3.2.1.3 Mobile and Fixed-Station Tracking Detection Assessment

This section provides an overview assessment for tag detections by species for the period March to October 2008, which are also illustrated on Maps 1-12. General observations for detection results by species for the 2006, 2007 (excluding mountain whitefish because so few were detected) and 2008 tags combined:

- Arctic grayling were not detected outside of the Pine River watershed.
- Most rainbow trout were detected in the Pine River watershed, with the exception of two rainbow trout that moved into the Peace River (one upstream and one downstream of the Pine River).
- Bull trout were largely restricted to the Pine River watershed, particularly major tributaries such as the Sukunka and Burnt drainage and Murray/Wolverine system; exceptions included a few fish that made moderate forays between the Pine and Peace rivers.
- Walleye showed clear evidence of distinct seasonal movements within and between the Peace River mainstem and major tributaries (the Beatton and Pine rivers) consistent with the observations in 2006 and 2007. However, this was based on relatively few tag detections during 2008.

For all the tagged bull trout combined, detections were widely distributed in the Pine River watershed as depicted on Maps 1-12. This distribution was most likely because of the large amount of tagging effort expended in 2008, as opposed to movements and dispersion of these tagged fish. Bull trout tagged in 2006 were mainly detected in the Sukunka and Burnt rivers and mid-Pine River mainstem, whereas the 2008 tagged fish were mostly within the mid-lower Pine River mainstem, the upper Pine River, and the Murray/Wolverine river drainage, where most were tagged. During both September surveys an increased number of 2006-tagged bull trout detections were observed in the vicinity of the Sukunka-Burnt river confluence; these fish were detected downstream and movements to the confluence were presumed to be spawning related.

As mentioned previously, very few tagged bull trout tagged in the Pine River were detected in the Peace mainstem during the 2008 surveys. However, some tagged bull trout made more extensive movements based on their tag detections. These movements are illustrated in Figure 25-29 and discussed further below.

One tagged bull trout (Tag 457; Figure 25) was initially released in the Wolverine River on 28 August 2008 and was subsequently detected on 9 September approximately 20 km upstream from its release location. On 27 October, Tag 457 was detected approximately 250 km downstream from its first detection. This fish exited the Murray River, swam down the Pine River, exited the Pine River and then moved down the Peace River to the vicinity of the Alces River.

A second tagged bull trout (Tag 274) was initially released in the Pine River near the Peace River confluence (Figure 26). In 2007, Tag 274 was detected in the Peace River (near Cache Creek), where it was subsequently detected during all surveys conducted in 2008; this tag was last detected on July 7, 2008 near the mouth of the Moberly River.

A third tagged bull trout (Tag 334; Figure 27) also moved past the proposed Site C dam location in 2007 and 2008. Tag 334 was initially released in the Wolverine River and in fall 2007 it was detected in the Peace River just near the Moberly River, where this fish was assumed to have overwintered; it moved into the Murray River during summer 2008 and was still there when it was last detected on October 28, 2008.

Tagged bull trout were not detected moving between the Pine and Halfway rivers in 2008, although such movements were observed for two bull trout (Tag 322 and 273) in 2007 (AMEC & LGL 2008d). The 2008 tracks for these fish are shown in Figure 28 and 29.

Based on tag detections for a bull trout (Tag 273) that was initially released in the Pine River, it was concluded that this fish migrated approximately 447 km from its release location all the way to the upper Halfway River watershed in fall 2007 and then it returned to the Pine River to overwinter. In 2008, this fish was detected in the Peace River (near Wilder Creek) in May and then was subsequently detected in the Pine River in September. A similar pattern was observed for another bull trout (Tag 322; Figure 29) in 2007, which moved approximately 741 km between its release location in the upper Sukunka River and the upper Halfway River watershed and the Pine, where it remained in the lower Pine River for the rest of 2008.

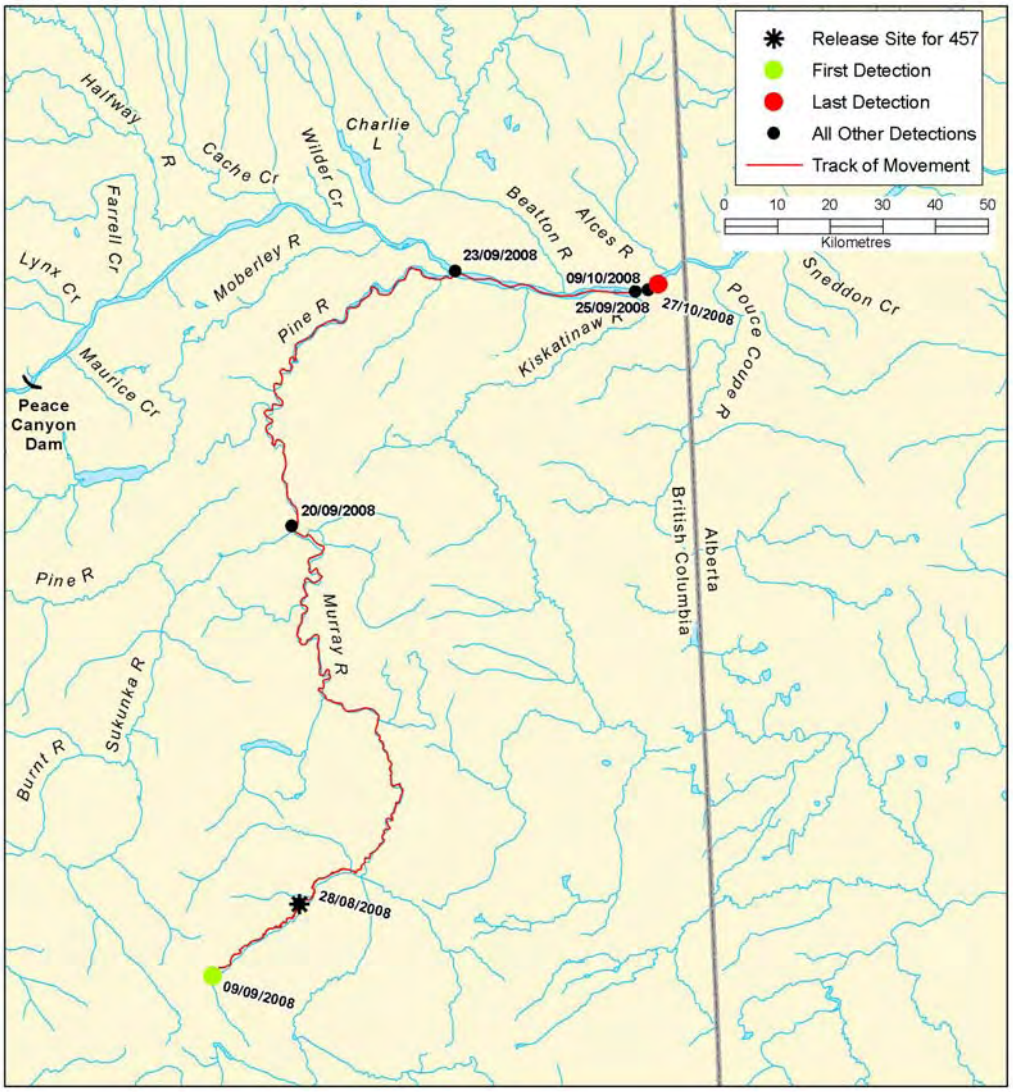

Figure 25: **Individual track of a bull trout (Tag 457) with a total distance tracked of 324 km in 2008**

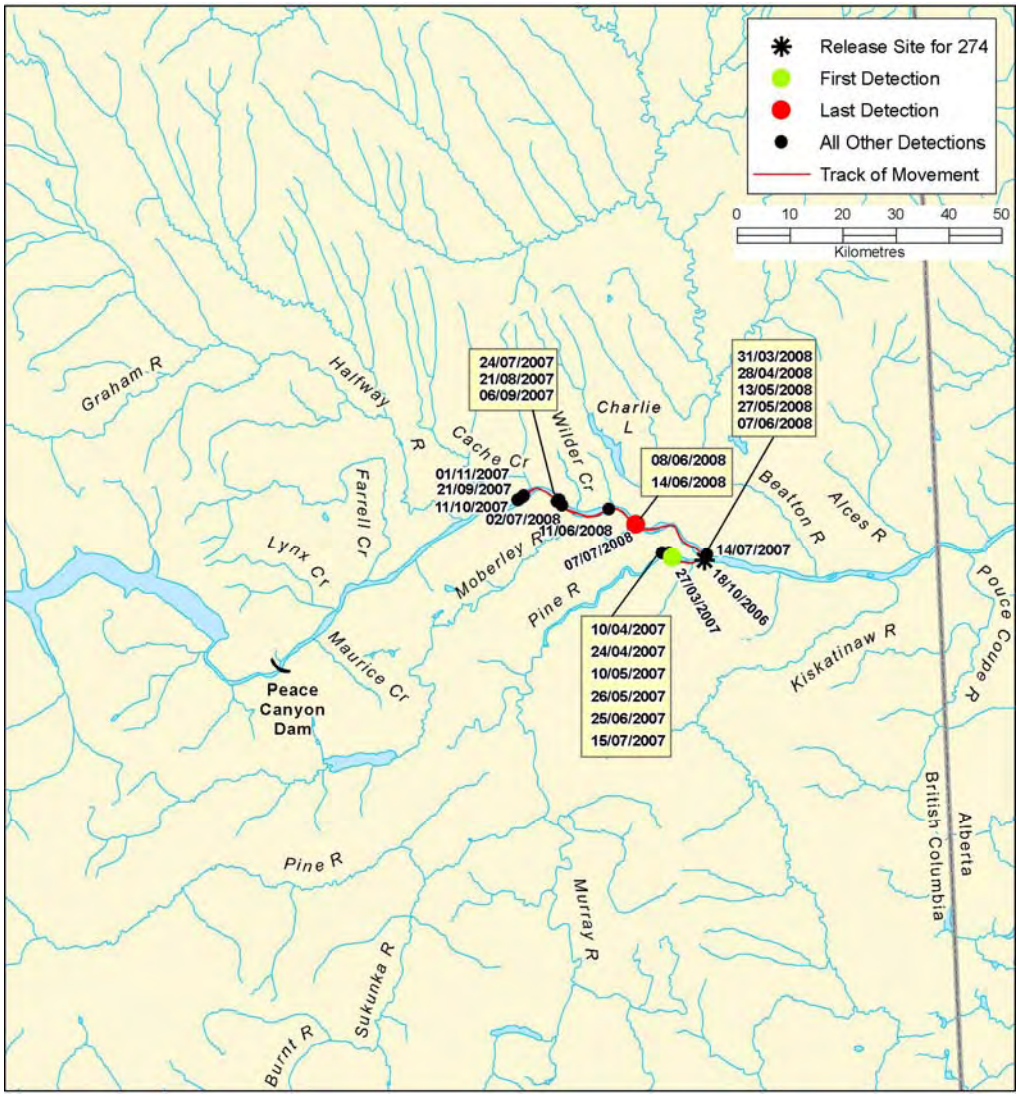

Figure 26: Individual track of a bull trout (Tag 274) with a total distance tracked of 124 km in 2008

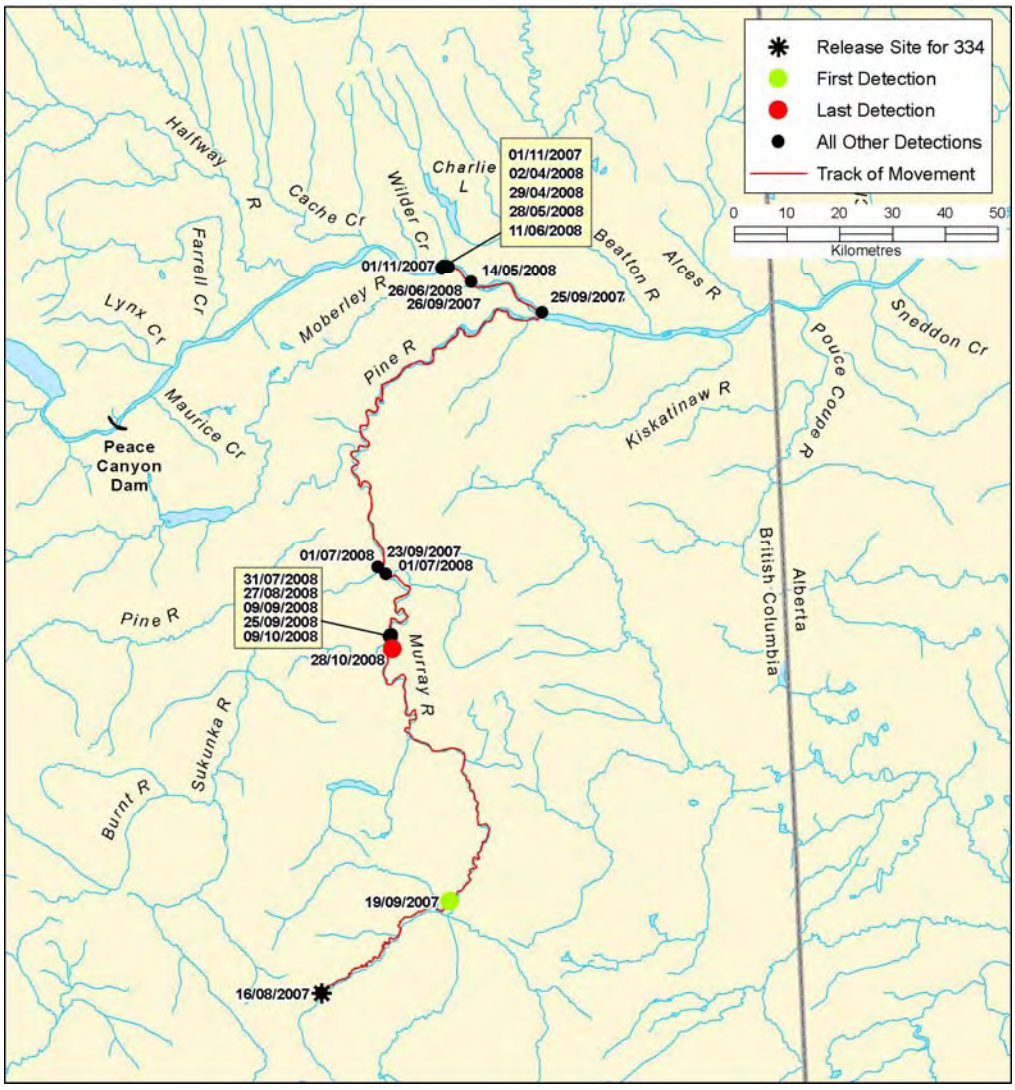

Figure 27: Individual track of a bull trout (Tag 334) with a total distance tracked of 151 km in 2008

