downstream. On occasion, a fish would move both downstream and upstream within the same movement event (e.g., a fish detected in the Beatton River and subsequently in the Alces River had to move downstream in the Beatton River, downstream in the Peace River, and then upstream into the Alces River). In these events, the direction of the final leg of the movement was assigned to the whole of the movement. For each movement, a displacement was calculated as the magnitude of the movement multiplied by 1 for upstream movements, or by -1 for downstream movements. Displacement rates were calculated as the displacement divided by the time at large.

Once the distance, direction, and duration were calculated, invalid records became apparent. Detection sequences that made fish appear to move too quickly were examined more closely. Also, detection sequences that made

fish appear to move too far, especially without being detected by fixed-station receivers in between, were also examined. These examinations revealed that the fixed-station receivers at the mouths of the Beatton and Moberly rivers (Zones 110 and 70, respectively) were prone to error. Detections that were obviously invalid were examined for pattern, and were found to have very strong power, with "detections" every few seconds in blocks lasting only a few minutes on any given day. As such, detections were only considered valid if: 1) they lasted for longer periods of time (hours or days); or 2) if the fish was recently detected in a neighbouring area, and if weak power values were recorded at the start and end of the block of detections, indicating the movement of a fish into and out of the zone. Overall, 1305 and 482 invalid detections were removed from the Beatton and Moberly fixed-station zones, respectively.

A second issue/challenge that arose was that of simultaneous mobile and fixed-station detections. Fish that remained in the detection field of a fixed-station receiver at the time of a mobile track would show artificially high displacement rates because they would be recorded at the UTM co-ordinates of the fixed-station receiver, then instantly appear at the UTM co-ordinates of the mobile survey aircraft, and then immediately return to the UTM of the fixed-station receiver. To avoid this problem, mobile detections were ignored if they occurred simultaneously to a series of fixed-station detections.

Once all of the invalid records and artificial movements were cleared out of the database, the movement distances, directions, and durations were recalculated. For these final calculations, movement distances were estimated using ARC-GIS software. For each fish, all detection positions were plotted, and each sequential position was connected with a straight line (making *n-1* lines joining *n* detection positions). Tracking tools in the software were used to confine each of these connector-lines to within the river contours, hence taking all river-curvatures into account. Time at large, movement direction, displacement and displacement rates were all calculated using the methods as previously described. The same procedure was applied in re-analyzing the 2006 dataset so that the results between years were comparable.

All movement events, with their associated direction, displacement, time at large, and displacement rate, were linked to an individual fish (and hence a species) and a timestamp for subsequent analyses. Analyses included comparisons among species, between years and among months for displacement rates, over-winter displacement, displacement during monitoring periods, and the effects of time at large on displacement.

Basis for Tag Exclusion

Radio-tagged fish confirmed or presumed to be dead and those that were never detected were filtered from the dataset and excluded from further analysis.

Potential Mortality

From position-based telemetry data, it is not possible to determine if a fish is living or dead. A live, sedentary fish would "track" the same as a dead fish, or as an expelled tag on the riverbed. It is generally acceptable to assume, when movements are observed, that an individual is alive. For this study, tags that never changed positions were called "potential mortalities". The error associated with our method of position estimation was determined (see below), and used as the minimum movement threshold below which any observed "movements" might be spurious. Any fish that did not move a distance greater than this threshold was called a potential mortality, and was excluded from subsequent analyses.

The error associated with mobile track-derived position estimates can be expressed as a function of aircraft speed, receiver scan time, the number of scanning receivers, and the number of channels being scanned by each receiver. As an aircraft flies along the river, it is possible to detect a single tag multiple times. The strength of the tag detection is greatest when the aircraft is in close proximity to the tag, and weakens as the distance increases. In this study, the position of the fish was estimated by using the UTM co-ordinates of the aircraft at the time when the most powerful of these detections was recorded. Thus, it should be apparent that an aircraft containing a single telemetry receiver (scanning 4 channels for 6 seconds each), moving at speed, may travel a considerable distance between detections of any given tag; and the most powerful detection of a given tag may be recorded several hundred metres away from the "actual" position of the fish.

In this study, three receivers were operated onboard the aircraft. Each receiver scanned 4 channels for 6 seconds each. In the worst case scenario, in which all three receivers scanned the same channel simultaneously, there would be an 18 second interval between scans of a given channel. In the best case scenario, in which the three receivers never duplicated each other during scanning operations, the interval would be 6 seconds. The aircraft pilots were asked to travel from 70 to 80 mph, thus moving 36 m/s in the worst case and 31 m/s best case. Combined, the error bounds of the mobile track-based position estimates can be set between 188 m (in the best case) and 644 m in the worst case.

It should be noted that every effort was made to ensure that, on any given instance, the three receivers were scanning different channels. Also, when mobile tracks were conducted from a helicopter, the aircraft could slow down or hover, and fixed-wing aircrafts could circle back to do a second pass. Position error is likely to be less than that calculated above given that measures were taken to collect the most accurate position. Based on these "unquantifiable" factors, we believe that 644m is too large, and the threshold should lie closer to the best-case (188 m) scenario.

A conservative threshold, set at 350 m (double the lowest scenario), resulted in no potential mortalities in 2006, and, for 2007 potential mortalities of 0%, 2%, 3%, 3%, 7% and 0% were calculated for rainbow trout, mountain whitefish, walleye, Arctic grayling, and bull trout, respectively (Figure 8). A slightly more liberal threshold of 300 m produced almost identical mortality estimates. Based on the mobile tracking crew's efforts to pin-point fish locations, and the observed plateau in the mortality curves, it is felt that a mortality threshold of 300 m is adequate. Also, this threshold does not exceed the low movement observed in mountain whitefish (~5% of the radio-tagged population moved <400 m).

Known Mortalities

All fish (or tags) that were recovered from anglers (or found on the riverbank) and returned to us were classified as "known mortalities". These fish, together with the potential mortalities (described above) were excluded from all subsequent analyses. In total, 23 fish were excluded (Table 4) for reasons of mortality. Of these, 12 were known mortalities in 2006, and were excluded from both study years. The remaining 11 fish were known mortalities by 2007, and were excluded only from the second year of analyses. Mortality by species is summarized in Table 5.

Undetected Tags

Several tags were never detected (Table 5). These fish (10 in 2006, 32 in 2007) either moved out of the study area, were removed by predators or anglers (that did not return the tag) or their tags failed. Expected tag failure based on information from past LGL studies is approximately 0.3%, so it is more likely that most of those fish that were not detected had moved out or were removed from the areas that were tracked. Note that the survey efforts were adequately intense to expect that tags associated with dead fish would be detected at least once. For this reason, tags that were never detected were not known mortalities, but were nevertheless censored from subsequent analyses.

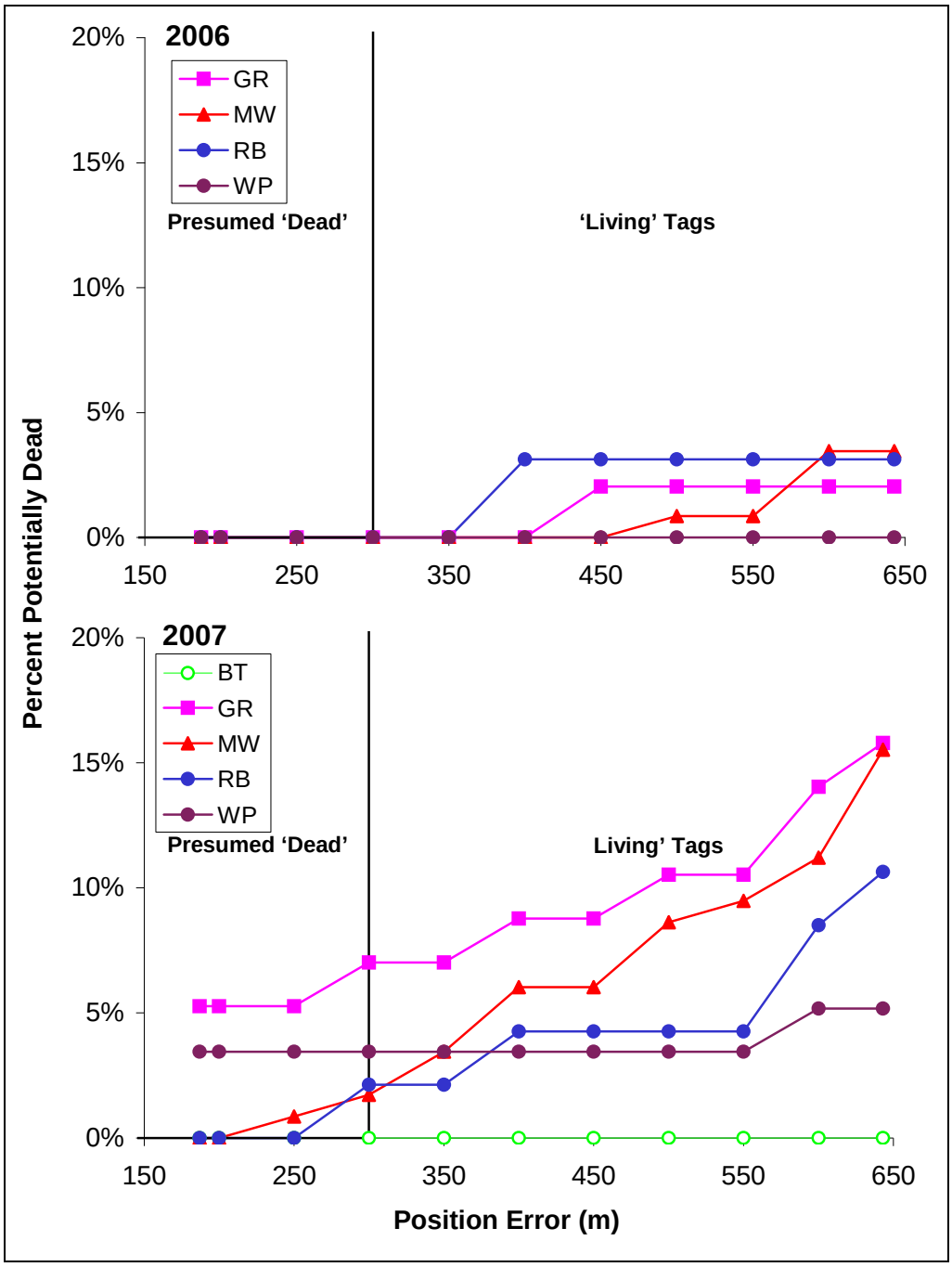


Figure 8: ***Potential mortalities of radio-tagged fish in 2006 and 2007, by species.***

Table 4: Radio-tagged fish presumed or confirmed dead

Species	Tag #	Date Tagged	Tag Site[1]	FL (mm)	Weight (g)	Recovery Date	Comments[2]
Bull Trout	303	08/21/06	-47	44	740	9/3/07	Caught by an angler
	304	08/20/06	-47	47	1010	9/19/07	Caught by an angler
Arctic grayling	44	09/23/05	-17	276	300	- -	Stationary; presumed dead
	47	09/23/05	-17	331	550	- -	Stationary; presumed dead
	48	09/23/05	-17	289	375	- -	Stationary; presumed dead
	52	09/23/05	-17	290	425	- -	Stationary; presumed dead
Mountain Whitefish	139	06/24/06	-9	372	575	9/9/06	Eaten by bull trout, caught by angler
	141	06/24/06	-9	315	375	- -	Stationary; presumed dead
	180	06/24/06	-9	368	475	- -	Stationary; presumed dead
	232	06/27/06	-15	337	425	9/2/06	Tag found on riverbed
	252	06/26/06	-5	326	350	7/15/06	Tag found on riverbed
Rainbow Trout	33	09/23/05	-17	309	400	- -	Stationary; presumed dead
	74	09/26/05	-7	276	300	5/17/06	Tag found on riverbed
	88	09/27/05	-9	396	825	8/28/06	Eaten by bull trout, caught by angler
	95	09/28/05	-3	341	450	6/1/06	Caught by an angler
Walleye	3	09/21/05	-31	473	1350	6/8/07	Caught by an angler
	10	09/21/05	-31	411	800	2/10/06	Fish found dead at Pouce Coupe River
	26	09/21/05	-31	275	225	- -	Stationary; presumed dead
	28	09/21/05	-31	439	1100	1/31/06	Caught by an angler
	102	09/29/05	-31	361	575	7/8/06	Fish found dead at Beatton River mouth
	113	09/29/05	-31	441	1050	4/7/06	Caught by an angler
	121	09/29/05	-31	446	825	- -	Stationary; presumed dead
	126	09/29/05	-31	507	1725	10/11/07	Caught by an angler

Notes: [1]See Appendix B, Table B2 for definitions of Tag Site codes; [2]Confirmed deaths are based on tag recoveries and presumed deaths are based on the stationary position of the tag over the study duration.