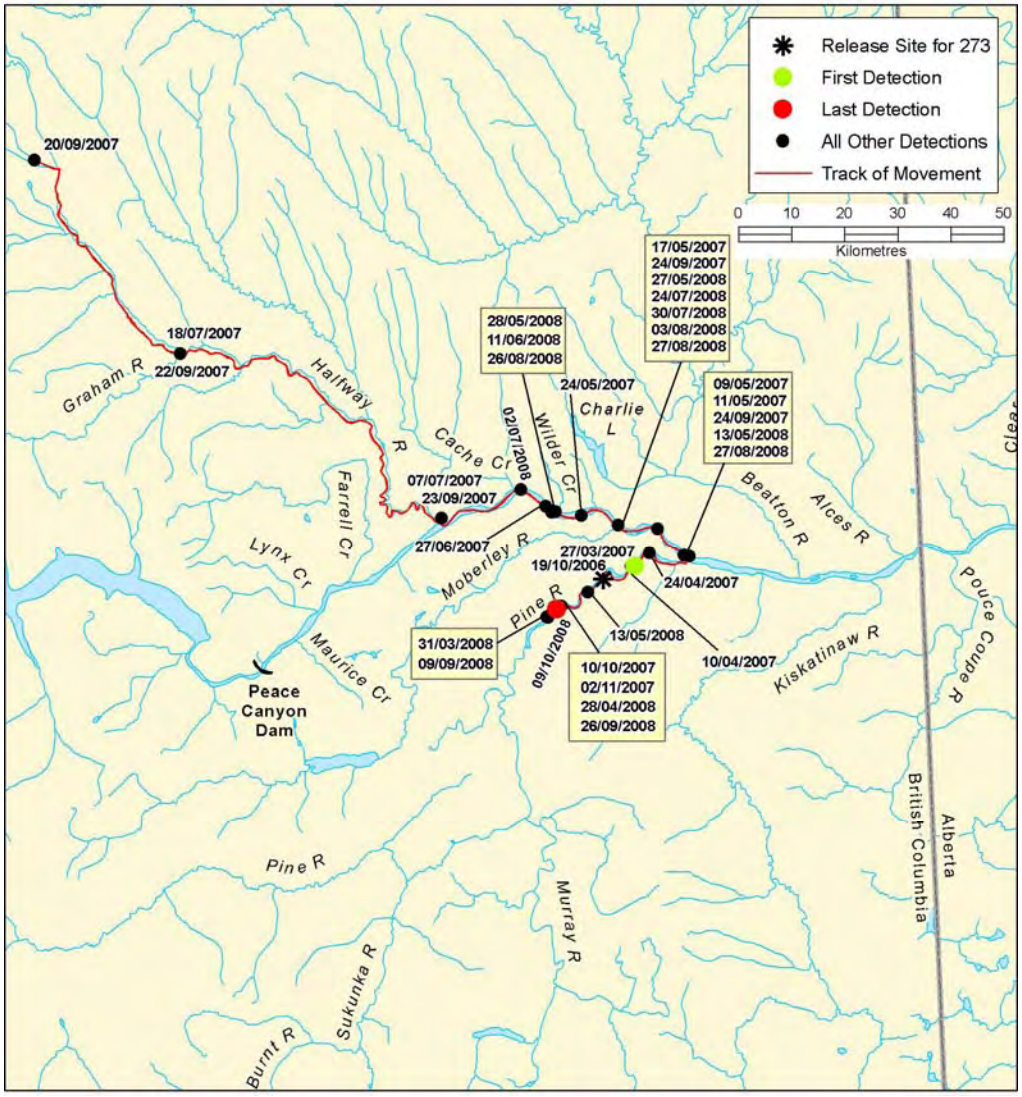

Figure 28: **Individual track of a bull trout (Tag 273) with a total distance tracked of 205 km in 2008**

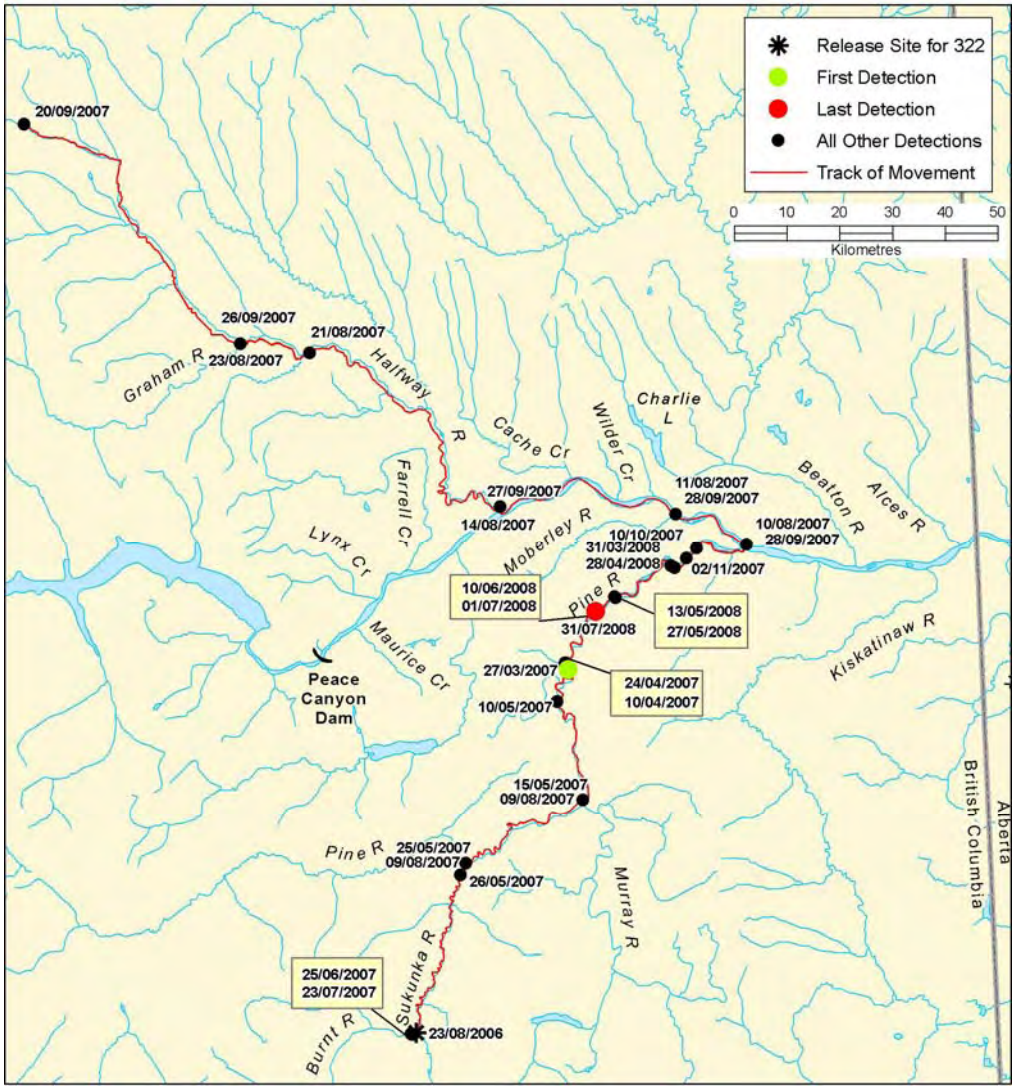

Figure 29: **Individual track of a bull trout (Tag 322) with a total distance tracked of 27 km in 2008**

Overall, based on tag detections, the movements of rainbow trout and Arctic grayling tagged in the Pine River watershed were minor, particularly for Arctic grayling which were detected almost exclusively within the mid-Pine River mainstem throughout the 2008 tracking period. Figure 30 to 33 depict examples of tagged rainbow trout and Arctic grayling that made more significant movements. Rainbow trout that were observed to move over 100 km during 2008 surveys are illustrated in Figures 31 and 32; these fish were the only rainbow trout to exit the Pine River watershed. One rainbow trout (Tag 384) moved upstream past the Site C dam location in the Peace River and the other (Tag 364) moved downstream of the Pine River.

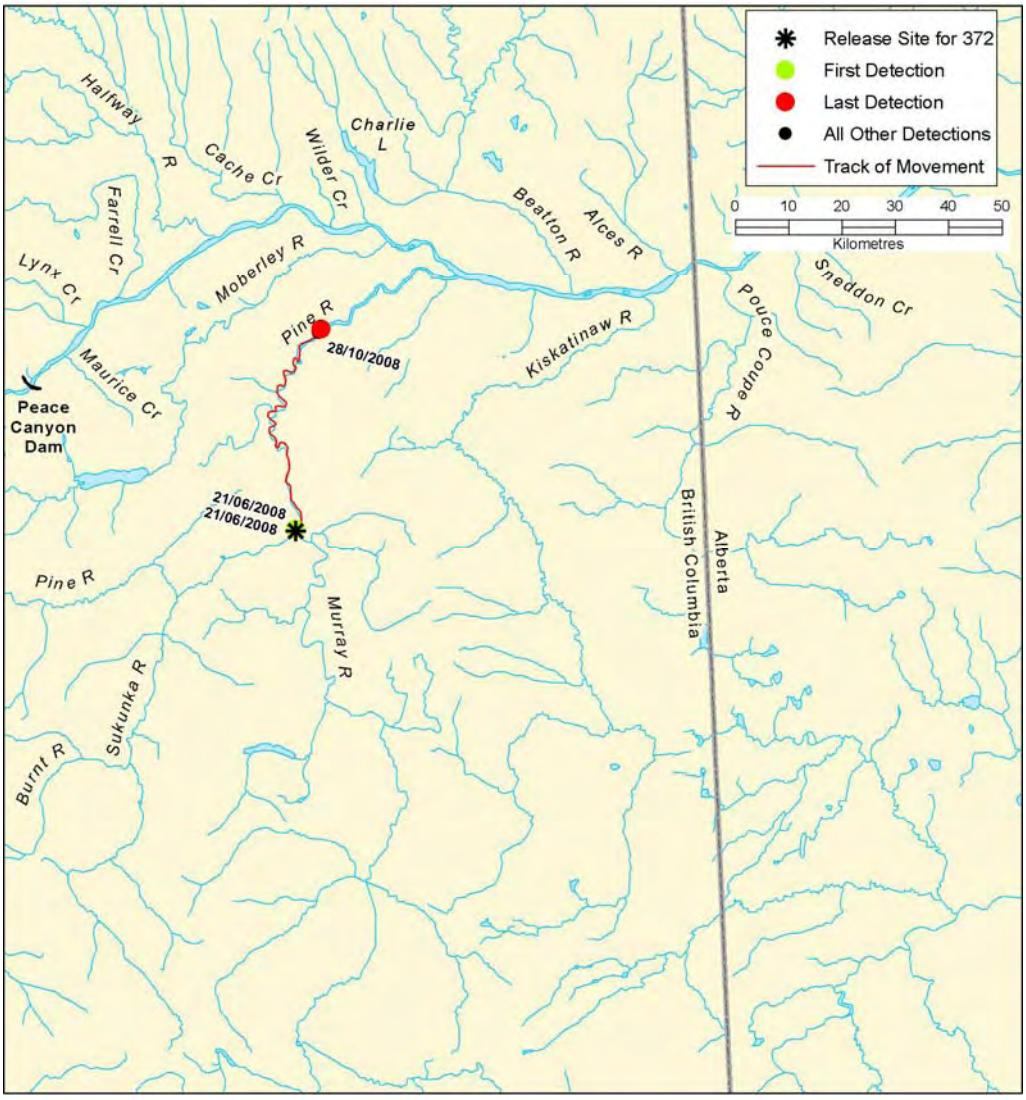

Figure 30: Individual track of a rainbow trout (Tag 372) with a total distance tracked of 58 km in 2008

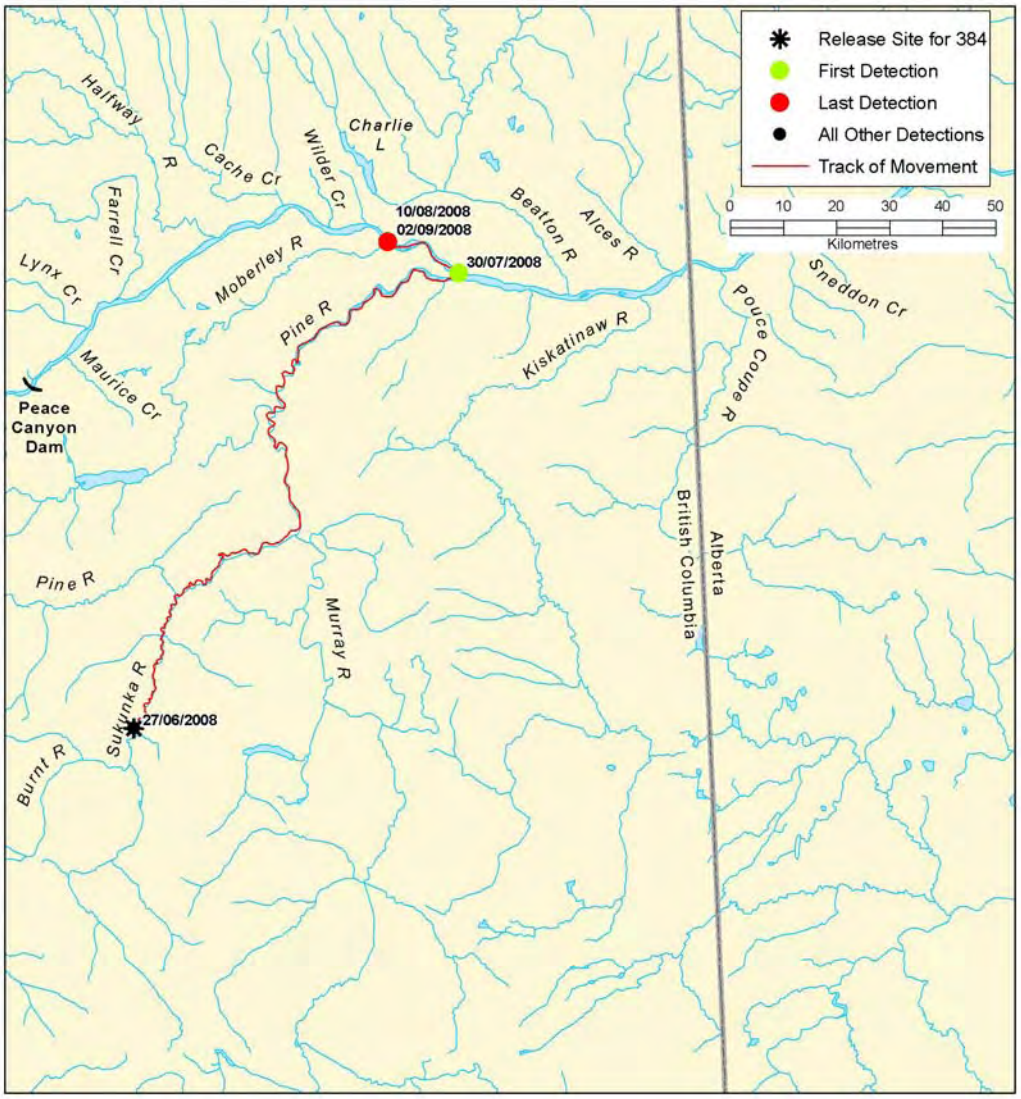

Figure 31: Individual track of a rainbow trout (Tag 384) with a total distance tracked of 179 km in 2008

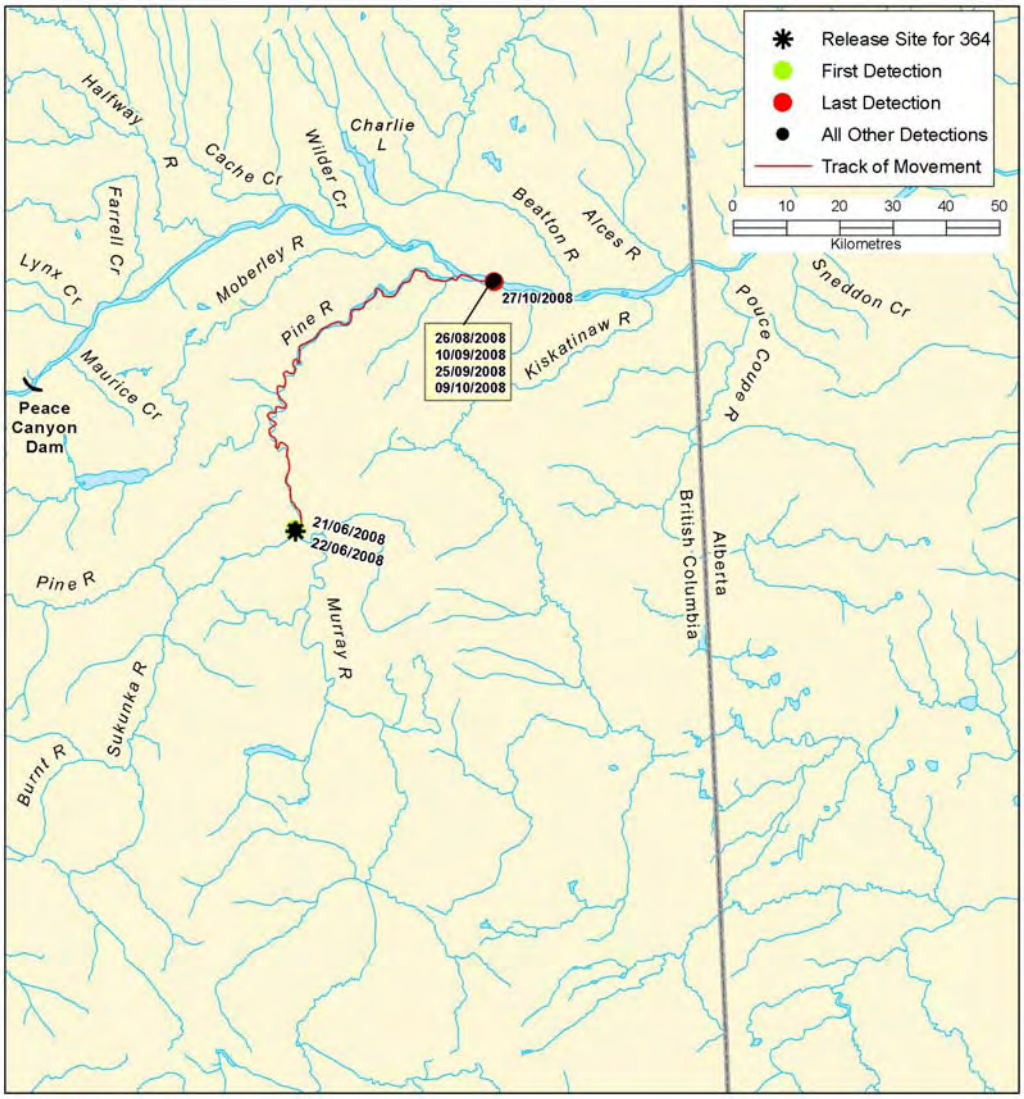

Figure 32: Individual track of a rainbow trout (Tag 364) with a total distance tracked of 102 km in 2008

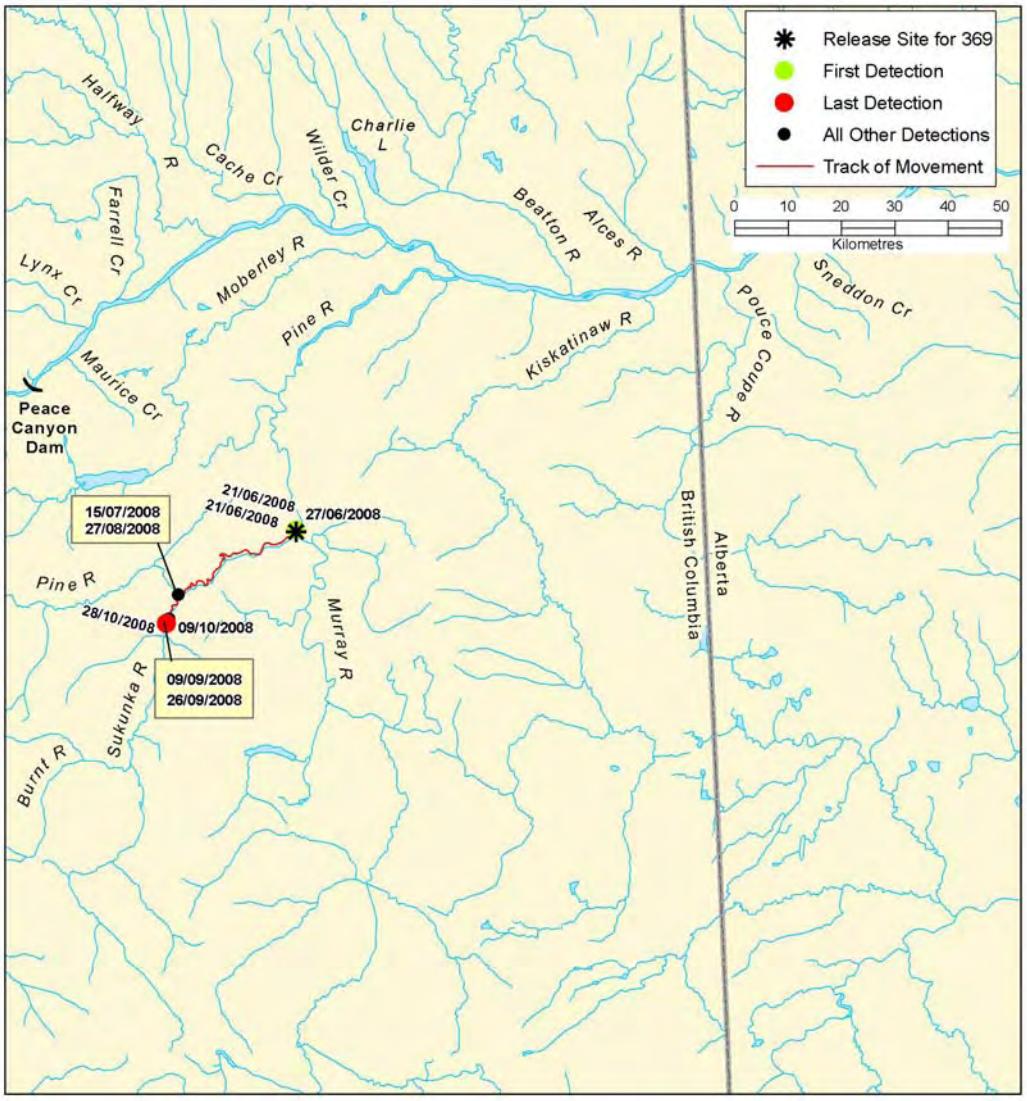

Figure 33: **Individual track of an Arctic grayling (Tag 369) with a total distance tracked of 44 km in 2008**

For the remaining active tags implanted in walleye, distinct seasonal movements were observed in 2008 within and between the Peace mainstem and its major tributaries (Figure 34 and Figure 35). For example, *Tag 8 and Tag 21* were at the mouth of the Beatton River in March, then moved upstream, where they were suspected to have spawned in May, they exited the Beatton River in June and subsequently, moved up the Peace mainstem, turned into the Pine River and moved well upstream, exited the Pine River in late autumn, and returned to the Beatton mouth by October to overwinter (Figure 34 and 35). Similar movements for walleye were observed in 2006 and 2007 (AMEC & LGL 2008d).

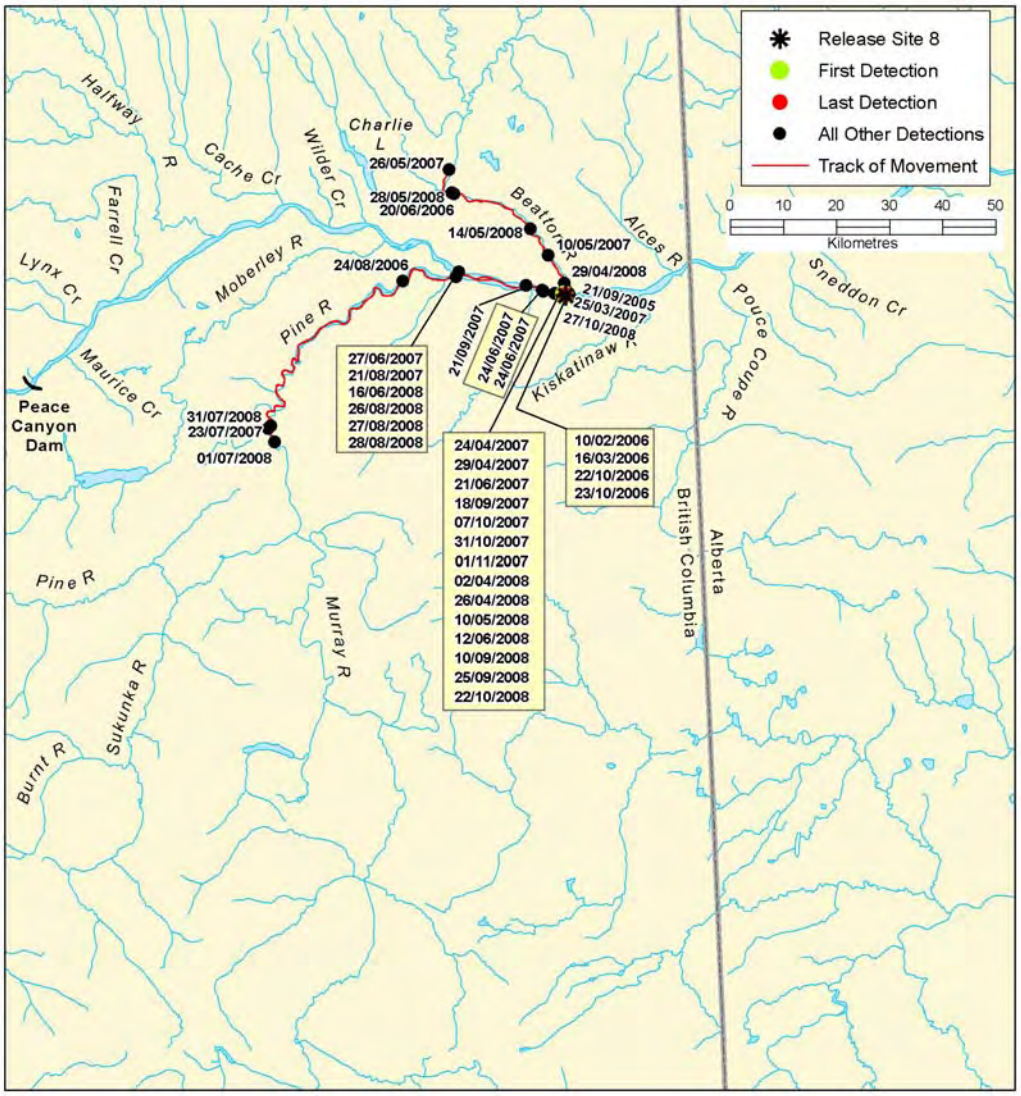

Figure 34: Individual track of a walleye (Tag 8) with a total distance tracked of 264 km in 2008

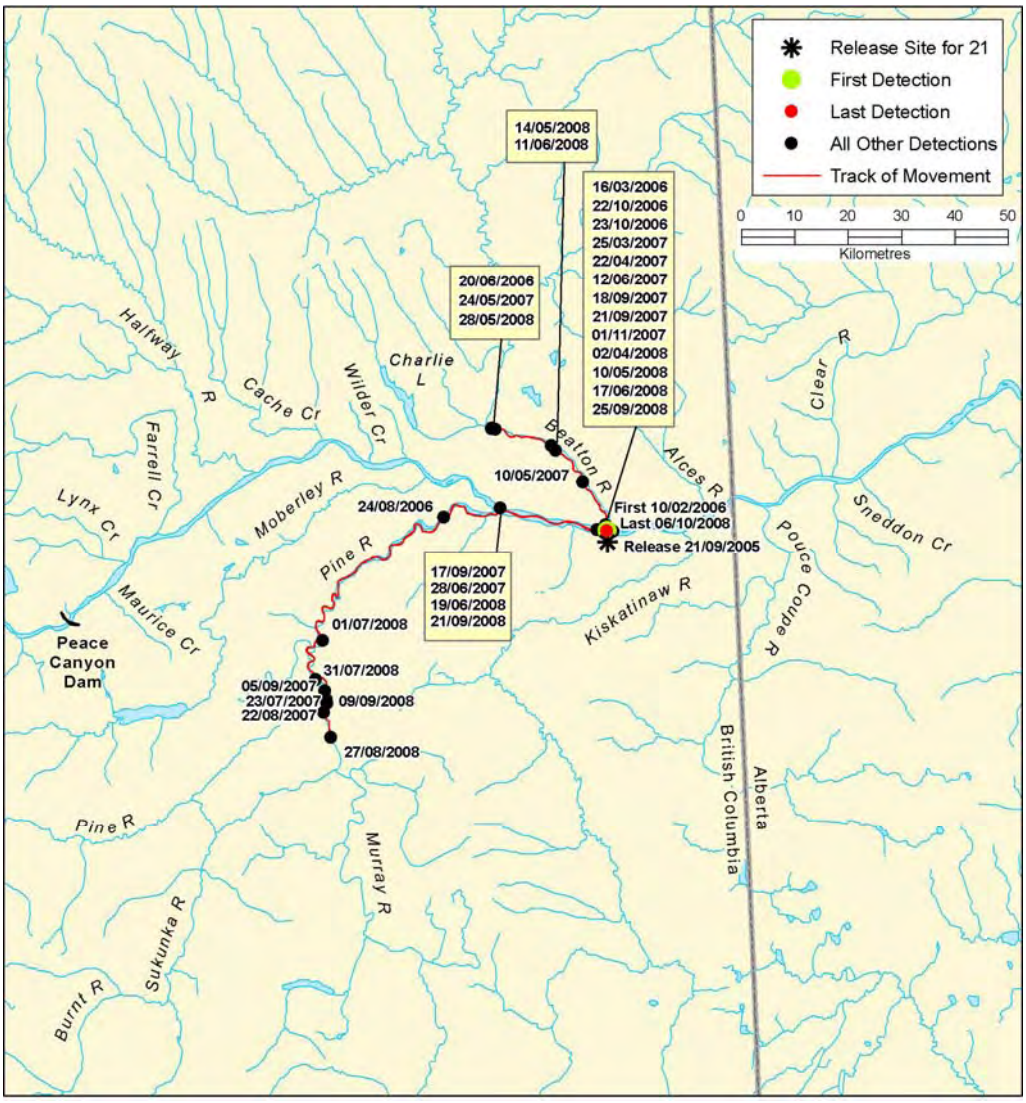

Figure 35: Individual track of a walleye (Tag 21) with a total distance tracked of 288 km in 2008

3.2.1.4 Further Assessment of Bull Trout Movement

Bull trout tag detections were further assessed to summarize seasonal movements within and between watersheds of the Peace River system. For this investigation, the study area was divided into five divisions:

1) Pine River mainstem;

2) Sukunka/Burnt river drainage;

3) Murray/Wolverine river drainage;

4) Halfway River drainage; and,

5) Peace River mainstem and its other tributaries.