Table 5: Summary of radio-tagged fish confirmed or presumed to be dead, and those that were never detected.

Species	Total tagged	Dead			Never Detected		
		Confirmed	Presumed	Total (%)	2006	2007	Both Years
Bull trout	63	2	0	2 (3)	0	7	0
Arctic grayling	57	0	4	4 (7)	1	9	2
Mountain whitefish	116	3	2	5 (4)	2	4	0
Rainbow trout	47	3	1	4 (9)	0	5	3
Walleye	58	6	2	8(14)	1	1	1

Fish Movement Past the Moberly River Potential Zone of Inundation

In 2007, a fixed-station receiver was installed on the Moberly River, approximately 10 km upstream from the Peace River at the upstream extent of the potential zone of Site C inundation. For each fish, any sequence of movements that showed detections both upstream and downstream of the potential zone of inundation was included as a single passage event. Passage events were associated with a date and an individual (and hence a species) for subsequent analyses. Note that passage events did not include cases in which fish approached the receiver and were detected, and then turned back in the direction that they had come; these were tallied among the fish that entered the lower Moberly River. Analyses included comparisons of movement events among species and among months.

Fish Movement Past Site C

The fixed-station receiver that was closest to the proposed Site C location was installed at the mouth of the Moberly River (Zone 70), approximately 0.5 km upstream. For each fish, any sequence of movements that showed detections both upstream and downstream of Zone 70 was included as a Site C passage event. Passage events were associated with a date and an individual (and hence a species) for subsequent analyses. Fish that approached Zone 70 from upstream, but immediately returned back upstream (without being detected downstream of Zone 70) were not considered to have passed Site C, since Site C is located downstream. Conversely, fish that approached Zone 70 from downstream must have passed Site C, regardless of their subsequent movements. Analyses included comparisons of movement events among species, between years and among months.

Statistical analyses

Movement distances were highly skewed in that many short movements and very few long ones were observed (skewness = 1.97). Since displacement

and displacement rates are a function of these individual movement distances, these metrics too were highly non-normal; displacement and displacement rate were both highly leptokurtic (Kurtosis = 22.8 and 170.1, respectively). As such, the majority of statistical analyses were non-parametric. Typical tests included the Kruskal Wallis H test (one-way ANOVA non-parametric equivalent), and the Scheirer-Ray-Hare (SRH) two-way non-parametric ANOVA (Zar 1984). The main exception was the analysis of displacement as a function of time at large, for which slopes were compared between years and among species using first and second order ANCOVA.

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, Halfway, Moberly, Pine and Beatton rivers for 1996 to 2007 (WSC 2007a; 2007b) are presented in Appendix A (Tables A1 to A5).

Peace River flows in 2006 generally ranged between the 1996-2005 daily mean and daily minima (Figure 9). In contrast, flows in 2007 were generally between the 1996-2005 daily mean and the maxima indicating higher overall flows in 2007. Although flow regulation is attenuated downstream by discharge from unregulated tributaries, Peace River flows at Taylor, BC are largely dictated by flows out of Peace Canyon Dam.

In the major Peace River tributaries, flow patterns were similar among tributaries but varied between 2006 and 2007 (Figures 10-13). In 2006, flows were consistently below the 1996-2005 daily mean flow; they were slightly above the 10 year minima in spring but were frequently less than the minima following June. In 2007, the Halfway and Beatton rivers had flows between the 1996-2005 daily mean and maxima in the spring while flows after June fluctuated around the daily mean. Flow data for 2007 was unavailable at report time for the Moberly and Pine rivers; however it is likely that flow patterns would be similar to those seen in the Halfway and Beatton rivers, although the actual magnitude of flow would vary.

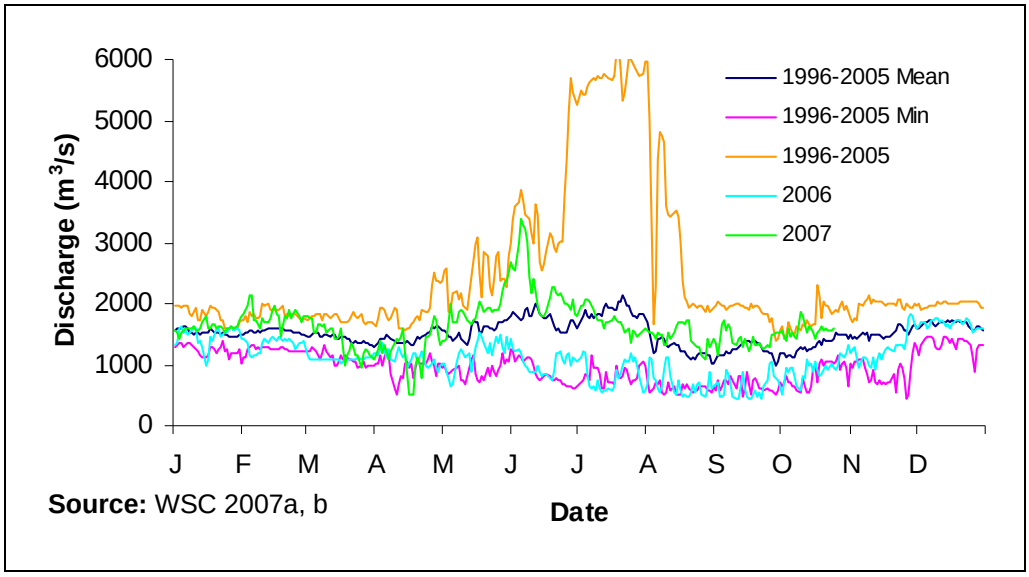


Figure 9: ***Daily discharge (m^3/s) of the Peace River near Taylor, BC for 2006, and 2007, compared to 1996 to 2005.***

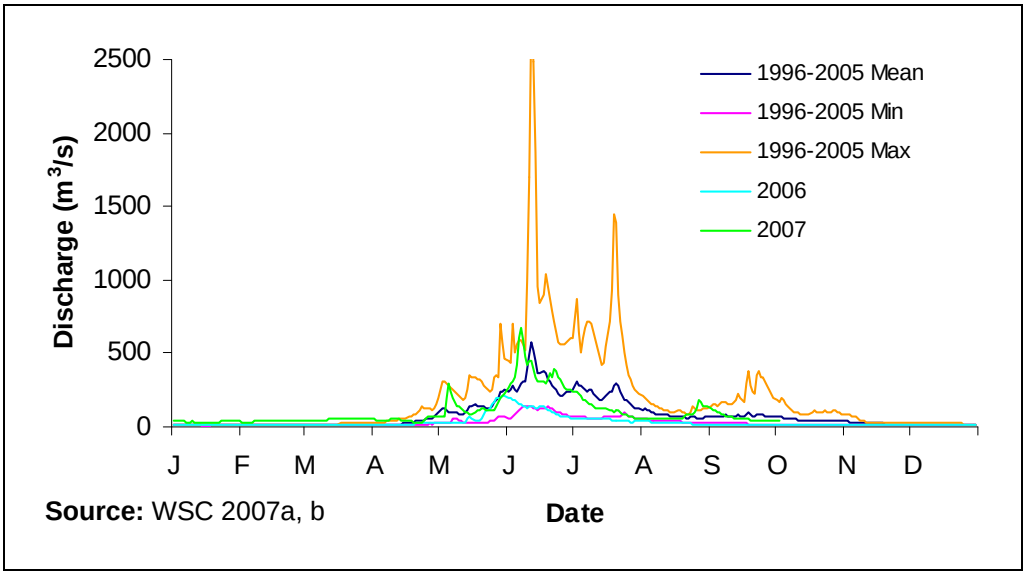


Figure 10: ***Daily discharge (m^3/s) of the Halfway River for 2006, and 2007, compared to 1996 to 2005.***

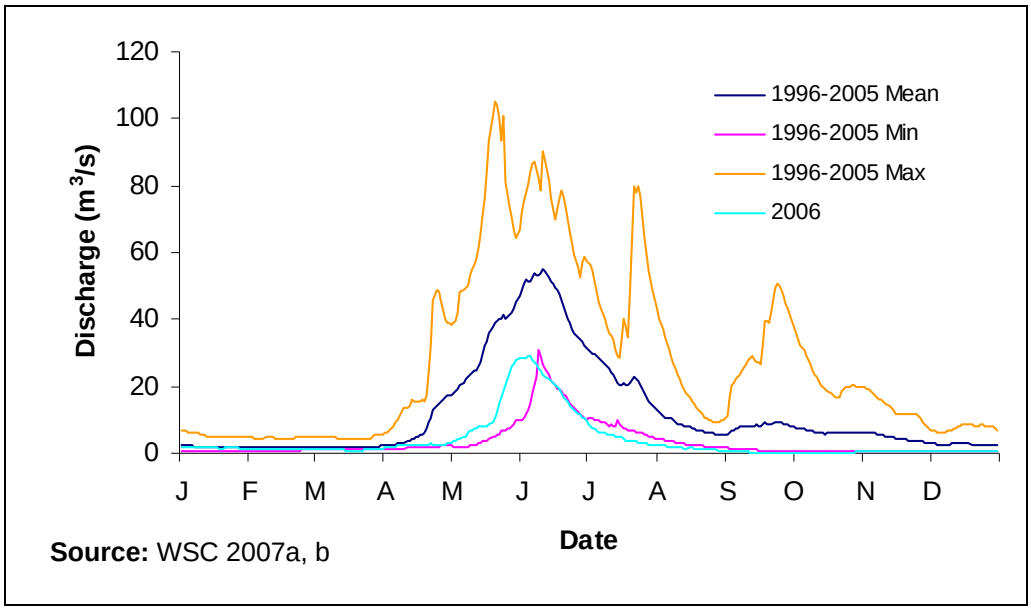


Figure 11: ***Daily discharge (m^3/s) of the Moberly River for 2006, compared to 1996 to 2005.***

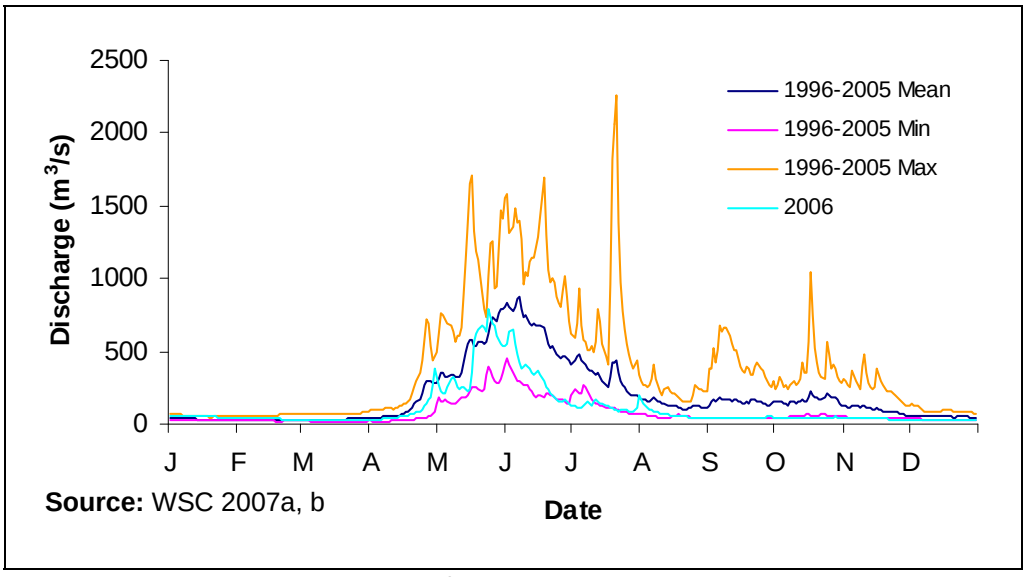


Figure 12: ***Daily discharge (m^3/s) of the Pine River for 2006, compared to 1996 to 2005.***

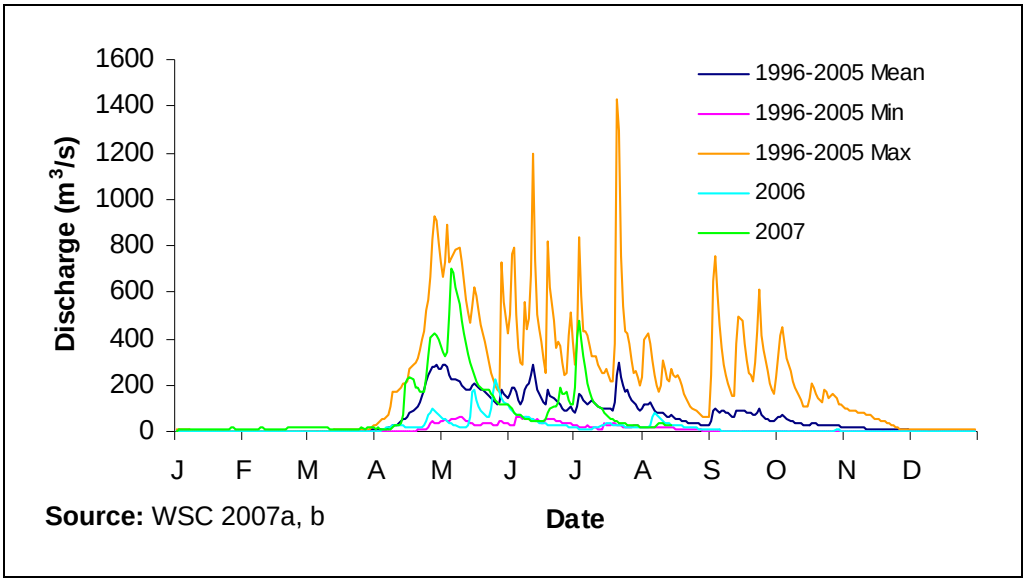


Figure 13: ***Daily discharge (m^3/s) of the Beatton River for 2006, and 2007, compared to 1996 to 2005.***

3.1.2 Water Temperatures

Mean daily water temperatures in the Peace River at the proposed Site C dam, and near the mouths of the Beatton River, Pine River, and Moberly River, Wilder Creek, Cache Creek, Halfway River, Farrell Creek, Lynx Creek, and Maurice Creek for the 2005, 2006, and 2007 are presented in Appendix A (Table A6), and in Figures 14 to 23, respectively.

A common pattern was apparent between 2006 and 2007 for the Peace, Beatton, Pine and Moberly rivers, although water temperatures varied among locations. In the Peace River and its major tributaries, mean daily water temperatures were at least two degrees cooler in summer of 2007 than in 2006. In the smaller tributaries, like Cache, Farrell, Lynx and Maurice creeks, water temperatures were similar between 2006 and 2007.

Mid-summer temperatures in the Peace River were more moderate (<17ºC) than in any of the Peace River tributaries which, in the smaller creeks, neared 25ºC in summer. 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. Water temperatures were highest in Farrell and Cache creeks in both years.

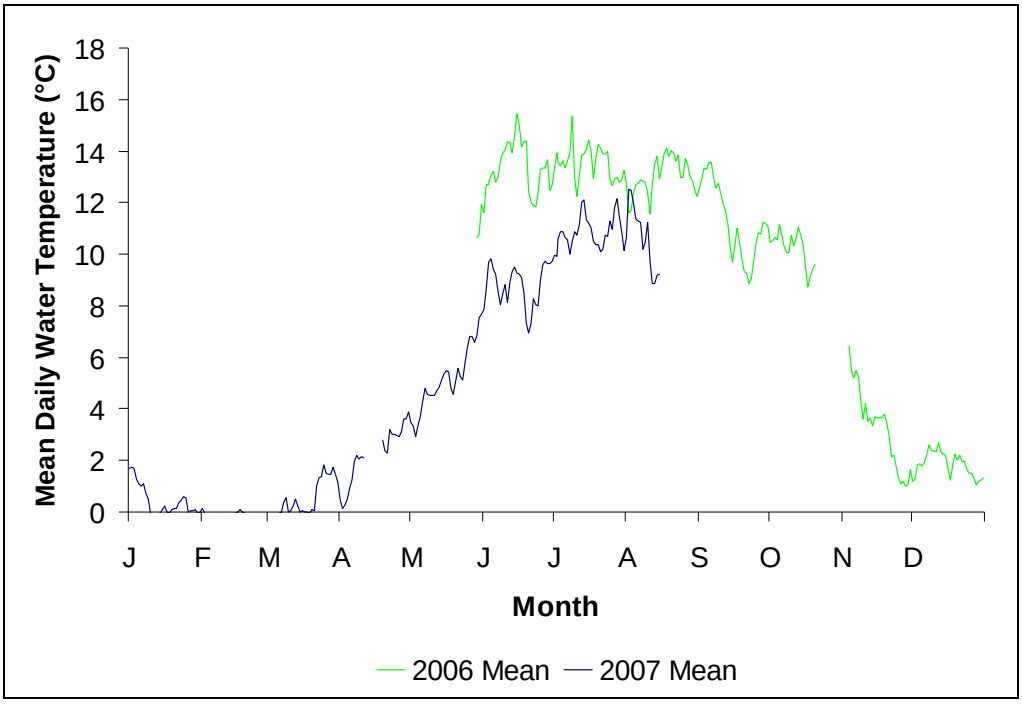


Figure 14: ***Water temperatures for Peace River near the proposed Site C dam location.***