Figure 36 shows the relative proportions of bull trout (excluding the 2008 tagged fish) that were detected in these five locations by month during tracking conducted in 2008.

From March to June 2008, the majority of bull trout were detected in the Pine River mainstem. From July to October 2008, the largest concentrations of bull trout were detected in the Sukunka/Burnt river drainage. The largest concentrations of bull trout in the Murray River were observed from August through September 2008. In 2007, two bull trout made long-distance movements (i.e., >450 km), from the Pine River up the Peace River mainstem to the Halfway River drainage, and back to the Pine River. No similar movements were observed in 2008.

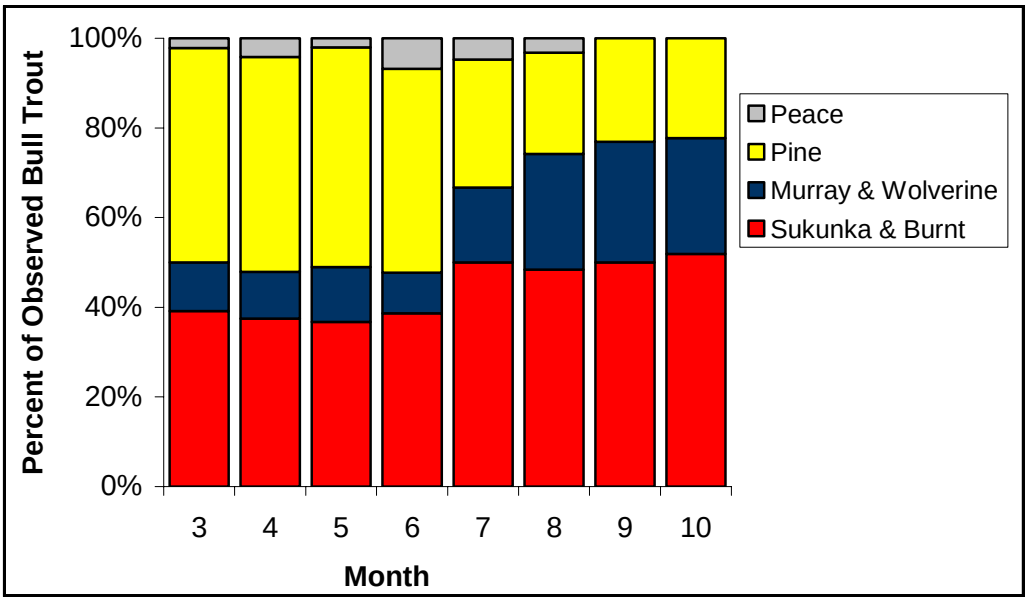

Figure 36: Seasonal pattern in the distribution of bull trout (excluding 2008-tagged fish), 2008

3.2.2 Magnitude, Direction and Seasonal Variability of Movement by Species

3.2.2.1 Overwinter Displacement

As mentioned previously, the first track in March 2008 represented the winter distribution of radio-tagged fish in the Peace River study area due to tributary

ice-cover. The distribution of radio-tagged fish during this first track is shown in Figure 37.

Arctic grayling were found in the Pine and Sukunka rivers, approximately 155 to 835 m from their last detection in November 2007 (see Figure 38).

Similarly, rainbow trout that were detected in the Pine, Murray and Sukunka rivers during fall 2007, showed a similar distribution in early 2008. Overwinter displacements, the distance between fall locations and spring locations, were less than 1 km for 7 of the 12 tagged rainbow trout. The longest displacement was 20.6 km downstream in the Pine River (Figure 38).

During the first 2008 track, 9 of 12 tagged walleye were concentrated around the confluence of the Beatton River with some additional walleye in the Peace River downstream of the Alces River (3 of 12 tagged fish; Figure 37). The distribution of detected walleye in late March was similar to that observed in November 2007, and seven fish were less than 2 km from their last detection in 2007. The longest displacement was 23.8 km (Figure 38), from the Peace mainstem into the Beatton River. Two walleye were located about 3 km from their previous position: one moved into the Beatton River, and the other moved out of the Beatton River.

Most bull trout detections were in the Pine (22 of 47 tagged fish), Sukunka (18 of 47 tagged fish) and Murray (5 of 47 tagged fish) rivers (Figure 37). In addition, two bull trout were located in the Peace River, one near Cache Creek, and one near the Pine River mouth both of which were in similar positions in November 2007 (displacements of 1.4 and 0.3 km, respectively). As with other species, the distribution of bull trout tag detections in late March was similar to that observed in November 2007 where 60% of the fish were within 1 km of their last known detection and 89% were within 4 km (Figure 38). Five bull trout showed longer-distance overwinter displacements, including one fish that had been in the Peace River (near Cache Creek) in November 2007 and was located in March 2008 approximately 48.9 km in the Pine River.

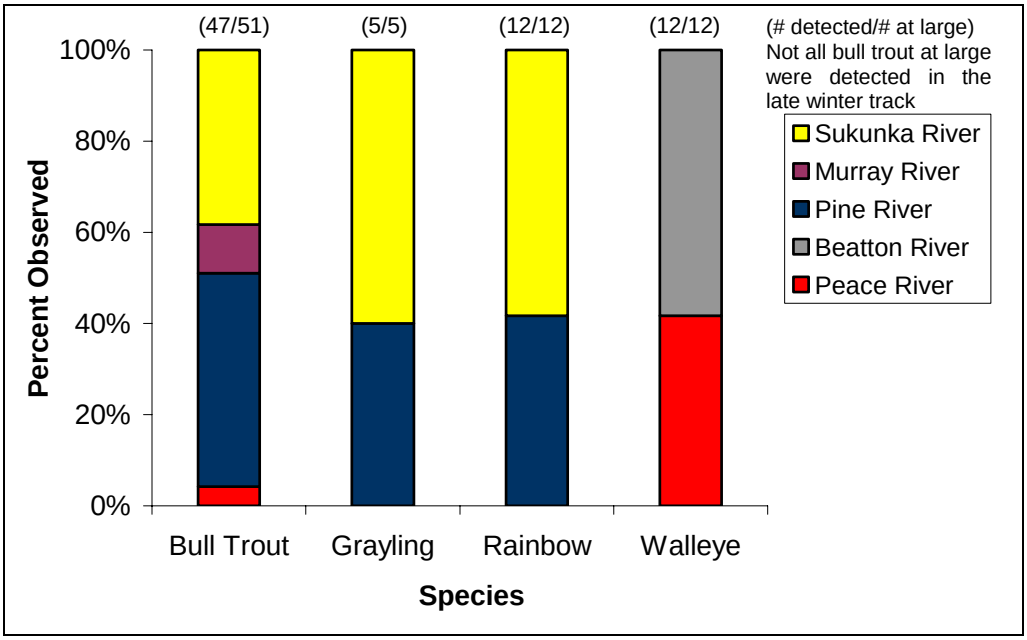

Figure 37: Distribution by watershed for bull trout, Arctic grayling, rainbow trout and walleye for late winter track (March/April 2008)

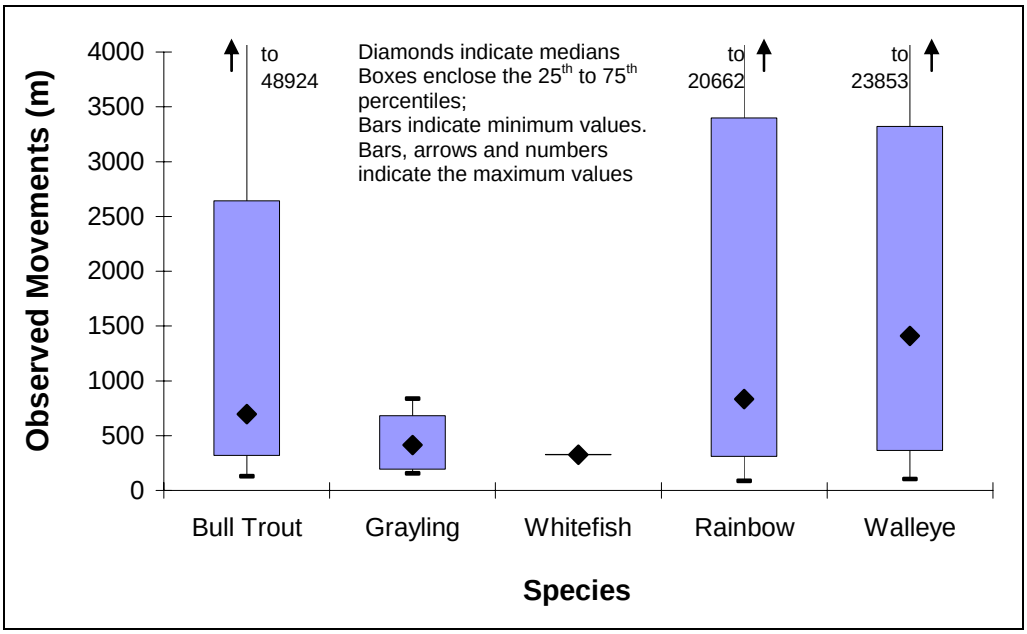

Figure 38: Distribution of observed overwinter (November 2007 to March 2008) movements, by species.

3.2.2.2 Displacement during the Monitoring Period

The relationships between displacement (defined here as the distance between first detection and last detection annually) and time at large are shown for all species and years in Figure 39. A second-order fully-factorial ANCOVA (displacement as the dependent variable; species, year, and time at large as predictor variables) showed that the relationship between displacement (upstream or downstream) and time at large for each of the three years of tracking varied significantly among species (species X time at large interaction: $F_{3,3895} = 23.7$; $P < 0.0001$), and among years (year X time at large interaction: $F_{2,3895} = 4.3$; $P = 0.013$). A statistically significant second order interaction (species X time at large X year interaction: $F_{6,3895} = 13.0$; $P < 0.0001$) showed that species-specific slopes (displacement upstream or downstream) varied among years. However, bull trout were excluded from the ANCOVA since they were not present in all three study years.

In 2008, statistically significant displacement was observed for walleye, but not for the other species (Figure 39). Walleye slopes were significant in all three study years, but in 2006 and 2007 the slopes were significantly negative (downstream), whereas in 2008 the slope was significantly positive (upstream). Two long-distance overwinter displacements likely contributed strongly to the positive slope. Significantly negative slopes observed for bull trout (2006-2007) and Arctic grayling (2005-2006 and 2006-2007) were not observed in 2008 (Figure 39). Walleye slopes were significant in all three study years, but in 2006 and 2007 the slopes were significantly negative (downstream), whereas in 2008 the slope was significantly positive (upstream). Two long-distance overwinter displacements likely contributed strongly to the positive slope. Significantly negative slopes observed for bull trout (2006-2007) and Arctic grayling (2005-2006 and 2006-2007) were not observed in 2008 (Figure 39).

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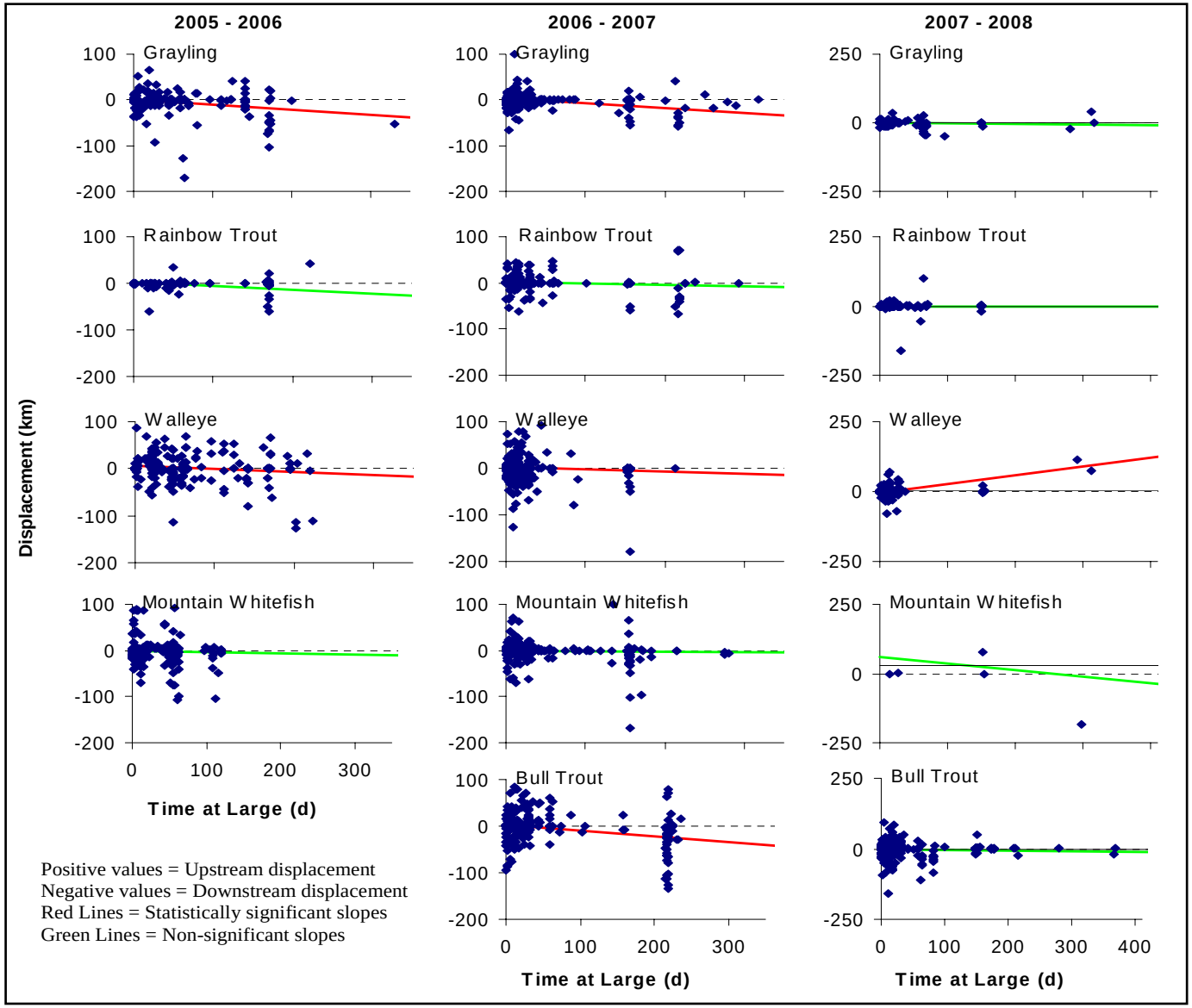

Figure 39: Displacements (km) as a function of time at large (d=day), by species and year

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For most species, median displacements showed significant variation among months (Table 7). The most striking of the seasonal displacement patterns were those of bull trout (Figure 40). In 2007 and 2008, bull trout typically made downstream movements in the spring and fall (September to March), and generally made upstream movements in the summer (May to August, especially July and August). Walleye displacement was most variable in the late spring and summer. Their movements tended to be in the upstream direction in May and July, whereas downstream displacement was more common in June. Walleye displacements did not vary significantly among months in 2008 (Table 7). Arctic grayling displacements in 2008 showed a pattern in which downstream displacement was most common in June, whereas upstream displacements were more often observed in July and August (Figure 40). In 2006 and 2007, Arctic grayling were more sedentary, with downstream movements mostly in July 2006, and March 2007. Arctic grayling displacements did not vary significantly among months in 2007 (Table 7). In 2008, rainbow trout showed some striking downstream displacements in June. A similar temporal pattern of displacements was not observed in prior years (Figure 40). Median mountain whitefish displacements in 2006 were typically in the downstream direction, whereas 2007 displacements were of shorter distances and more variable in direction. Very few mountain whitefish were tracked in 2008.

Table 7: Median displacement rates (meter/day) by species, month and year

		Median displacement (meter/day)				
Year	Month	Bull trout	Arctic grayling	Mountain whitefish	Rainbow trout	Walleye
2006	Feb		-23		x	1
	Mar		-15		-8	3
	Apr		51		-49	262
	May		-10		-25	505
	Jun		15	-3555	-4	-68
	Jul		-3710	-2527	x	1289
	Aug		2	-138	4	75
	Sep		x	x	x	x
	Oct		-9	2	3	5
2007	Feb					
	Mar	-91	-5	-1	-4	-2
	Apr	-10	5	0	6	0
	May	1	-3	6	14	1117
	Jun	13	-3	-4	11	1
	Jul	32	-1	3	6	23
	Aug	9	-2	-8	-2	-59
	Sep	0	-3	-1	-8	8
	Oct	-9	-6	-2	-1	1
2008	Feb					
	Mar	2	x	x	2	x
	Apr	2	x	x	-15	-13
	May	5	4	x	5	313
	Jun	0	-800	x	-19	6
	Jul	12	23	x	-2	35
	Aug	-8	-157	x	-10	-2
	Sep	-14	-4	x	0	50
	Oct	-28	-3	x	-6	37
	p (2006)		<0.0001	<0.0001	0.03	<0.0001
	p (2007)	<0.0001	0.19	0.06	0.02	<0.0001
	p (2008)	<0.0001	<0.0001		0.23	0.2966

Note: Overwinter movements are included; *P* values are from Kruskal-Wallis tests of the effects of month on displacement; Cells with n < 10 have been excluded and are marked with “x”.

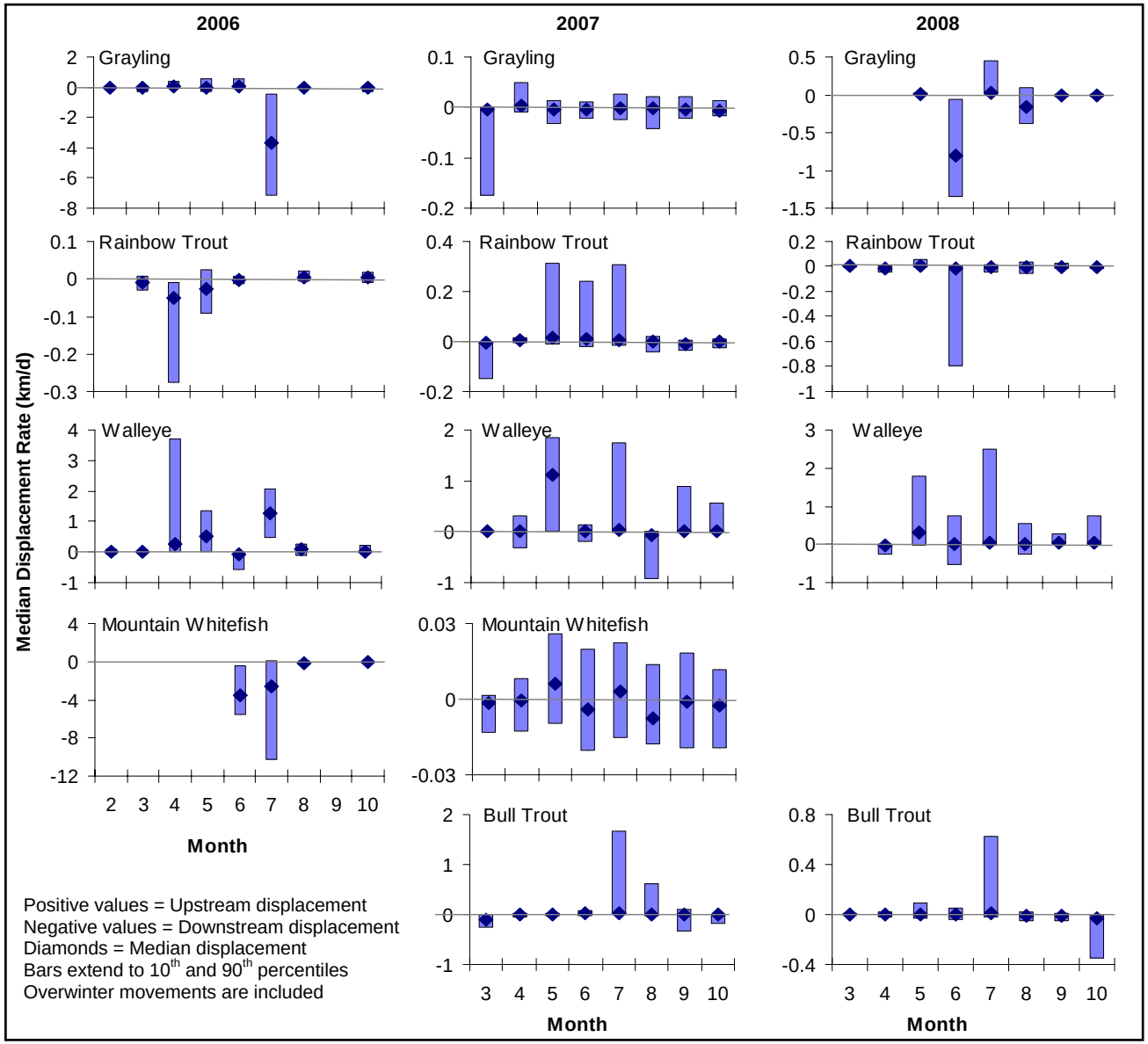

Figure 40: Distribution of observed median individual displacement rates (km/d) by species, month and year

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Displacement rates, in meters per day (m/d), varied significantly among species ($H_{2,1583}$ = 1.94; P <0.0001), but not among years ($H_{2,1583}$ = 2.7; P = 0.26; Figure 41); bull trout and mountain whitefish were excluded from the analysis since they were not tracked in all three study years. There was no significant interaction effect between species and years ($H_{4,1583}$ = 2.4; P = 0.66). The differences among species were driven largely by the walleye, which was the only species to have median displacement rates in the upstream direction in all years (13, 0.8, and 8.3 m/d in 2006, 2007, and 2008, respectively). When the 2008 data were analyzed in isolation (which allowed bull trout to be included in the test), a significant species effect was observed (H_3 = 15.9; P = 0.0012), and the largest difference was between Arctic grayling (median displacement of -18.2 m/d) and walleye. The differences among species were most pronounced in 2006, when the median displacement rate of mountain whitefish was 69.5 m/d in the downstream direction. The median displacement rate of mountain whitefish in 2007 was -1 m/d, which was significantly different from the 2006 rate (P < 0.0001). In 2006, tracking commenced immediately (approximately one week) after fish in the Peace River mainstem were tagged, so the significantly greater displacement is probably largely due to handling stress and insufficient recovery time

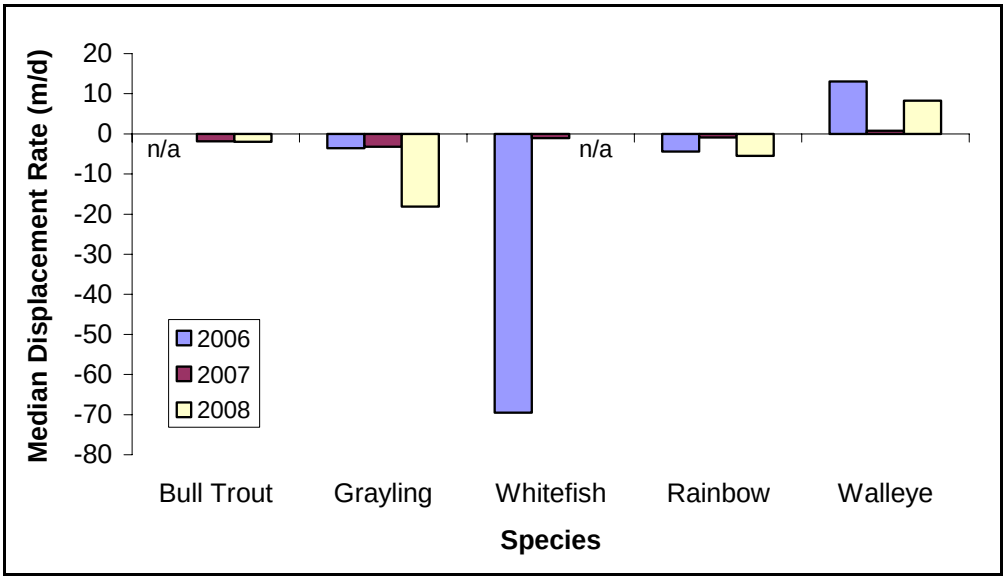

Figure 41: Median displacement rates (meter/day) by species and year

3.2.2.3 Distances Moved During Monitoring Periods

Overall distances moved varied significantly among species ($H_{2,309}$ = 24.3; P < 0.0001), but not among years ($H_{2,309}$ = 5.8; P = 0.055; Figure 42); bull trout and mountain whitefish were excluded from the analysis since they were not tracked in all three study years. There was no significant interaction effect between species and years ($H_{4,309}$ = 2.2; P = 0.70). When 2008 data were analyzed in isolation (which allowed bull trout to be included in the test), a significant species-effect was observed (H_4 = 19.8; P = 0.0005).

In 2008, the median movements among species were not statistically significant; mountain whitefish were not included because of low numbers. In all years, the median distance moved by walleye (2006: 80.1 km; 2007: 117.7 km; 2008: 61.1 km) was longer than that of any other species (differences were statistically significant in 2006 and 2007). In 2006, the median distance moved by Arctic grayling (45.4 km) was significantly greater than all other species except walleye. There were no significant differences in the distances moved between the remaining species (mountain whitefish: 20.3 km; rainbow trout: 8.9 km) in 2006. In 2007, the median distance moved by bull trout (51.2 km) was significantly greater than all other species except walleye. There were no significant differences in the distances moved between the remaining species (Arctic grayling: 8.9 km; mountain whitefish: 6.3 km; rainbow trout: 7.4 km) in 2007 (Figure 42).

Among year differences in median distance moved were statistically significant for bull trout (2007: 51.2 km; 2008: 26.6 km; p = 0.027), Arctic grayling (2006: 45.4 km; 2007: 8.9 km; 2008: 14.2 km; p = 0.0003) and mountain whitefish (2006: 20.3 km; 2007: 6.3 km; p < 0.0001). The differences among years for walleye was large, but not statistically significant (P = 0.08) due to the large variance in distances observed within each year. The differences among years for rainbow trout (8.9 km, 7.4 km, and 7.8 km in 2006, 2007, and 2008, respectively) was negligible (P = 0.70).

Temporal patterns in movements varied among years and among species (Figure 43). Temporal trends observed in 2006 and 2007 did not appear to hold for 2008. For example, in 2007, bull trout moved longer distances in late summer and in the fall, compared to the spring and early summer, whereas in 2008 temporal trends were less clear. Also, in 2006 and 2007, Arctic grayling and rainbow trout movements peaked in the spring; in 2008, peak movements were closer to the end of the year.

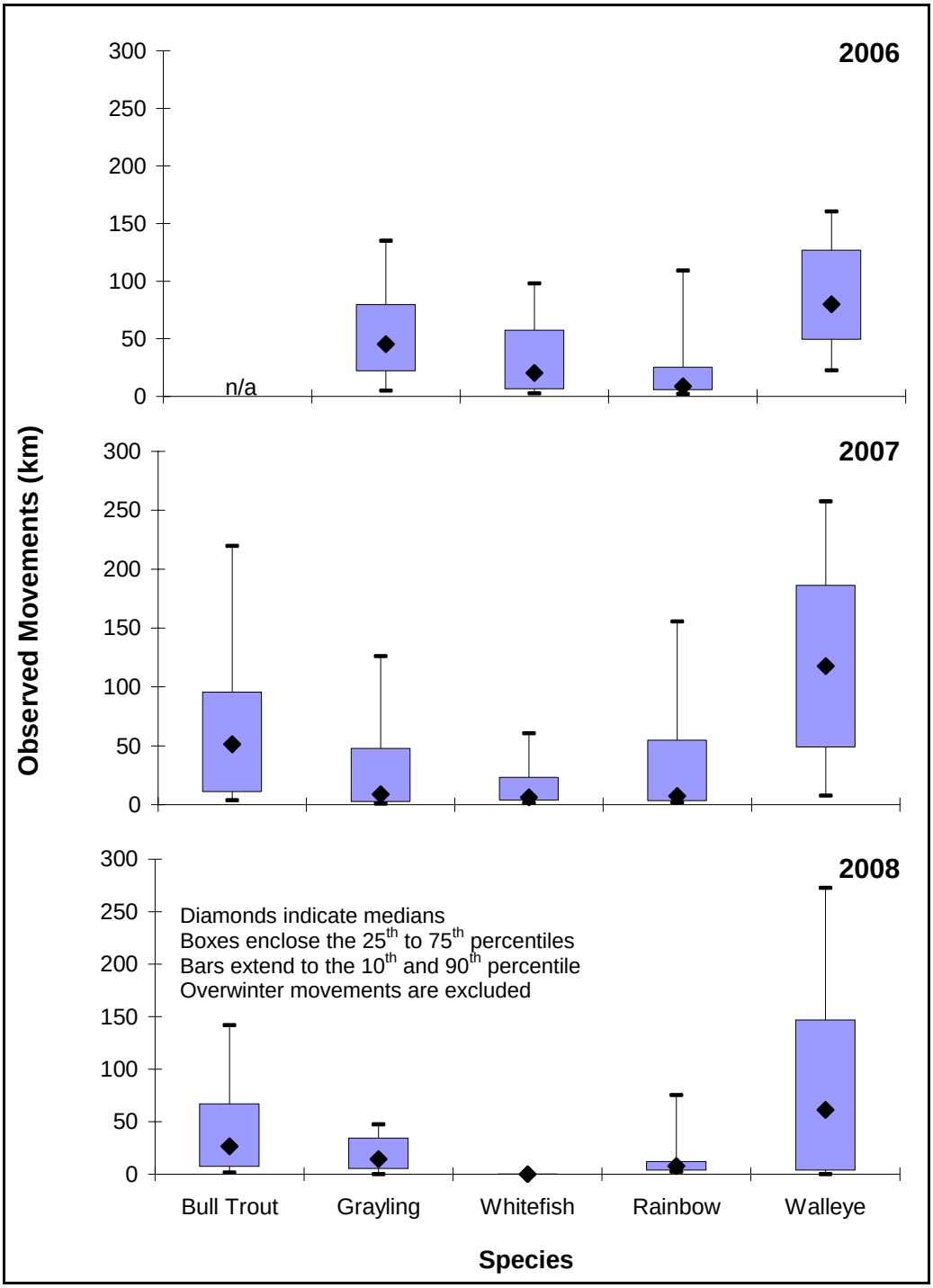

Figure 42: **Frequency distribution of observed movements (km) for each species and year. Each box-plot shows the range of observed 'total movement' values for individuals of a given species within a given year. The 'total movement' for each individual was calculated by summing all observed movements for that individual over the study period.**