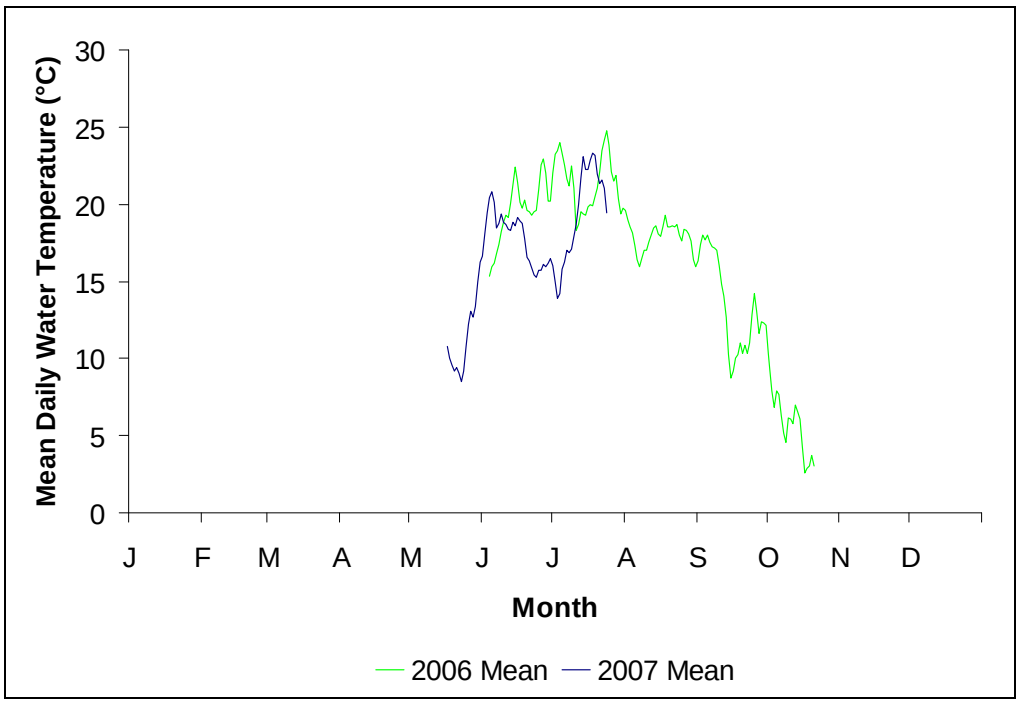


Figure 15: ***Water temperatures for the Beatton River.***

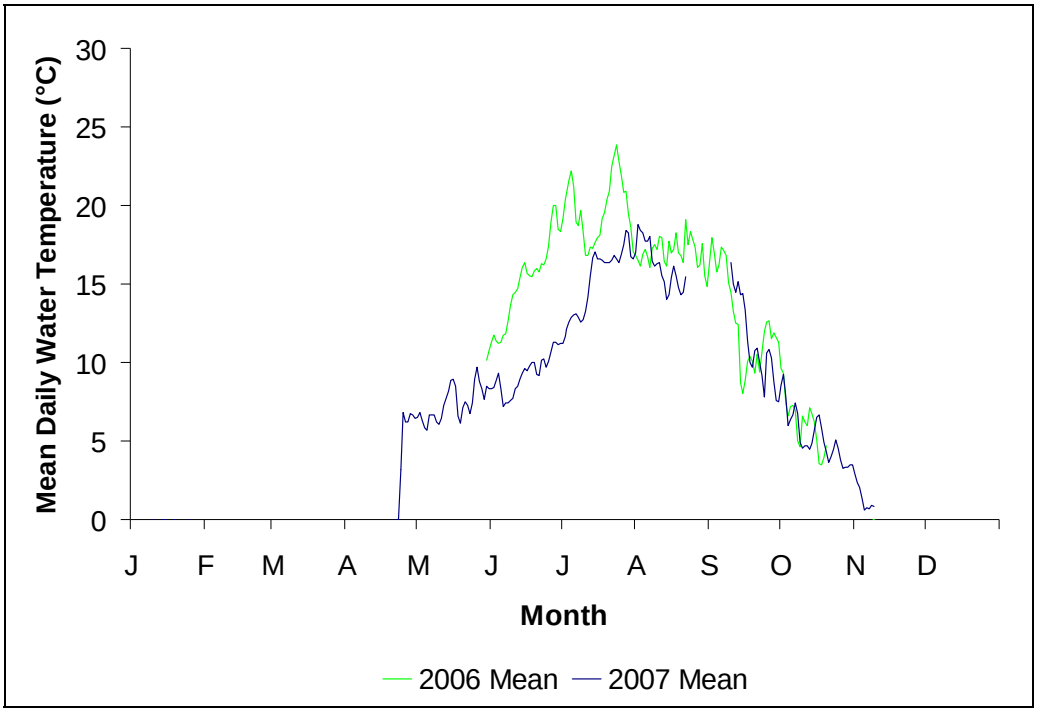


Figure 16: ***Water temperatures for the Pine River.***

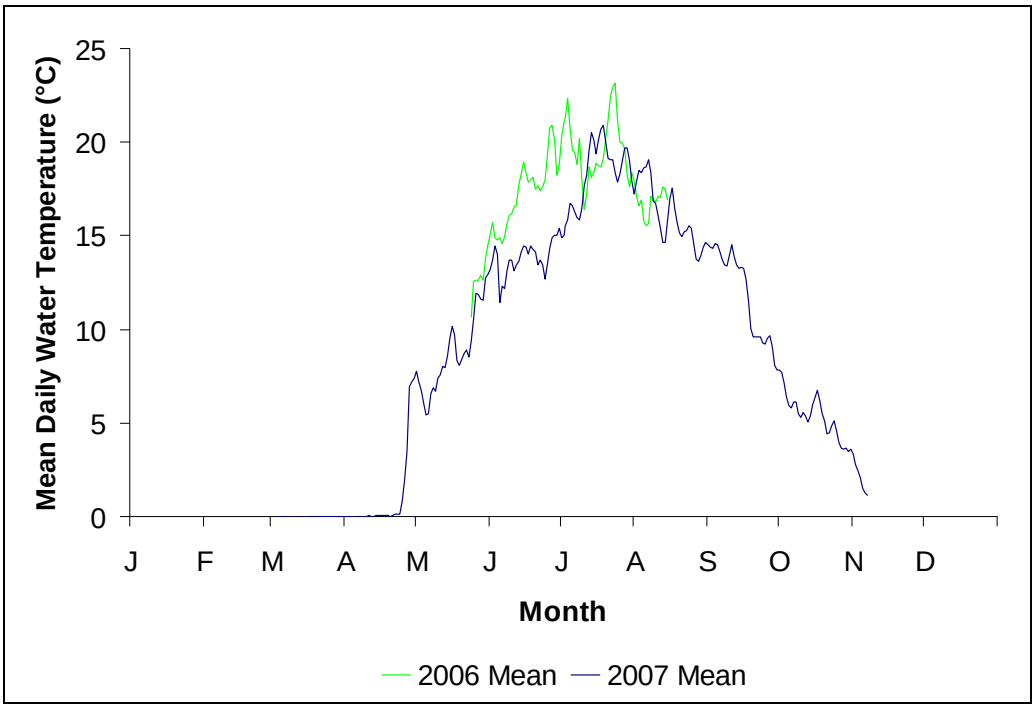


Figure 17: ***Water temperatures for the Moberly River.***

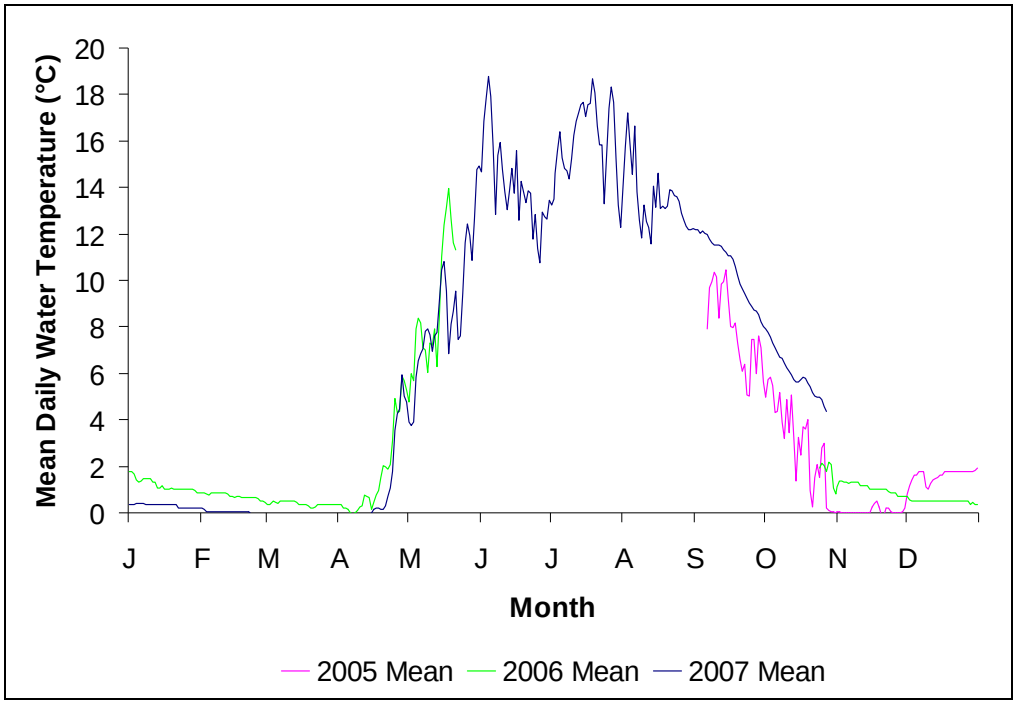


Figure 18: ***Water temperatures for Wilder Creek.***

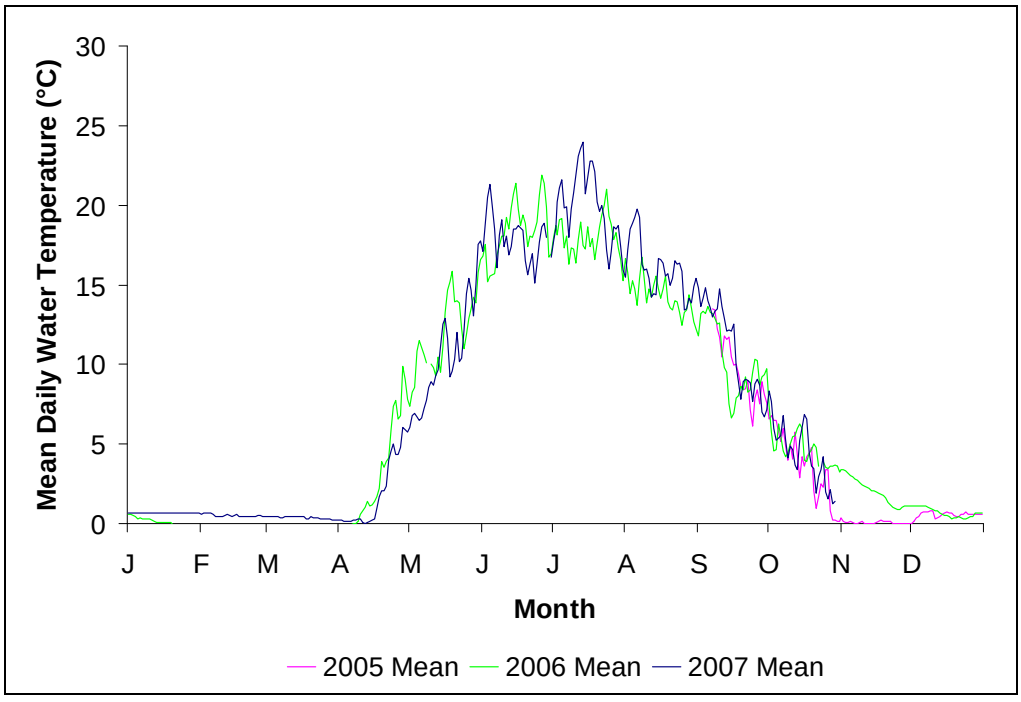


Figure 19: ***Water temperatures for Cache Creek.***

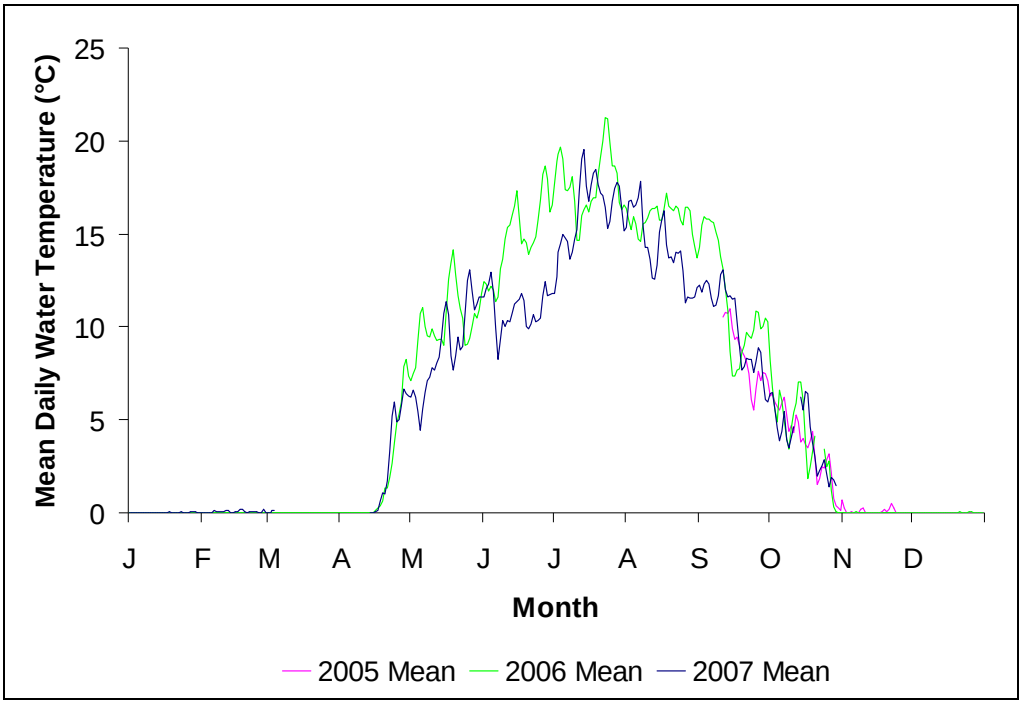


Figure 20: ***Water temperatures for the Halfway River.***

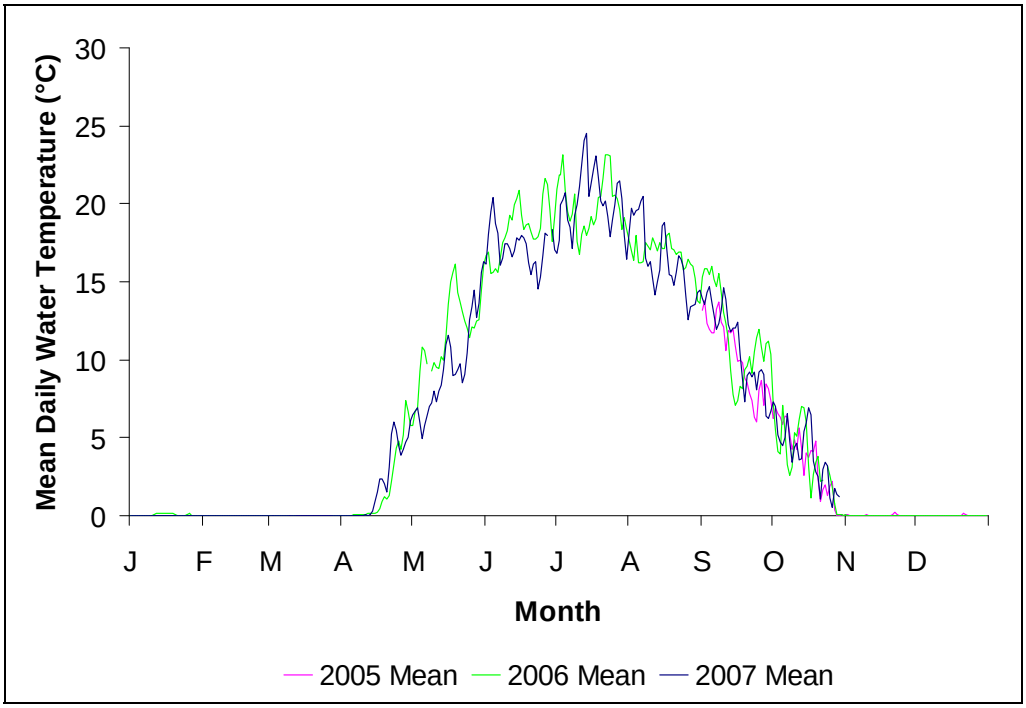


Figure 21: ***Water temperatures for Farrell Creek.***

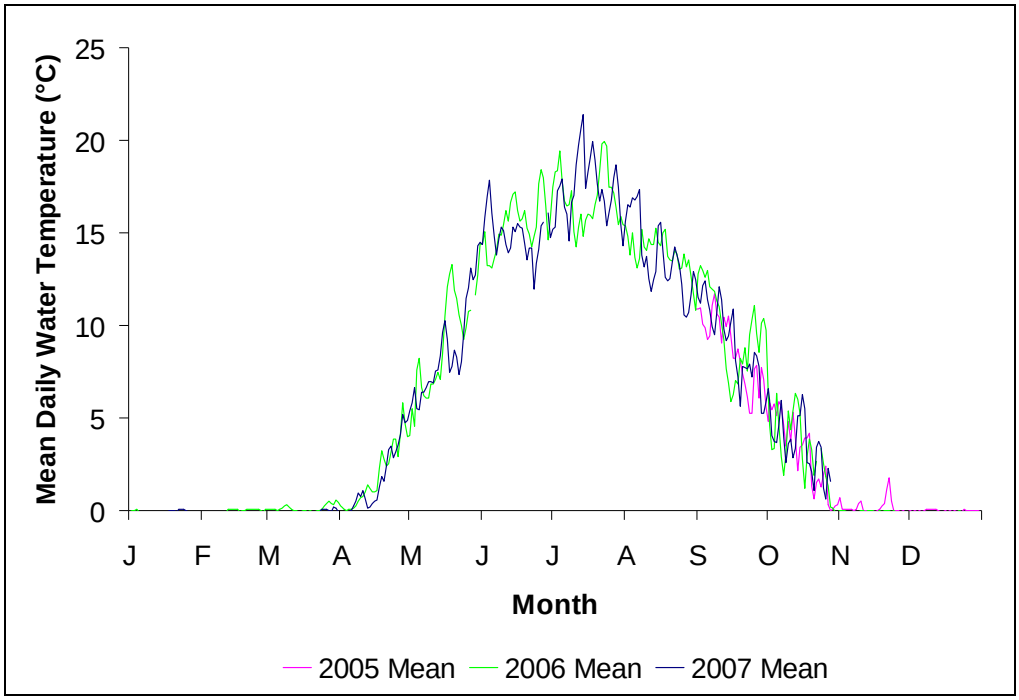


Figure 22: ***Water temperatures for Lynx Creek.***

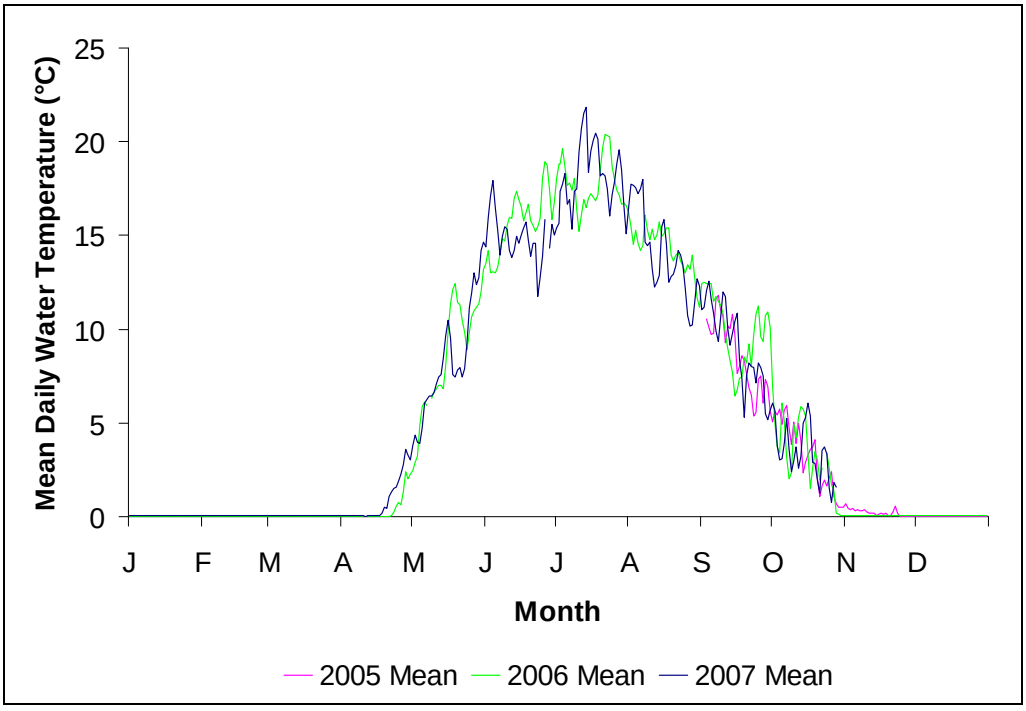


Figure 23: ***Water temperatures for Maurice Creek.***

3.2 Radio Telemetry

3.2.1 Monitoring Fish Movement

3.2.1.1 Fixed-stations

During the main part of the 2007 study period (April-October), a total of 176 of the 318 fish (55%) were detected at more then one fixed-station receiver. The proportion of the living radio-tagged fish that was detected at each of the fixed-station receivers is shown by species in Table 6.

A greater proportion of bull trout was detected at the stations in the Pine River system than elsewhere, whereas for walleye the proportion of detections decreased with distance upstream in the Peace River mainstem from the Beatton River confluence. One walleye (Tag #109) was detected at the Farrell Creek station. This fish was released on 29 Sept 2005 near the mouth of the Beatton River; it was first detected in the lower Beatton River during aerial tracks on 16 March and 13 April, 2006. It was not detected in any subsequent aerial tracks, but it was detected at the fixed station at the mouth of Farrell Creek on 24 June, 2007 at approximately 9 pm. It is possible that the walleye detection at the Farrell Creek station is an error; however, the detections met all our filter criteria (i.e., multiple hits were recorded within 1 minute, and travel times were not unreasonable). It is possible that the fish traveled deep and/or fast in the Peace mainstem and was missed at the other receivers located downstream from Farrell Creek; we cannot know for sure.

Detections of Arctic grayling were mostly (17%, 23%) at the Moberly River stations. Overall, the proportion of the tagged populations of mountain whitefish and rainbow trout detected at fixed-stations was low, indicative of their movements frequently being less than the distance between fixed-stations.

Table 6: The percent of radio-tagged fish that was detected at each fixed-station receiver, April-October 2007

	Species				
Fixed-station	Bull trout n=61	Arctic grayling n=53	Mountain whitefish n=111	Rainbow trout n=43	Walleye n=50
Lynx Creek			4%		
Farrell Creek			4%	7%	2%
Halfway River	3%		5%	2%	
Graham River	3%				
Moberly River	7%	23%	5%	2%	10%
Pine River	8%	9%	12%	2%	40%

	Species				
Fixed-station	Bull trout n=61	Arctic grayling n=53	Mountain whitefish n=111	Rainbow trout n=43	Walleye n=50
Beatton River			4%		64%
Moberly at innundation		17%			
Pine at Murray	16%			5%	
Pine at Sukunka	26%	6%		14%	

3.2.1.2 Mobile Tracks

The numbers and percentages of the tags detected at large in each of the 12 mobile tracks conducted in 2007 are summarized in Table 7. The decrease in detection rates for Arctic grayling, rainbow trout and walleye toward the end of the 2007 tracking period is most probably attributable expected tag battery failure and not to a decline in tracking efficiency. Although the life expectance of the tags used was 560 and 761 d for the small and large tags, respectively, these are very conservative estimates and in reality the tags are known to perform for considerably longer periods. The distance tracked among the 12 surveys ranged from 801 to 1,380 km, with the greatest distance covered being in the last track in 2007.