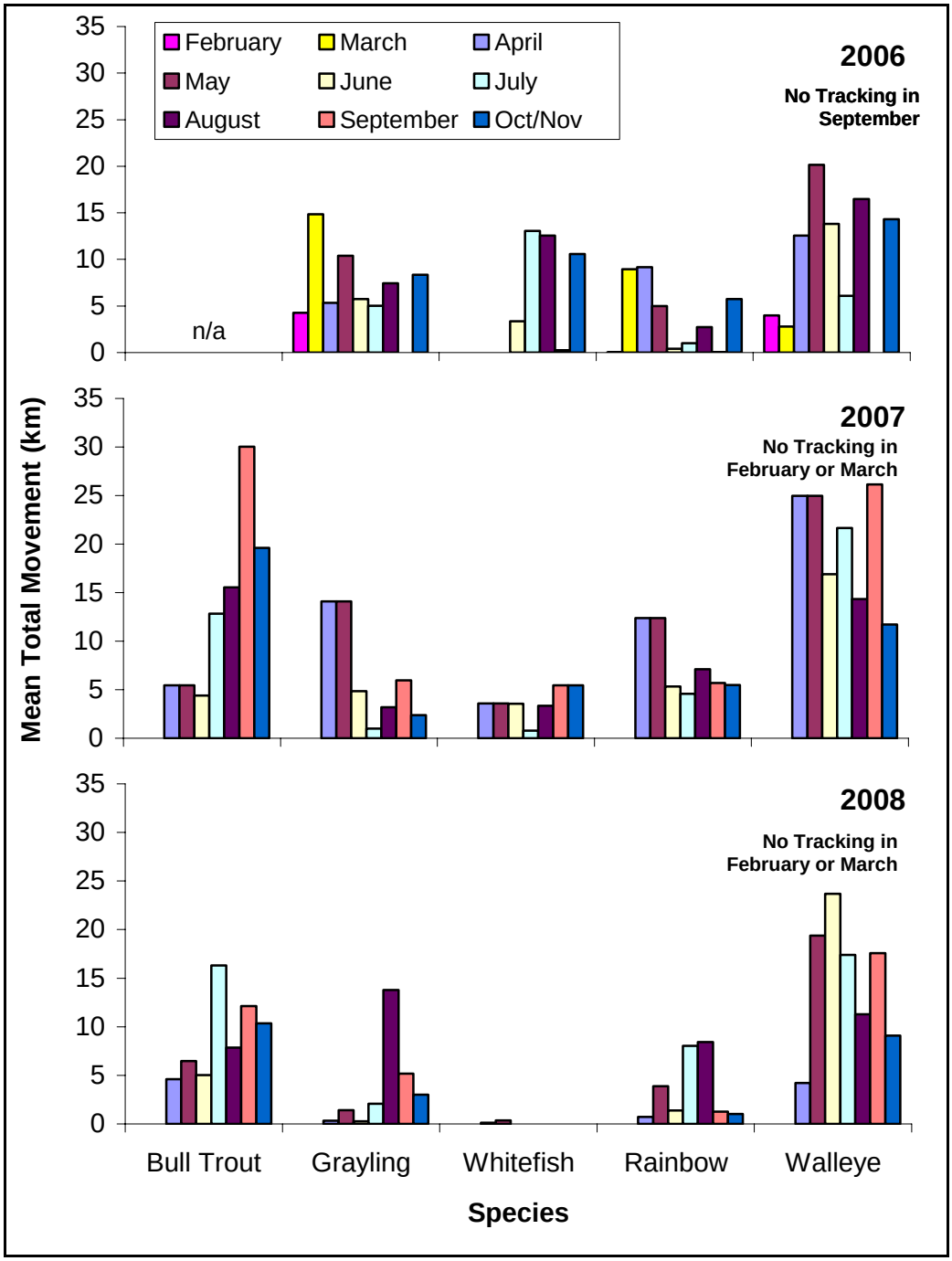

Figure 43: **Mean total distance moved (km), calculated by summing the total distance moved by each individual and dividing by the total number of individuals, and plotted for each month, species and year**

The proportion of radio-tagged fish that passed the Site C dam location differed significantly among species ($H_{3,526}$ = 10.7; P = 0.014) and among years ($H_{2,526}$ = 17.5; P < 0.0001); bull trout were excluded from the analysis since they were not tracked in all three study years. No significant interaction between species and years was detected (Figure 44; $H_{6,526}$ = 6.6; P = 0.36).

In 2006, the percentage of Arctic grayling (72%; 33 fish) that passed the potential Site C dam location was significantly greater than that of all three other study species, probably largely because of the proximity of the dam site to the Moberly River, the main spawning stream for Arctic grayling and the location of their original release (Figures 7 and 8). The percentage of mountain whitefish (29%; 32 fish) that passed the potential Site C Dam location was significantly greater than that of walleye (6.0%; 3 fish), but not statistically different from that of rainbow trout (15%; 4 fish). Rainbow trout were not significantly different from walleye in their propensity to pass the Site C dam location.

In 2007, significantly smaller proportions of radio-tagged fish passed the Site C dam location compared to 2006 (Figure 4544). Nevertheless, the relative pattern of differences among species in 2007 was similar to that in 2006 (as indicated from the lack of statistical significance in the interaction term in the SRH ANOVA). In 2006 and 2007, Arctic grayling was the species most likely to pass the Site C dam location. In 2007, 24% of the radio-tagged Arctic grayling (10 fish) passed the Site C dam location. Only 29% of Peace River-tagged Arctic grayling moved past Site C while none of the Pine River-tagged Arctic grayling left the Pine River system. The proportion of tagged Arctic grayling that passed Site C in 2007 was significantly less than the proportion that passed in 2006, and significantly higher than that observed for all other species in 2007, with the exception of walleye which was not significantly different. The proportion of bull trout that passed the Site C dam location in 2007 was <10% (5 fish). Only one (of 35) radio-tagged rainbow trout passed Site C in 2007 and this was one of the 20 rainbow trout that had been radio-tagged in the Peace River mainstem.

In 2008, only four tagged fish passed the Site C dam location; all of them were Pine River-tagged fish. One bull trout (*Tag 273*) passed this location four times, once in May, once in July, and twice in August. A second bull trout (*Tag 274*) passed the Site C dam location going upstream in June and downstream in July. A third bull trout (Tag 334), located upstream of the Site C dam location at the beginning of the year, passed downstream of this location in June before moving into the Pine River drainage. One rainbow trout passed the Site C dam location in August and stayed near the fixed-

station receiver at the mouth of the Moberly River until September, but was not detected after this time.

None of the fish tagged from the Peace River in 2008 passed the Site C dam location, which included active tags for 20 Arctic grayling, 4 mountain whitefish, 6 rainbow trout, and 15 walleye. One rainbow trout and three bull trout initially tagged from the Pine River passed the Site C dam location, which included active tags for 84 bull trout, 10 Arctic grayling, and 18 rainbow trout.

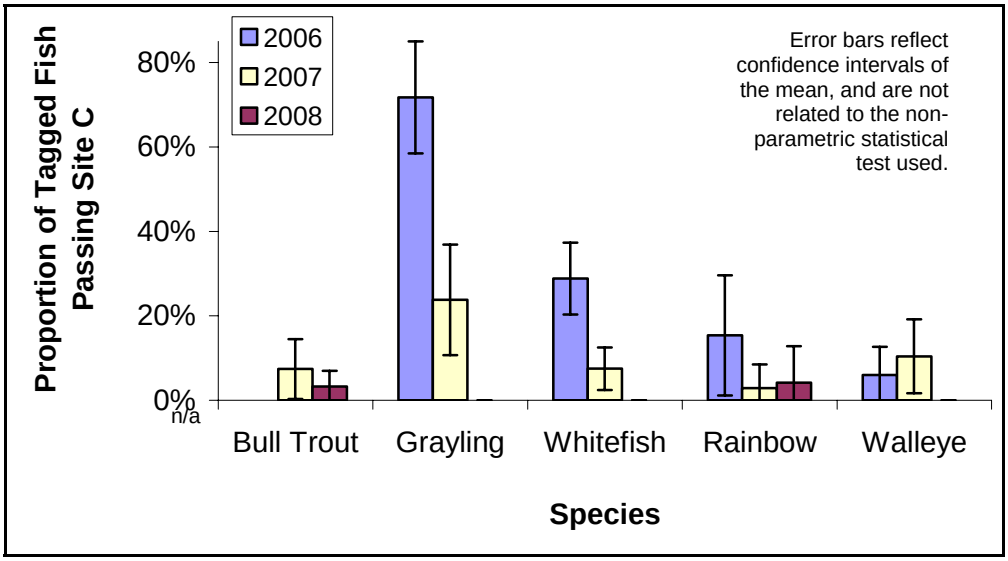

Figure 44: Proportion of radio-tagged fish that moved past Site C, by species and year

Passage events across the proposed Site C dam location occurred throughout the year, and some species showed seasonal passage patterns (Figure 45). For example, Arctic grayling passage peaked in April and May in 2006 and 2007, with lower proportions of fish passing in June 2006 and 2007, July 2006, and March 2007. Mountain whitefish passage peaked in June and July 2006, but was relatively constant throughout 2007. The lack of pre-June 2006 mountain whitefish detections is an artefact of the sampling program since mountain whitefish were not tagged before June 2006. In all years, rainbow trout and walleye passage past the proposed Site C dam location was sporadic.

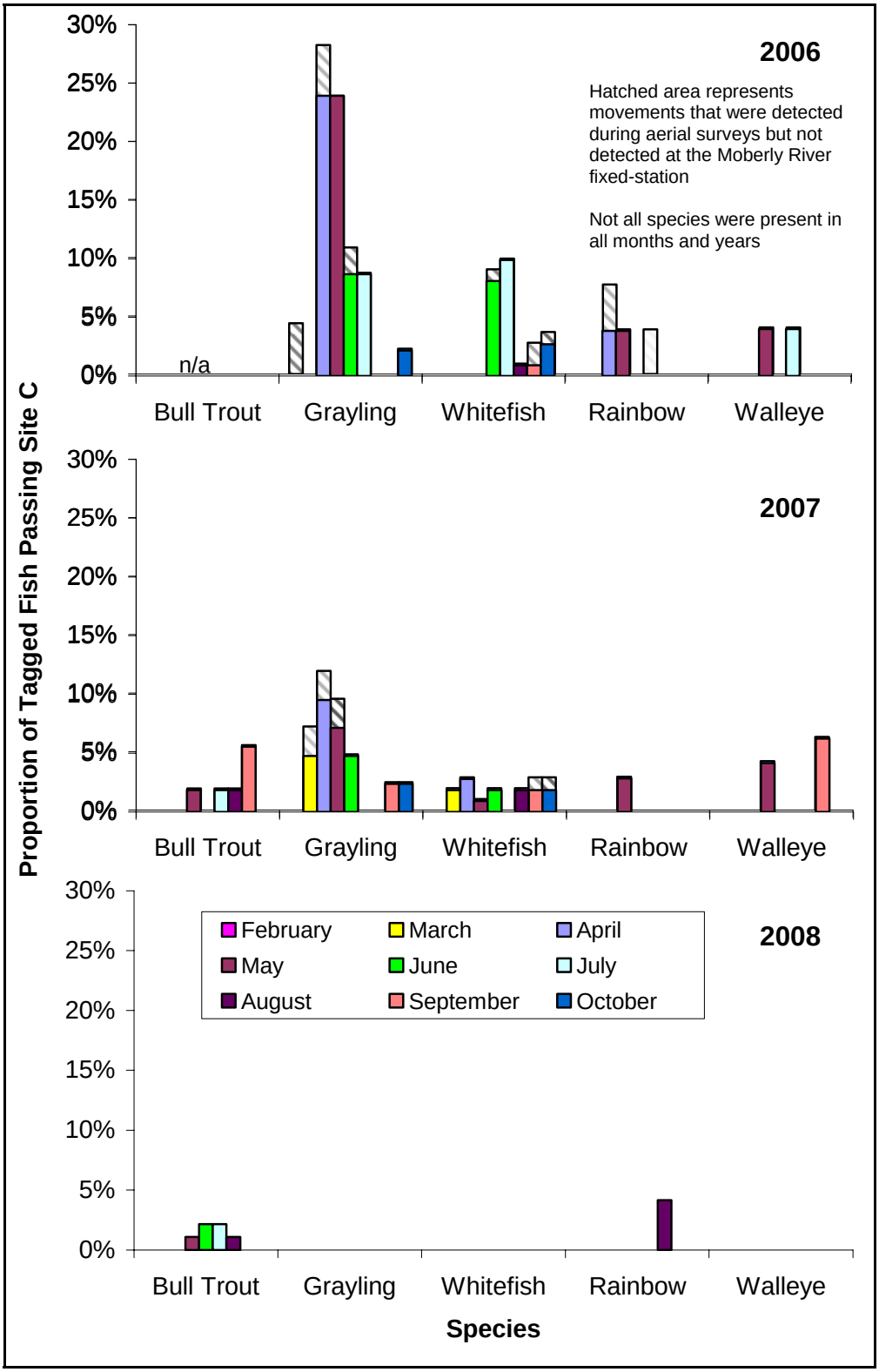

Figure 45: **Proportion of radio-tagged fish that moved past Site C, by month species and year**

4.0 DISCUSSION

4.1 Fish Movements in the Peace River

4.1.1 Arctic Grayling

None of the Arctic grayling that were tagged in the Peace River mainstem in September 2005 were detected in 2008 because their tags were past their expected battery life and all remaining radio-tagged Arctic grayling were tagged in the Pine River system. As such, the 2008 tracking results did not further our current state of knowledge of the movements of Arctic grayling in the Peace River mainstem. The following discussion for Arctic grayling is based on tracking studies from 2006 and 2007 (AMEC & LGL 2008c, 2008d), as well as, some additional information from other researchers (e.g., R. L. & L. 1991a, 1991b, Mainstream 2004, 2005, 2006 and 2007).

In summary, the Arctic grayling population in the Peace River mainstem appear to:

- Occur primarily in the Peace River reach between the Halfway River and Beatton River confluences, and to some extent in the lower Halfway River;
- Migrate into specific tributaries (e.g., mainly the Moberly River, and occasionally the lower Halfway and Beatton rivers) in early spring to spawn, and subsequently returns to the mainstem to feed and overwinter (some may overwinter in the lower Halfway River);
- Use smaller tributaries sparingly or not at all upstream of the potential Site C dam location (i.e., Maurice, Lynx, Farrell, and Cache creeks) for spawning and rearing; and
- Pass the Site C dam location more compared to that of any other sportfish in the study area.