Overall, there is reasonable consistency in detection rate for all species and frequently more than 60% of the tags at large were detected (Table 7). Detection was consistently high for mountain whitefish (74-89%), but more variable for the other species. Detections of bull trout, for example, ranged from 65-87%. Detection of Arctic grayling was highest (70%) in late March and thereafter declined, but did improve to 68% in September. Detections of walleye reached a high of 85% in late May, and rainbow trout a high of 77% in late April. Radio tag battery exhaustion, after September, results in detection rate reduction for species tagged in 2005 (Arctic grayling, rainbow trout and walleye).

Table 7: Numbers and percentages of the tagged fish detected by species for each of the mobile tracks

Date (2007)	Distance Tracked	Arctic grayling		Mountain whitefish		Rainbow trout		Walleye		Bull trout	
	(km)	N	%	N	%	N	%	N	%	N	%
Mar 26-27	965	40	70	98	87	31	71	40	74	47	87
Apr 9-10	801	37	65	94	83	29	66	42	78	43	80
Apr 22	900	36	63	100	89	34	77	47	87	46	85

Date (2007)	Distance Tracked	Arctic grayling		Mountain whitefish		Rainbow trout		Walleye		Bull trout	
	(km)	N	%	N	%	N	%	N	%	N	%
May 10-11	1094	34	60	94	83	29	66	44	81	43	80
May 24-26	896	37	65	94	83	31	71	46	85	47	87
Jun 24-27	869	36	63	91	81	28	64	43	81	46	85
Jul 23-24	870	32	56	83	74	23	52	38	72	30	56
Aug 21-22	850	34	60	89	79	24	55	43	81	40	74
Sept 5-6	996	39	68	95	84	24	55	42	79	40	65
Sept 19-21	1310	36	63	96	85	20	45	41	77	40	66
Oct 10-11	986	23	40	91	81	18	41	33	64	41	67
Oct 31-Nov 3	1380	23	40	96	85	18	41	24	46	44	67

Note: Percentages are based on the total number of known active tags remaining in the tagged population at the time of survey.

The distribution of detections by species for each of the tracks is shown on Maps 1-12. Because of the considerable number of tagged fish at large and differences in release times, for clarity purposes the detections are shown on three maps for each of the 12 tracks as follows: the detections of bull trout (maps labelled c) and mountain whitefish (map labelled b) are plotted on separate maps, whereas those of Arctic grayling, rainbow trout and walleye are combined on to a single map (map labelled a).

For comparison of early spring conditions (i.e., ice and flows) in the Peace River mainstem and major tributaries within the study area between 2006 and 2007 refer to Appendix B, Plates 1-7. The year of 2006 was characterized as an early spring with no ice cover by late March in the tributaries and relatively low flows thereafter. In contrast, 2007 had a late spring characterized by ice cover conditions in the tributaries in late March and considerably higher flows after spring break-up than in 2006.

March Track, 26-27 March (Map 1)

The tributaries were still frozen over in late March of 2007, so this track was considered indicative of the winter distribution of the radio-tagged fish populations in the Peace River study area. Overall, the tagged populations were distributed almost exclusively in the Peace River mainstem and Pine River system, consistent with their tagging locations. Of the Arctic grayling, rainbow trout, walleye and mountain whitefish released in the Peace River mainstem, almost all detections were in the Peace River mainstem, the exceptions being 7 (18%) walleye and 6 (6%) mountain whitefish detected in

the Beatton and Halfway rivers, respectively. Detections of bull trout, Arctic grayling and rainbow trout released in the Pine River system in 2006, were, with one exception (a bull trout near the Beatton River confluence), all within the Pine River system.

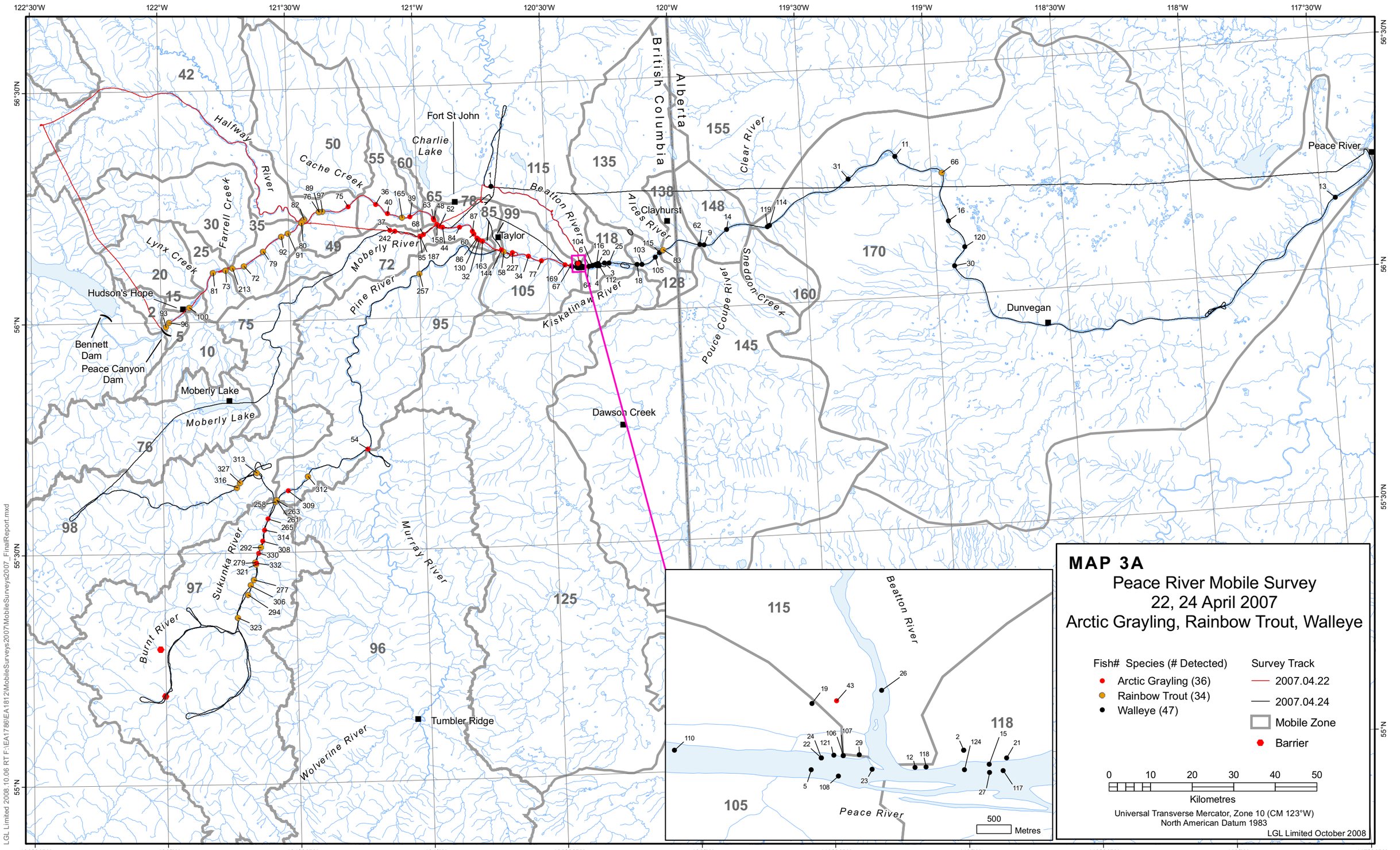
Of the 47 bull trout detected in late March, 60% were in the Pine River mainstem between the headwaters and near the confluence, 38% were in the Sukunka/Burnt River system, and one fish, originally released in the Burnt River, was in the Peace River mainstem at the Beatton River confluence. Two bull trout were in the Pine River within 10 km of the Peace River, one of which was released in this area, but the other was released in the Burnt River. Although a high proportion (76%) of bull trout were tagged and released in the Burnt River, only three fish (6%) were detected there in March, with the majority having moved downstream into the Sukunka River and Pine River mainstems. A similar pattern of downstream movement is evident for Arctic grayling and rainbow trout released in the Pine River system, with none detected in the Burnt River, although a high proportion were released there. A few rainbow trout had moved upstream in the Pine River system from where they were released.

Overall, the distribution of fish detected in the Peace River mainstem in March 2007 was similar to that recorded in October 2006. Rainbow trout were mainly detected between the Peace Canyon Dam and Cache Creek, with a few individuals near the Alberta border and beyond. Arctic grayling were mostly between Cache Creek and the Beatton River, with some fish further downstream; the farthest being approximately 15 km past Dunvegan in Alberta. A high proportion of walleye were aggregated within the vicinity of the Beatton River (63% of the 40 detected), with the rest widely distributed downstream to as far as Peace River, Alberta. Mountain whitefish were fairly evenly distributed in the Peace River mainstem between Lynx Creek and the Alces River, with a few individuals further downstream to within the vicinity of Dunvegan, Alberta. Of the total number of mountain whitefish detected, 8 (8%) were in major tributaries (Halfway and Pine rivers).

Second Track, 22 April (Maps 3)

Overall, the distribution of bull trout in late April was similar to that of the previous survey, with all of the 46 detected found the Pine River system; 57% were in the Pine River mainstem, with the remainder being in the Sukunka (36%) and Burnt (7%) rivers.

Some movement from the Peace River mainstem into the tributaries was detected for Arctic grayling in late April, indicative of the beginning of the spawning migration. Of the total 36 Arctic grayling detected, 14% were in the lower Moberly River, with the farthest one upstream approximately 15 km from the mouth. In contrast, Arctic grayling in the Pine/Sukunka River system showed no evidence of movement into tributary streams. Overall, the distributions of rainbow trout, walleye and mountain whitefish in late April were similar to that of the previous survey. No evidence of movement into the tributaries by rainbow trout was detected. Nineteen (40%) of the 47 walleye detected were within the vicinity of the Beatton River (within 2 km of the Beatton River mouth) and 2 (4%) were in the Beatton River.



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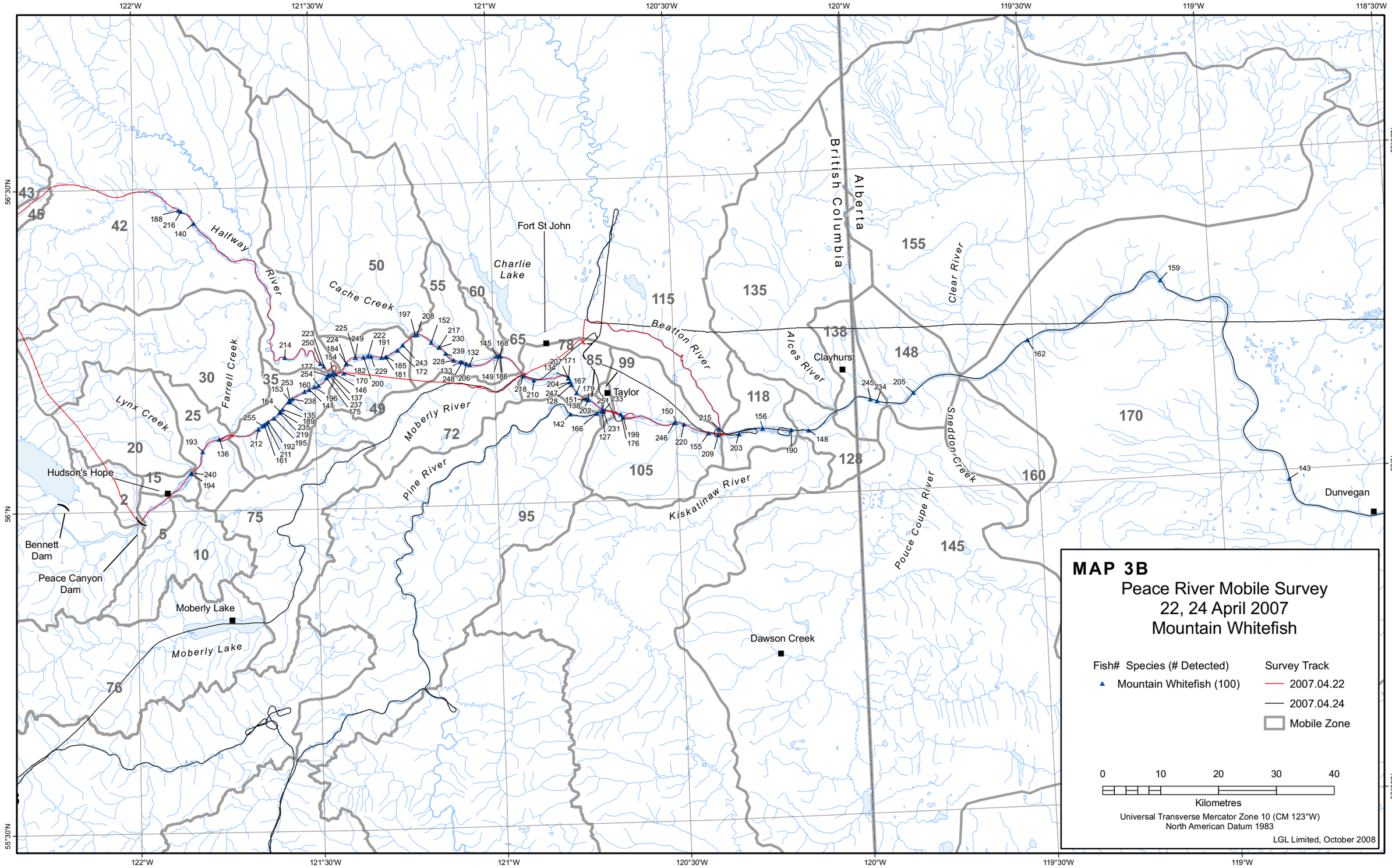
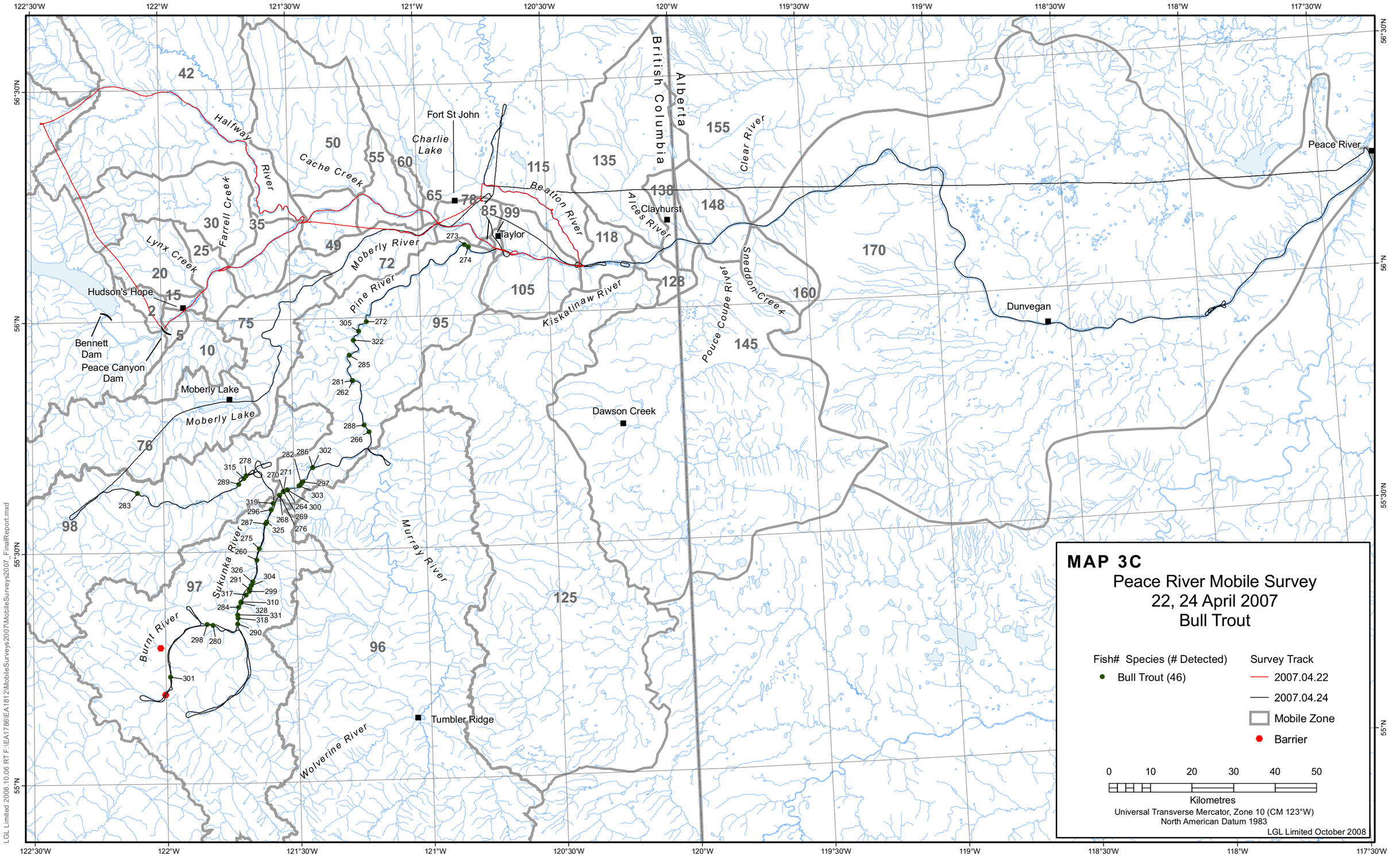
Map 3a: Mobile survey for Arctic grayling, rainbow trout and walleye (April 22, 2007).



Map 3b: Mobile survey for mountain whitefish (April 22, 2007).