It appears that the Moberly River is the main contributor to annual juvenile recruitment of the Arctic grayling population in the Peace River mainstem within the Site C study area (AMEC & LGL 2008c, 2008d). From April to May, several Arctic grayling from the Peace River mainstem were detected well upstream in the Moberly River, and by June they had retreated back to the mainstem. These results are consistent with those of previous studies which reported finding more Arctic grayling in the Moberly River in spring than in any other tributary. Arctic grayling young-of-the-year were found as far upstream as 69 km and 75 km from the mouth of the Moberly River in 1977 and 1989, respectively (ARL 1991b, RRCS 1978). Other supporting

evidence of the Moberly River as an important spawning and rearing area for Arctic grayling comes from the spring hoop-netting and summer electrofishing surveys conducted in 2006 (AMEC & LGL 2008c). Adult and ripe Arctic grayling were captured while moving up the Moberly River, and small numbers of young-of-the-year were found in the lower Moberly River suggestive of spawning upstream.

The extent of the distribution of Arctic grayling spawning and rearing in the Moberly River is not precisely known. Based on the locations of tagged grayling in the spring, spawning appears to occur both downstream and upstream of the potential zone of inundation of the Site C Dam (AMEC & LGL 2008c). In May 2007, radio-tagged Arctic grayling were detected as far as 50 km from the mouth of the Moberly River (AMEC & LGL 2008d).

Some inter-annual variation in Arctic grayling migration timing from the Peace River mainstem to the Moberly River has been observed during our tracking studies, probably largely due to variability in the arrival of spring. Arctic grayling are early spring spawners, and typically move into tributary streams during or immediately after ice break-up to spawn (Tripp and McCart 1974). Fewer fish were detected in the Moberly River in 2006 (2; 10%) compared to 2007 (7, 25%), likely because our aerial surveys were not well timed for an early spring and movement up river was detected in 2007 with a fixed stations in the Moberly River but this was not installed in 2006.

Based on current results, the smaller tributaries upstream of the Site C dam location are probably of limited importance for Arctic grayling spawning and rearing. For example, tracking surveys conducted in 2006 and 2007 did not detect Arctic grayling in Maurice, Lynx, Farrell, and Cache creeks (AMEC & LGL 2008c, 2008d). Consistent with this observation, neither adults nor young-of-the-year were captured during instream surveys in the smaller tributaries in 2005 and 2006, but an adult fish was captured in the lower Halfway River (AMEC & LGL 2008a, 2008c). Contrary to our findings, minor upstream movements of Arctic grayling were recorded in Farrell, Lynx, and Maurice creeks in an earlier study (RRCS 1978); these minor differences between studies may be indicative of change in Arctic grayling distribution in these drainages over time.

In regards to the tributaries downstream of the Site C dam location, some spawning by Arctic grayling likely occurs in the Beatton River. Distinct spring upstream migrations were not observed but several adult fish were captured and radio-tagged within the vicinity of the Beatton River confluence in September 2005 (AMEC & LGL 2008a), and subsequently several fish were detected within the Beatton mouth area in most months between spring and autumn 2006 and 2007 (AMEC & LGL 2008c, 2008d). In addition, one fish

was detected approximately 20 km upstream from the mouth of the Beatton River in May 2007, which may have been related to spawning migrations (AMEC & LGL, 2008d).

In contrast to the Arctic grayling tagged in the Peace River, the movements of Arctic grayling in the Pine River watershed are as yet not well documented since a large proportion of the tagged population was not tagged until 2008. As a result, 2008 tracking in the Pine River watershed was based on 43 Arctic grayling of which, 18 and 25 were released in 2006 and 2008, respectively. Therefore, detections for Arctic grayling released in 2008 are considered preliminary because sufficient time (~2 wks for some fish) may not have been allowed for recovery and dispersion prior to tracking. For example, significant differences were observed for mountain whitefish movements between 2006 and 2007, likely because insufficient time was provided for recovery and dispersion prior to tracking in 2006. Results from 2009 tracking surveys should provide more definitive information on Arctic grayling movements for the Pine River system.

Preliminary conclusions based on 2007 and 2008 tracking studies conducted in the Pine River, as well as some tracking observations from MOE in the late 1990s (AMEC & LGL 2008b) indicate that Pine River Arctic grayling:

- Are year-round residents similar to that observed for the upper Halfway River populations;
- Occur mainly in the Sukunka and Burnt rivers and in the Pine River mainstem near the mouth of the Murray River;
- Do not move much from their preferred areas, except to spawn;
- Spawn mainly in the Sukunka and Burnt rivers; and
- Have a low probability of moving past the proposed Site C dam location.

While more definitive results on the movements of Pine River tagged Arctic grayling will not be available till late 2009, the findings to date do nonetheless concur with those reported by AMEC and LGL (2008b) for MOE radio-tagged fish in the Sukunka River in the late 1990s. In that study, none of the Arctic grayling was detected outside of the Pine River, and their movements overall were minor. Similar results have been reported for Arctic grayling in the Halfway River drainage, mainly the headwater tributaries (ARL 1997, AMEC & LGL 2008b), Cumulatively, the findings from these studies support the notion that Arctic grayling populations in big-river tributaries, such as the Halfway and Pine rivers, within the Site C study area are likely resident year-round and as such these fish have a low probability of entering the Peace River mainstem and moving past the Site C dam location.

The results to date indicate that overwinter displacement is minimal for Arctic grayling in both the Peace River mainstem and Pine River; the same most likely applies to the Halfway River population, but these data have not yet been analyzed. Overall, Arctic grayling were detected in the spring within a kilometre from where they were last detected in autumn in the previous year. Among the five species of fish tracked, displacements rates for Arctic grayling during the monitoring period were found to be moderate (10-50 km) and differed somewhat seasonally among years, which may be partly due to the mix of 2006 and 2008 tagged fish detected during 2008 surveys. The median distance moved by Arctic grayling was found to be greater than that moved by rainbow trout and mountain whitefish in all years. Although premature at this stage, the median distance (i.e., 14 km in 2008) moved by Pine River Arctic grayling appears to be less than that observed for the Peace River mainstem population in 2006 (45 km).

4.1.2 Bull Trout

Our results for bull trout are based on releases from all three years (54 in 2006; 9 in 2007; 42 in 2008). As such, the 2007 results are based primarily (86%) on fish tagged in 2006, whereas the 2008 results are based on a mix of 'old' and 'new' fish, with the proportion of 'new' fish increasing from 14% in early July to 56% by end October. Due to the increasing incidence of 'new' fish, the results from July onward in 2008 may not be wholly representative of 'wild' fish because of insufficient time allowed for recovery and dispersion before tracking for reasons mentioned in Section 4.2.2.

Despite the differences in recovery time before tracking, the overall distribution of bull trout detections in the Pine River system was reasonably similar for 2007 and 2008. The key points that can be summarized from these findings include:

- From the March to May period, the majority of bull trout detected were in the Pine River mainstem;
- The largest concentrations of bull trout in the Sukunka/Burnt River drainage occurred after June as the proportion of bull trout in the Pine River mainstem decreased during this time;
- The largest concentrations of bull trout detected in the Murray/Wolverine rivers occurred from August to October 2008;
- Median movement was considerably shorter in 2008 (27 km) compared to 2007 (51 km); and
- Movement past the proposed Site C dam location was low in both years (3 fish, 3.3% and 4 fish, 7.4% in 2008 and 2007, respectively).

A major difference between years is that no long-distance movement by bull trout between the Pine and Halfway rivers was observed in 2008, as occurred in 2007. In 2008, the detections of bull trout outside of the Pine River watershed were restricted to five fish in the Peace River mainstem and they were distributed upstream as far as Cache Creek to downstream near the Alces River. Possible explanations for the lack of long-distance movements observed in 2008 include:

- A very minor proportion of adult bull trout present in the Pine River watershed are migratory;
- Very few of the migratory bull trout were tagged in 2006, and if any were tagged in 2008 they may not have adequately recovered from capture and tagging to migrate this year; and
- The possibility that bull trout migrants that were tagged in 2006, 2007, and 2008 may not have spawned in 2008, and may migrate to the Halfway River in 2009.

The Halfway River watershed is composed of both resident and migratory bull trout (based on MOE's 1990s data analyzed and reported in AMEC & LGL 2008b). Additional evidence for the presence of a migratory bull trout population may be based on the behaviour of approximately 50 large bull trout that were observed holding in the lower Halfway River (~4 km upstream from the Highway bridge) and many others that were sampled within the vicinity at four time intervals from mid-May to early June 2008 (>20 fish were caught on first day to 4-5 fish on the last sampling interval; Rick Pattenden, Mainstream Aquatics, pers. com. 2008). These fish presumably had overwintered in the Peace River and may have been moving up the Halfway River to the headwaters or were just in the area to forage.

Bull trout are known to spawn in several headwater tributaries of the Halfway River (Burrows et al. 2000, AMEC & LGL 2008b). Bull trout were captured and tagged from several tributaries of the Halfway River by MOE in the late 1990s. Tracking surveys conducted by MOE at this time indicated that several tagged fish made extensive migrations between the upper Halfway River and Peace River mainstem well into Alberta (AMEC & LGL 2008b). Like bull trout in the Halfway River system, Pine River bull trout likely make long-distance migrations, although this is based on few observations. Information available to date indicates that Pine River bull trout migrate upstream through the Peace River into the Halfway River, whereas bull trout residing in the Halfway River migrate downstream through the Peace River, with some fish making extensive movements into Alberta (AMEC & LGL 2008b). The migratory sector of bull trout in the Pine River may well be of

fish that spawn in the headwaters of the Halfway River, which make feeding movements into the Pine River; this possibility needs to be verified by DNA analysis of tissue samples from these populations.

The findings from other studies provide supporting evidence that the Halfway and Pine rivers are important watersheds for bull trout. Juveniles have been captured in various locations in the Halfway River (RRCS 1978, ARL 1991a, 1991b, R.L.&L. 1991a, 1991b, AMEC and LGL 2008b, Burrows, et al. 2000). Some juveniles have also been captured in Maurice and Lynx creeks during spring and summer 2006 (AMEC & LGL 2008c).

As with other sportfish species presently studied, the Pine River tagged bull trout generally moved relatively little during the winter period. For example 60% (28) and 89% (42) of the fish detected in March 2008 were within 1 km and 4 km, respectively, of their last known position in November 2007. However, a small proportion (11%, 5) of tagged bull trout showed longer-distance overwinter displacement, the most extensive being that of a fish that had moved 49 km from the Peace River (near Cache Creek) to the Pine River during the November 2007 to March 2008 period. Longer-distance overwinter displacements were also observed for other species at this time (see below).

The seasonal displacement patterns of bull trout were similar between years, with downstream movements generally occurring from September to March and upstream movements from June to August.

The median distance moved by bull trout was considerably smaller in 2008 (27 km) compared to 2007 (51 km), where this movement was greater than that of all other study species, except walleye (118 km). Mean monthly movements for bull trout were low from March through June in both years, but increased movements were observed in September 2007 and July 2008. The more significant movements in 2008 were observed for the 2006 tagged fish, most of which were in the upper reaches of the Pine River, but from July to October the majority were in the Sukunka and Burnt river area, presumably to spawn.

Only three bull trout (4%) passed the proposed Site C dam location in 2008, whereas in 2007, five (10%) bull trout passed this area mostly in September. In 2007, the percentage of the tagged bull trout population that passed Site C was not significantly different from that of mountain whitefish, rainbow trout and walleye, but was significantly lower than that of the Arctic grayling mainstem population.

4.1.3 Mountain Whitefish

Little movement information was acquired for tagged mountain whitefish during 2008 tracking since fish were not detected at the fixed-station receivers and only two fish (one was considered dead) were detected during the first three aerial surveys (31 March-14 May period). A potential spawning area may include the Beatton headwaters area. However, this is based on the detection of one mountain whitefish at this location at the end of March 2008.

A summary of our main conclusions for mountain whitefish based mostly on 2006 and 2007 tracking surveys and other research in the area follows:

- Mountain whitefish are widely distributed in the Peace River mainstem from the Peace Canyon Dam downstream to the Alberta border;
- Generally, they do not move great distances (median 6 km in 2007);
- Typically, their numbers are quite low within the tributaries, but likely increase during August through October (the most was 12% of total number detected in the Peace River study area in fall 2007), probably in relation to spawning;
- Radio-tagged fish have been detected in the upper and lower reaches of the Halfway River and lower Pine River and some predation of radio-tagged adult mountain whitefish by large migratory bull trout may account for the occasional whitefish detections in the upper Halfway;
- Mean monthly movement is slightly greater during the September through October period, probably largely due to increased movement between the mainstem and tributaries during the spawning period;
- The Halfway River appears to be important for recruitment based on observations of large numbers of spawning mountain whitefish in the lower Halfway River during autumn 1989, with the highest numbers of larval mountain whitefish recorded in the Peace River mainstem downstream of the Halfway River in the following spring and summer (R.L. & L. 1991a, 1991b);
- Young of the year mountain whitefish were captured in the lower reaches of the Moberly River and Maurice, Lynx, Farrell, and Cache creeks in summer 2006; their numbers were highest in Lynx and Maurice creeks (AMEC & LGL 2008c). These fish may have come from the Peace River mainstem, or are the progeny of fish that spawned in the lower reaches of these tributaries; and
- Spawning in tributaries likely occurs, although there is the risk of eggs freezing in the smaller drainages. Adult mountain whitefish were the most

common large-bodied fish in the Moberly and Halfway rivers and Cache, Lynx and Maurice creeks in autumn 2005 (AMEC & LGL 2008c); similar findings have been reported by others for the Moberly River (ARL 1991a) and Farrell and Lynx creeks (RRCS 1978).

In regards to the limited movements of mountain whitefish in the potential Site C study area, our findings agree with those reported by Mainstream Aquatics that most tagged fish were found 5 km upstream or downstream from their release location (Rick Pattenden, Mainstream Aquatics, pers. com. 2008); this is based on their long-term Community Indexing program involving mark and recapture of individuals in the Peace mainstem (Mainstream 2006). The median distance moved by mountain whitefish was 20 km in 2006 and 6 km in 2007 (AMEC & LGL 2008c, 2008d); their displacement in 2006 was mostly in a downstream direction and at a much higher rate (69 m/d) than in 2007 (3 m/d). We suspect the higher displacement in 2006 was largely due to insufficient time allowed for recovery and dispersement prior to tracking and their 2007 movements (median distance 6 km) may be more representative of the movements of the untagged population. Similar distances (average 8 km upstream, 10 km downstream) from tag returns have been reported for mountain whitefish movements in the Peace River mainstem (R. L. & L. 1991b).

The percentage of mountain whitefish passage events at the proposed Site C dam location was similar to that for rainbow trout in both years (2006 and 2007), but significantly lower than for Arctic grayling. Mountain whitefish passage peaked (~10%) in June/July 2006, but was fairly constant (<5%) in all months in 2007; the summer peak in 2006 was probably related to the relatively high downstream displacement (~3-4 km/d) immediately after tagging.