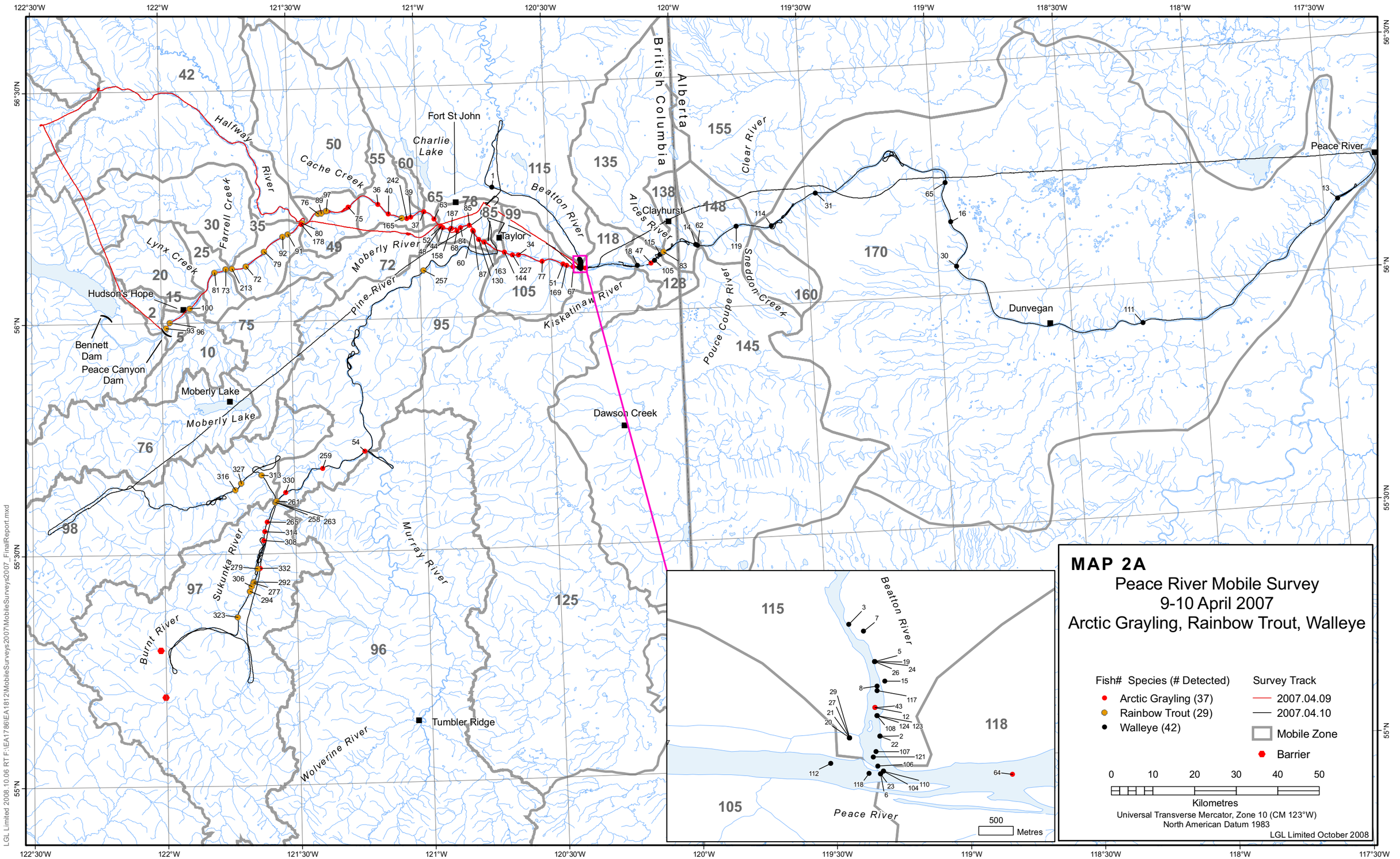
Map 3c: Mobile survey for bull trout (April 22, 2007).

April Tracks (Maps 2 & 3)

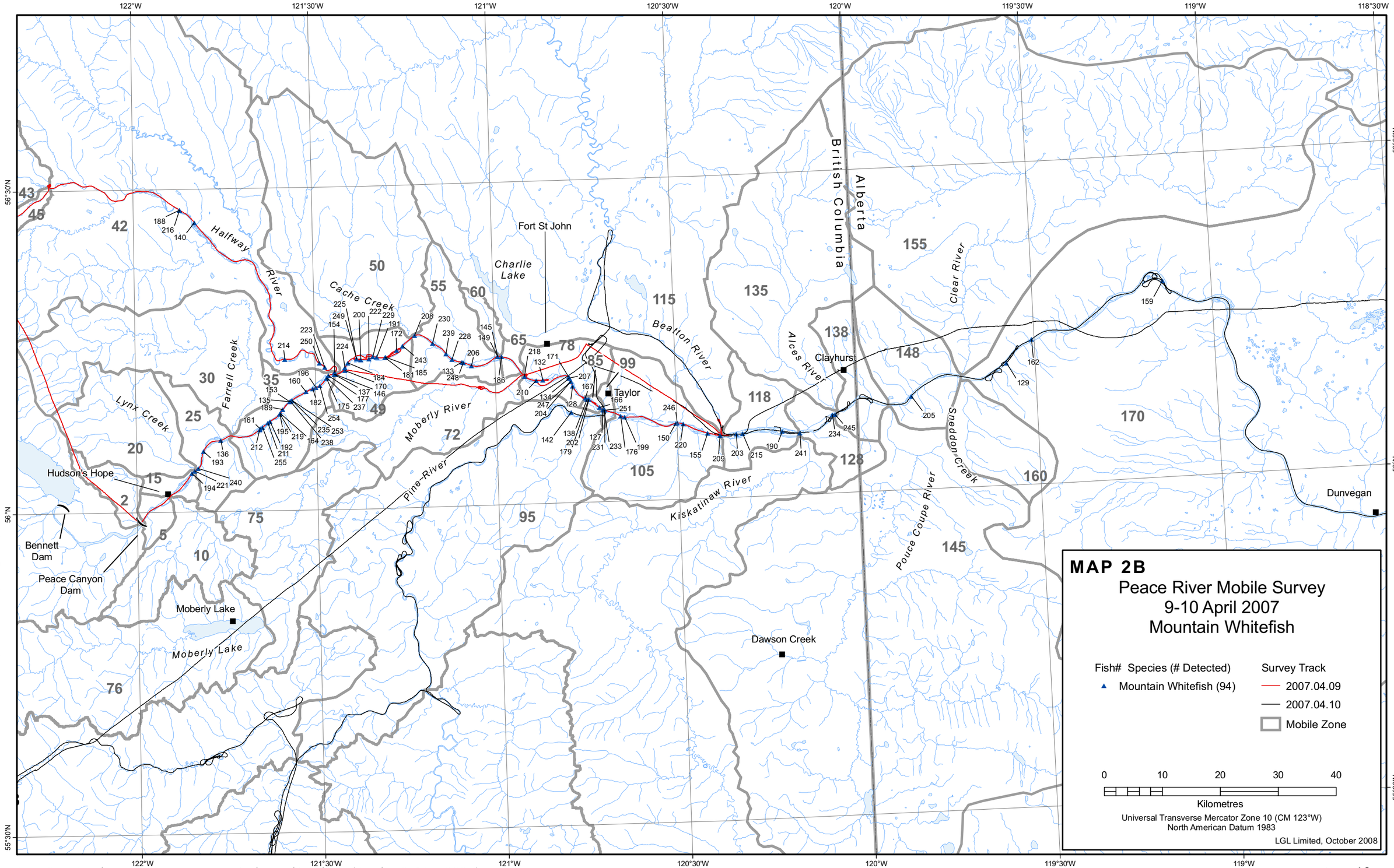
First Track, 9-10 April (Map 2)

Overall, the distribution of the tagged fish populations in early April was similar to that recorded in late March, with the exception of some notable movement by bull trout. The 43 bull trout detected during this track were exclusively in the Pine River system, with 63% in the Pine River mainstem from the headwaters to near the mouth, and the remainder in the Sukunka (32%) and Burnt (5%) rivers. The bull trout which was previously detected at the Beatton River mouth had moved to the upper reaches of the Sukunka River, a distance of some 120 km between detections.

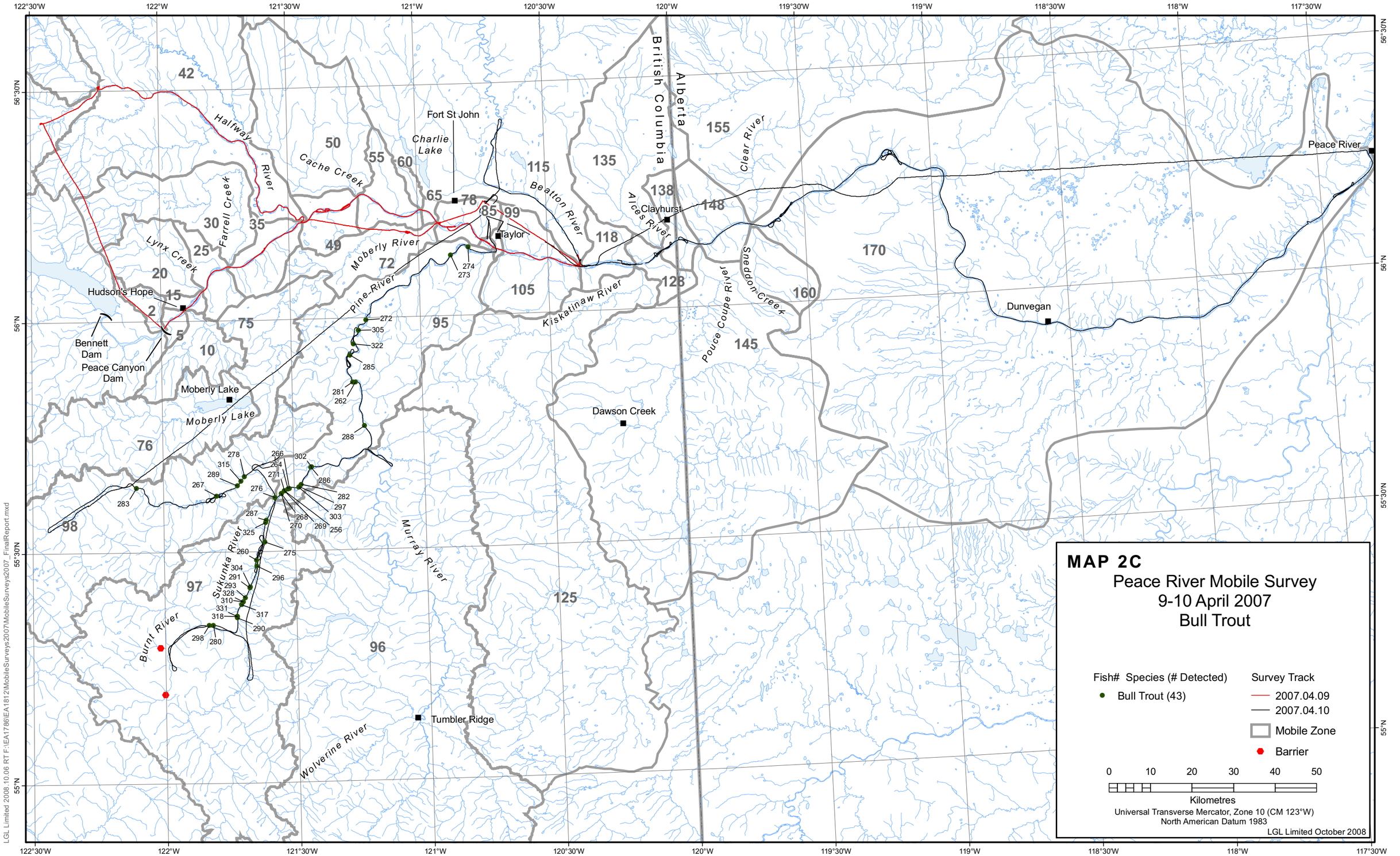
The other four fish species show no appreciable change in distribution between the March and early April surveys. There is no evidence of fish having moved from the Peace River mainstem into the tributaries. In the Peace River mainstem, rainbow trout were still primarily between the Peace Canyon Dam and Cache Creek and Arctic grayling were mostly downstream from Cache Creek to the Beatton River mouth. Walleye were largely congregated within the vicinity of the Beatton River mouth, although several were widely scattered downstream to as far as near Peace River, Alberta. Mountain whitefish were fairly evenly distributed from Lynx Creek to Alberta, with a few still further downstream. Likewise, there is no appreciable change in distribution of rainbow trout and Arctic grayling in the Pine River system from that of the previous track.



Map 2a: Mobile survey for Arctic grayling, rainbow trout and walleye (April 9-10, 2007).



Map 2b: Mobile survey for mountain whitefish (April 9-10, 2007).



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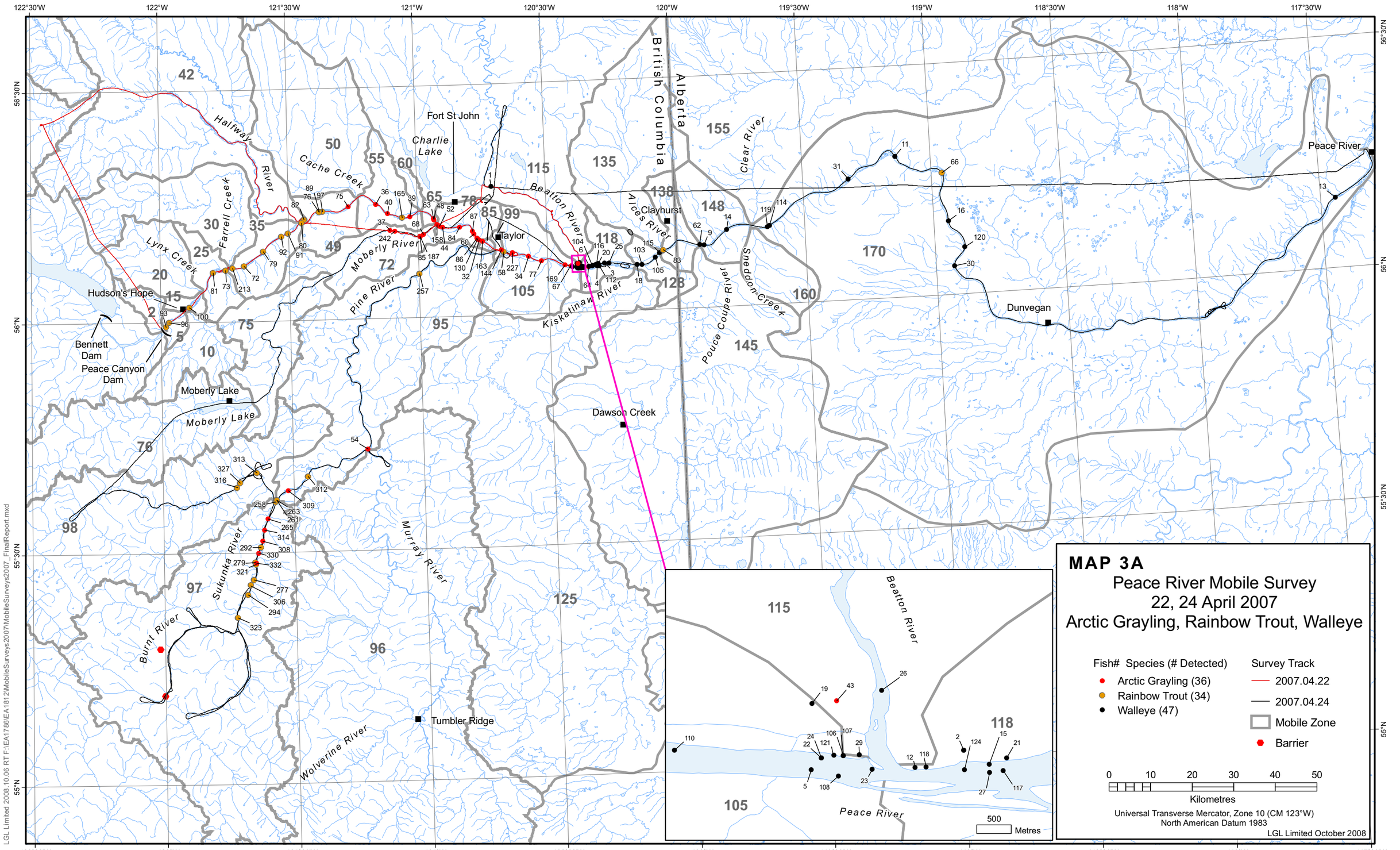
Map 2c: Mobile survey for bull trout (April 9-10, 2007).

Second Track, 22 April (Maps 3)

Overall, the distribution of bull trout in late April was similar to that of the previous survey, with all of the 46 detected found the Pine River system; 57% were in the Pine River mainstem, with the remainder being in the Sukunka (36%) and Burnt (7%) rivers.

Some movement from the Peace River mainstem into the tributaries was detected for Arctic grayling in late April, indicative of the beginning of the spawning migration. Of the total 36 Arctic grayling detected, 14% were in the lower Moberly River, with the farthest one upstream approximately 15 km from the mouth. In contrast, Arctic grayling in the Pine/Sukunka River system showed no evidence of movement into tributary streams. Overall, the distributions of rainbow trout, walleye and mountain whitefish in late April were similar to that of the previous survey. No evidence of movement into the tributaries by rainbow trout was detected. Nineteen (40%) of the 47 walleye detected were within the vicinity of the Beatton River (within 2 km of the Beatton River mouth) and 2 (4%) were in the Beatton River.



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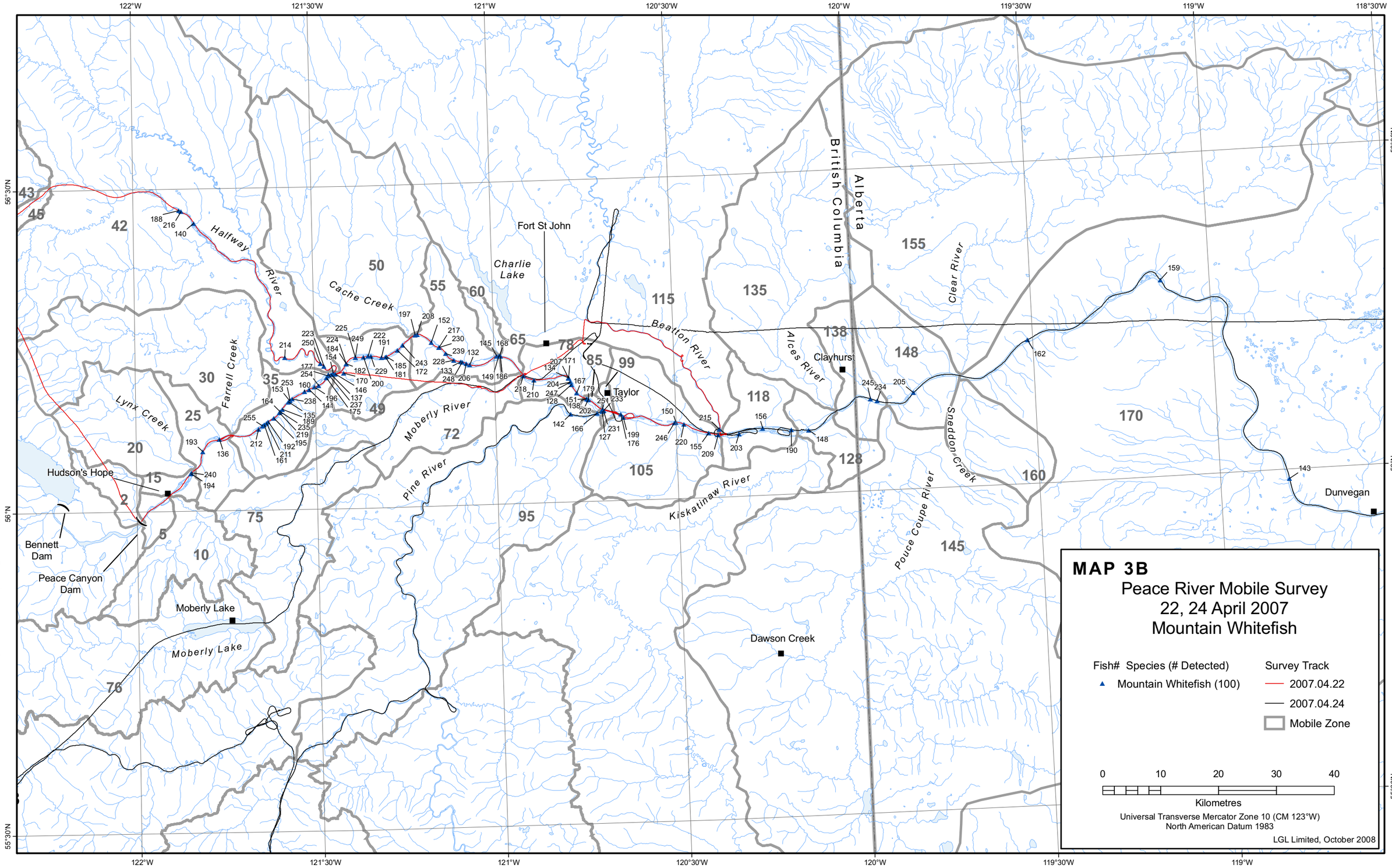
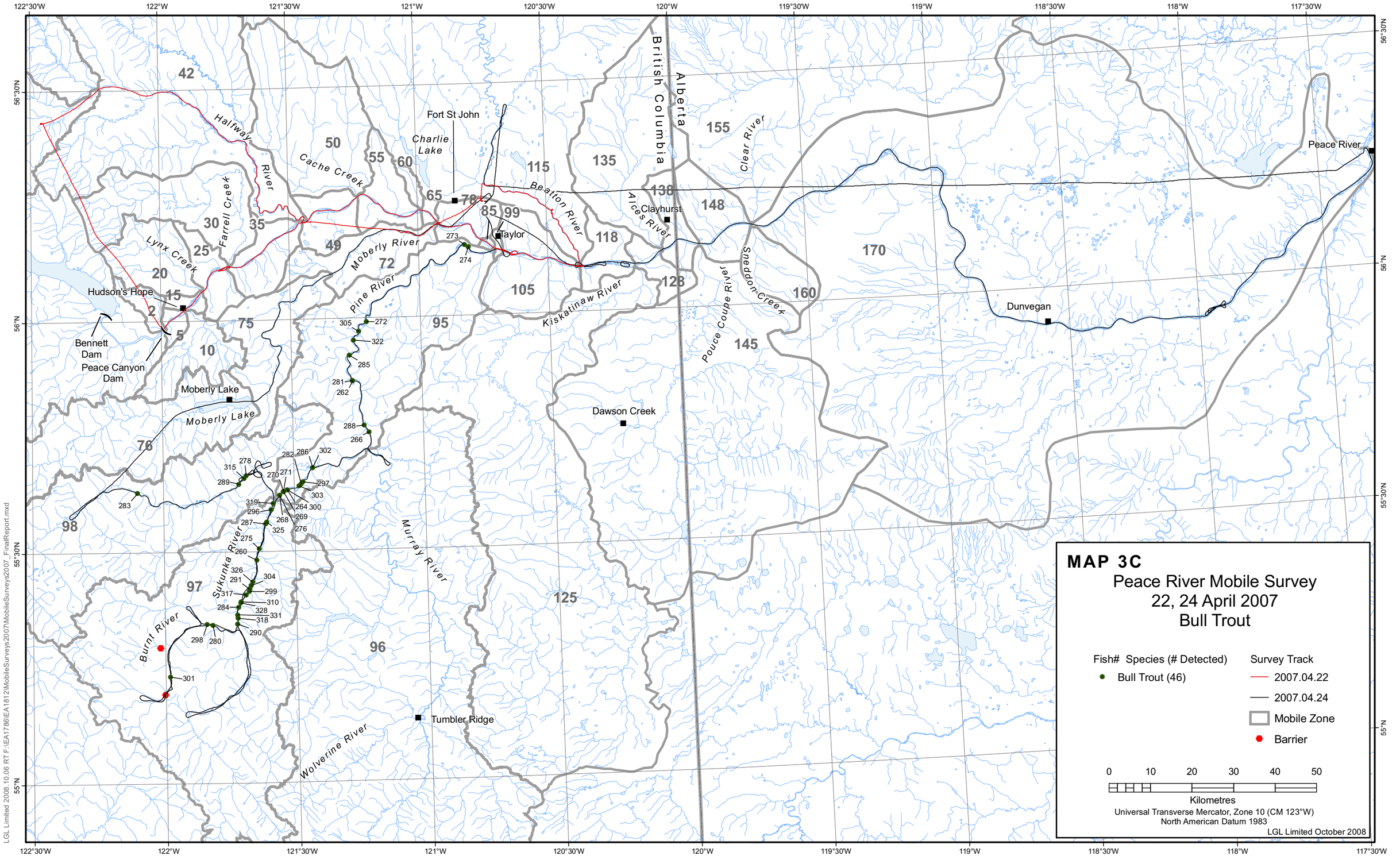
Map 3a: Mobile survey for Arctic grayling, rainbow trout and walleye (April 22, 2007).



Map 3b: Mobile survey for mountain whitefish (April 22, 2007).



Map 3c: Mobile survey for bull trout (April 22, 2007).