4.1.4 Rainbow Trout

Rainbow trout tagged in the Peace River mainstem during September 2005 were not detected in 2008 because their tags were past their expected battery life. Thus, tracking surveys in 2008 did not provide any new information on movements of the Peace River mainstem rainbow trout population. A summary of movement patterns for Peace River mainstem rainbow trout is provided below and is based on our 2006 and 2007 tracking studies (AMEC & LGL 2008c, 2008d), as well as information from earlier studies (e.g., R. L. & L. 1991a, 1991b). Rainbow trout in the Peace River mainstem:

- Are distributed primarily between the Peace Canyon Dam and the Cache Creek area;
- Spawn in the tributaries closer to the Peace Canyon Dam area (e.g., Maurice, Lynx, Farrell creeks) in spring and thereafter return to the mainstem to feed and overwinter; and
- Are likely to pass the potential Site C dam location (15% of tagged population in 2006) more frequently than walleye and bull trout, but less frequently than mountain whitefish and Arctic grayling.

Since the movements of the Pine River tagged rainbow trout will not be adequately documented until completion of the 2009 tracking, the conclusions below are preliminary. Moreover, rainbow trout tracked in the Pine River watershed in 2008 were composed of releases from 2006 (8 fish) and 2008 (14 fish), which further complicates comparisons between/among years and populations. Based on our 2007 and 2008 tracking studies in the Pine River watershed (AMEC & LGL 2008d), the preliminary observations on rainbow trout distribution and movements are as follows:

- Most (20 in all) of the tagged fish in this drainage were year-round residents, while two rainbow trout moved into the Peace River mainstem;
- In the Pine system, they occur mainly in the Sukunka and Burnt rivers and Pine River mainstem near the mouth of the Murray River;
- The do not move extensive distances (average ~7 km) and probably remain within their preferred areas (Sukunka/Burnt and mid–Pine River mainstem);
- They likely spawn in the Sukunka and Burnt rivers; and
- They have a low probability of moving past the potential Site C dam location (0% and 4% of Pine River-tagged fish in 2007 and 2008, respectively).

In general, the limited movements observed for the Pine River rainbow trout are not greatly different from that of the Peace River mainstem population. Like the Pine River fish, rainbow trout in the Peace River mainstem made minor movements throughout the tracking periods, with most movements occurring during the spawning season (May through June) when fish moved into the tributaries. Rainbow trout median distances were similar among years (9, 7 and 8 km in 2006, 2007 and 2008, respectively), and were similar to that of Arctic grayling (9 km) and mountain whitefish (6 km) in 2007, but not in 2006. As with the other study species, overwinter displacement by rainbow trout was minimal. Displacement between November 2007 and March 2008

was mostly (58%) less than 1 km, with the longest displacement being 20.6 km downstream in the Pine River.

Documentation of rainbow trout spawning movements into the tributaries was not observed in the Peace River mainstem (2006/2007) or the Pine River watershed (2007/2008). Despite biweekly aerial tracking in April and May 2008, only one rainbow trout from the Peace River mainstem was detected in Maurice Creek, and movements were not detected for fish from the Pine River mainstem between the Sukunka and Burnt rivers. However, since the distance a fish would have to travel from the Peace River mainstem to spawn in the small tributaries is <5 km, some movement into the tributaries may have gone undetected. Other studies have observed rainbow trout in these Peace River tributaries. Approximately 90% of the rainbow trout captured in fisheries investigations in the Peace River study area during autumn 2005 were from Lynx and Maurice creeks (AMEC & LGL 2008a). Additionally, adult rainbow trout was the second most common sportfish captured in Maurice, Lynx, and Farrell creeks in spring 2006, and juveniles (age 1^{+}) were found in Maurice and Lynx creeks in summer of that year (AMEC & LGL 2008c). Also, spawned out rainbow trout were captured in Maurice and Lynx creeks during spring 1989, and large numbers of YOY fish were caught in these streams in autumn of that year (ARL 1991b).

Passage events past the Site C dam location for rainbow trout from the Peace River mainstem were sporadic in all years. In both 2006 (15%; 4 fish) and 2007 (4%; 1 fish), rainbow trout passage occurred in April and May, and in 2008 one fish (4%) moved past the Site C dam location in August.

4.1.5 Walleye

The walleye population moves extensively within and between the Peace River mainstem and major tributaries, with a well-defined spawning migration into the Beatton River during spring. In summary, potential Beatton River spawners:

- Overwinter from October to April within the vicinity of the Beatton River mouth;
- Migrate in the Beatton River during May and likely spawn near the right angle bend of the river approximately 30 km from the mouth;
- Leave the Beatton River in June and likely make movements through the Peace River mainstem into the Pine River and upstream;
- Leave the Pine River by late September and migrates back to the vicinity of the Beatton River mouth; and

- Have a low probability (only <10% of the population) that move past the proposed Site C dam location.

The median distance moved by walleye was greater than that of all other study species in all years, although the difference was not significant in 2008. As in the previous years, the mean monthly distance moved by walleye was variable, but highest April through May and September 2008. A major proportion of the fish that moved up the Beatton River in spring were those that overwintered (October through April) within the vicinity of the Beatton River mouth. In contrast, fish that did not move up the Beatton River remained mostly downstream of the Beatton River in the Peace River mainstem, widely distributed, with some as far as Peace River, Alberta. Of these, some individuals moved long distances with one fish moving over 600 km from the release site in 2005 to where it was captured by an angler in 2007.

The proportion of potential Beatton River spawners observed in 2008 was 53% (8 fish) and was very similar to those observed in 2006 (50%; 25 fish) and 2007 (54%; 26 fish). Overall, the pattern of walleye movements was consistent with that observed during previous years. For example, most of these fish moved upstream from the Beatton River in the Peace River mainstem, entered the Pine and later came back out, and by late October were congregated at the Beatton River mouth to overwinter.

The walleye population within the Site C study area appears to make very little use of the smaller tributaries. Walleye were not captured in any of the tributaries in the Peace River study area upstream of the Pine River in autumn (2005; AMEC & LGL 2008a) and in spring and summer (2006; AMEC & LGL 2008c). Others have reported that walleye were found primarily in areas downstream of the Pine River (Hillebrand, 1990; R.L. & L. 1991a, 1991b, 2001; P & E 2002; Mainstream Aquatics 2004, 2005, 2006). Only two spawned out walleye have ever been captured/observed upstream of the Halfway River in Farrell Creek during spring 1989; the spawning location for this pair was not determined (ARL 1991a).

Previously, AMEC & LGL (2008d) concluded that the walleye population in the Site C area utilizes an extensive range within the Peace River mainstem and specific major tributaries, but based on our 2008 findings, it is likely that only a small proportion of the population (<5%) moves upstream in the Peace River mainstem past the Moberly River.

4.2 Limitations of the Study

A number of assumptions and limitations related to the methods used in this study are discussed in the following sections so that their potential impact on the study conclusions can be evaluated.

4.2.1 Environmental Conditions

Water temperature and discharge data included in the present report are based on the best available information to provide an indication of the environmental conditions experienced during these studies. All 2008 discharge data are preliminary and subject to change upon final calibration by the Water Survey of Canada.

4.2.2 Radio Telemetry

In previous reports (AMEC & LGL 2008c, 2008d), several limitations and assumptions inherent in the use of radio telemetry for tracking fish movements were listed. Most of these are reiterated here (with some modification where appropriate) as they remain applicable to the 2008 study, which is a continuation of the telemetry program begun in 2005. It is therefore assumed that:

- The small number of tagged fish adequately represents the movements of the entire population.
- Tagged fish behave similar to that of untagged fish (i.e., capture, tag implantation, and holding procedures impart only a short-term [one week to one month] behavioural change); the minimum time for recovery before tracking is likely to vary with species.
- The potentially confounding effects of noise from other sources of radio waves (e.g., hydroelectric facilities, telecommunication towers, and other tagged wildlife) can be filtered and any false records existing in the receiver files can be removed through consistent application of appropriate noise-filtering criteria.
- Mortalities or potentially dead fish can be detected over time through application of minimum movement threshold criteria applicable to the species tracked and removed from the data set to avoid biasing data interpretation.
- Species tagged actually make movements of sufficient magnitude and duration to be detected on the spatial and temporal scales deployed in the tracking program.

As stated previously, the effects of most assumptions and limitations of radio telemetry on data quality and interpretation can be minimized by having clear objectives, well thought-out study design, and rigorous data quality control and assurance protocol. We maintain that all of these factors have been adequately addressed for the Peace River radio telemetry study from its inception in 2005 to the present. To reiterate, for the Peace River study, the objectives of the radio telemetry program formulated in 2005 were:

- Determine the timing, direction, distance traveled, and relative magnitude of migrations of rainbow trout, Arctic grayling, mountain whitefish, and walleye in the Peace River study area. Bull trout, rainbow trout, and Arctic grayling tagged and released in the Pine River system were added to the study program in August 2006, and in June-August in 2008;
- Determine if any of these species move into Peace River tributaries at any time during the year; and
- Determine if any migrations involve obligatory movements past the proposed Site C dam site. Calculation of displacement and median displacement rates (i.e., displacement divided by time at large) for both upstream and downstream movements by species for 2008, as well as re-calculation of median displacement rates for all species for 2006 and 2007 were added to the data analysis in the current year for comparison among species and among years.

The study design criteria to meet these objectives and reduce the effects of the above listed limitations and assumptions included:

- Tagging and tracking the five sportfish species most likely to make migrations in the Peace River past Site C dam (including fish in the Pine River);
- Maximizing the number of tags implanted on each of the five species in approximate proportion to the species' abundance in the river;
- Distributing tags in approximate proportion to the natural distribution of the population of each fish species in the study area;
- Tagging fish when river conditions (e.g., favourable water temperatures) maximized survival rates;
- Using only highly experienced personnel for tag implantation;
- Holding tagged fish for a minimum of 20 minutes before release; and
- Combining monthly aerial tracks of the entire Peace River and its major tributaries from Peace Canyon Dam to Dunvegan, Alberta, with data collected from strategically placed fixed-station receivers on the Peace River and specific tributaries to monitor spatial and temporal movements

of radio-tagged fish. Since the Peace River system is rarely >4 m deep, radio-tags were determined appropriate for use in this study.

Quality control and assurance measures used during the study included biweekly downloading of fixed-station receivers and rigorous data filtering for noise giving bogus hits and mortalities using LGL's proven *Telemetry Manager* software. Filtering noise recorded by the receivers and assessing mortality were rigorously carried out on all datasets (2006, 2007, 2008). The application of a well defined minimum movement threshold for all five species that were tracked was effective in providing a realistic assessment of mortality in 2007; the suitability of this minimum movement threshold (300 m) for assessment of mortality of all five species was re-addressed in 2008 and found to be satisfactory. The declining detection rates in the final stages of the 2007 and throughout the 2008 tracking periods for those species tagged in 2005 and 2006 was unavoidable due to an increasing proportion of the batteries in the radio transmitters going dead as time progressed.

Despite all steps taken to ensure that assumptions were met (see above), the following limitations are still possible:

1. For all species, with the possible exceptions of bull trout, rainbow trout, and Arctic grayling tagged in the Pine in 2008, the movements in all three years of tracking are assumed to be representative of the movements of untagged fish as they had ample time (~8 months) to recover from tagging before being tracked. An example of insufficient time allowed for recovery before tracking may be that of mountain whitefish in 2006. The median distance moved by mountain whitefish was significantly greater in 2006 than in 2007, with most of it being in the downstream direction. For this reason, the 2007 movement data for mountain whitefish are considered more likely to be representative of untagged fish. Similarly, the movements of the 2008-tagged bull trout, rainbow trout, and Arctic grayling in the Pine River watershed may not be representative of the untagged populations as sufficient time for recovery before tracking may not have been provided. For these tagged fish, 2009 tracking will more likely be representative of the untagged population.

2. Small localized movements may have been missed if they occurred between mobile tracking events and between fixed-station receivers. 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; in addition, a fixed station receiver was deployed at the mouth of the Pine River which would detect fish downstream of Site C.

The calculated median displacement rates for each species are considered reasonable estimates of their overall movement in either an upstream or downstream direction.

While the possibility exists that some of these limitations and assumptions may have affected our interpretation of the results of the 2006-2008 data analyses, it is our view that no important results drawn from the study to date are erroneous or biased. The movements of the Peace River mainstem Arctic grayling, walleye, rainbow trout, and mountain whitefish populations are considered to be reasonably well documented and the conclusions drawn from these are within the bounds of the known movements of these populations by others. However, the results of movements of the Pine River watershed bull trout, Arctic grayling, and rainbow trout populations are currently tentative, and will not be finalized until data from tracking in 2009 have been collected and analyzed and a final report on the findings is completed; until then, no definitive conclusions can be made regarding the movements of these populations.

5.0 CONCLUSIONS

From the overall results obtained in the 2005-2008 tracking studies (AMEC & LGL 2008d), several general conclusions can be drawn regarding the movements of Arctic grayling, rainbow trout, mountain whitefish, and walleye radio-tagged within the Peace River mainstem. These are;

1. Arctic grayling movements are moderate (average 45 km), the fish occur primarily between the Halfway and Beatton rivers; spawning occurs in specific tributaries (mainly the Moberly, and occasionally the lower Halfway and Beatton rivers) in spring (April-May), after which they return to the mainstem to feed and overwinter (some overwintering occurs in the lower Halfway River).

2. Rainbow trout movements are minor (average 9 km), the fish occur mainly from the Peace Canyon Dam to the vicinity of the Halfway River; spawning occurs in spring (May-June) primarily in the smaller streams (e.g., Maurice, Lynx, Farrell), and subsequently the fish return to the Peace mainstem to forage and overwinter.

3. Mountain whitefish movements are minor (average 6 km), the fish are widely distributed in the Peace River mainstem from the Peace Canyon Dam downstream to the Alberta border; spawning occurs in autumn and appears to be widespread including Peace River mainstem and lower reaches of tributaries in the Site C study area.

4. Walleye move extensively (average 86 km) within and between the Peace River mainstem and major tributaries (Beatton and Pine rivers); spawning occurs in spring in the Beatton River, with extensive movements during the post-spawning period from the Beatton to the Pine (to forage) and later back to within the vicinity of the Beatton mouth (to overwinter); the non-Beatton River spawners (~50%) are typically widely scattered in the Peace River mainstem downstream from the Beatton River to within the vicinity of Dunvegan, Alberta.

5. Arctic grayling Peace River mainstem fish are likely to pass Site C (72%) more frequently than will fish from walleye (8%), rainbow trout (15%), and mountain whitefish (8%) mainstem populations.

Based on completion of the 2008 tracking study, some tentative conclusions that can be drawn for bull trout, rainbow trout, and Arctic grayling radio-tagged in the Pine River watershed are as follows:

1. Arctic grayling are resident and not likely to exit the Pine River watershed or pass the potential Site C dam location.

2. Rainbow trout move relatively little, but some may conduct longer migrations.

3. Bull trout consist mainly of resident fish, but approximately 5% are migratory. The migratory population migrates seasonally between the Pine, Peace and Halfway rivers.

4. Confirmation of the first three points awaits completion of the 2009 radio telemetry program; if the results are positive for each of the above two points, then only migratory bull trout will move past the proposed Site C dam location, the other sportfish species are not likely to do so.

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This report was prepared by Rachel Keeler, Gordon Glova, and Dave Robichaud. Carol Lavis of AMEC formatted and prepared the document.

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 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. accept 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. appreciate 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,

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