Report Title: Peace River Site C Development – Fisheries Habitat and Tributary Surveys 1989 Studies
Issuer: Tim Slaney, Aquatic Resources Ltd
Date: July, 1991

cobble 20% and boulder 5%. There was a large amount of scattered and accumulated debris (10%) due to the unstable nature of the channel.

Reach 2, extending from 23 to 32 km, is more stable and the flow is mainly confined to a single channel with less debris (5%). Gradient is slightly greater in this section resulting in increased riffle habitat (60%). Very little pool habitat is present. The substrate consisted of 10% fines, 30% gravel, 45% cobble, 10% boulder and 5% bedrock. Channel width was 26 m and the wetted width was 10 m. Water clarity was estimated to be 10 m.

The gradient decreases above Reach 2. The single channel meanders through meadow throughout most of Reach 3. This section contains little riffle (5%) and is mainly glide (75%) with a smaller proportion of pool (20%). The substrate consisted primarily of fines (50%), gravel (40%) and a small amount of cobble (10%). Channel widths averaged 16 m and wetted widths averaged 12 m. In one, 2 km section below the 45 km mark there is a series of cascades and falls dropping 2 to 3 m over bedrock sills. Above this point, the channel again meanders through meadow habitat. At 47 km the creek split into several channels in marsh habitat and is no longer as well defined.

3.2 FISH POPULATIONS

3.2.1 Species composition, distribution and morphology

A total of 17 species of fish was found within the study area during September and October 1989 (Table 14). Sport fish included burbot, rainbow trout, mountain whitefish, lake whitefish, northern pike, bull trout, and Arctic grayling. Six species of minnow (northern squawfish, peamouth, flathead chub, lake chub, longnose dace, and redside shiner), three species of sucker (white sucker, longnose sucker and largescale sucker) and sculpins were also found. Species composition in the Peace River tributaries studied generally appears to be similar to that reported by RRCS (1979) from surveys in 1974, 1975 and 1977. In some tributaries, species composition appears to shift between spring and fall (Table 15).

Table 14
Fish species found within streams of the Site C study area, September & October, 1989

Species	Moberly	Cam-eron	Ground Birch	Farrell	Cache	Graham	Kobes	Lynx	Colt	Blue-Grave	Maur-ice	Chow-ade	Horse-shoe	Cyp-ress	Wilder
Arctic grayling	+	+	+	-	+	+	-	-	+	-	-	+	-	-	-
Bull trout	-	-	-	-	-	+	-	-	-	+	-	+	-	-	-
Burbot	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cottids	+	-	+	+	-	+	+	+	+	+	+	-	+	+	-
Flathead chub	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-
Lake chub	+	-	-	+	+	-	-	-	-	-	-	-	-	-	-
Lake whitefish	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Largescale sucker	+	+	+	+	+	-	+	-	-	-	-	-	-	-	-
Longnose dace	+	-	-	-	+	-	-	-	-	-	-	-	-	-	-
Longnose sucker	+	+	+	+	+	-	+	+	+	-	+	-	-	-	-
Mountain whitefish	+	+	+	+	-	+	+	-	+	+	+	+	+	+	-
Northern pike	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Northern squawfish	+	+	+	+	+	-	+	+	-	-	-	-	-	-	-
Peamouth	+	-	-	-	-	-	-	-	-	-	-	-	-	-	+
Rainbow trout	-	-	-	-	-	+	-	+	+	+	+	+	-	-	-
Redside shiner	+	+	+	+	+	-	+	+	-	-	-	-	-	-	-
White sucker	+	-	-	-	-	+	-	-	-	-	-	-	-	-	-

Water courses are listed in order of decreasing species diversity.
+ present.
- not found.

Table 15.
Presence and absence of fish species in streams of the Site C study area during spring (June) and fall (September - October), 1989

	Cache		Farrell		Lynx		Maurice	
Species	spring	fall	spring	fall	spring	fall	spring	fall
Mountain whitefish	-	-	+	+	+	+	+	+
Rainbow trout	-	-	-	-	+	+	+	+
Arctic grayling	-	+	-	-	-	-	-	-
Longnose sucker	+	+	+	+	+	+	+	+
Largescale sucker	-	+	+	+	-	-	+	-
White sucker	+	-	+	-	+	-	+	-
Redside shiner	+	+	+	+	+	+	+	-
Northern squawfish	+	+	+	+	-	+	-	-
Lake chub	+	+	-	-	+	+	-	-
Sculpins	-	-	+	+	+	+	+	+
Longnose dace	+	+	+	-	+	-	+	-
Walleye	-	-	+	-	-	-	-	-

Fish collections from some of the tributaries were too small to permit a systematic comparison of growth rates and condition factors among each of the Peace River and Halfway River tributaries. Nevertheless, sufficient data were available for a comparison among some of the tributaries (Appendix III). Similarly, where possible, length-weight regressions were also computed and compared (Table 16). Aside from interspecific differences, growth, condition factors, and length-weight regressions generally were similar among each of the tributaries compared. The fact that fish densities often differ between systems suggests that fish may compensate for differences in growth conditions among tributaries (e.g. food availability, competition, predation, temperature, etc.) by migration. Differences in growth and condition of particular note are discussed individually in the sections below.

3.2.2 Peace River Tributaries

3.2.2.1 Moberly River.

A total of 14 fish species was sampled from the Moberly River between its mouth at Moberly Lake and its confluence with the Peace River (Table 14). Of the 13 species caught, five were sportfish. These included lake whitefish, mountain whitefish, Arctic grayling, northern pike and burbot. The majority of sportfish was captured in reaches 1 to 3 (Figure 3). In Reach 5 a small number of lake whitefish and northern pike were caught.

Table 16.
Summary of length-weight relationship of fish from tributaries of the Peace and Halfway Rivers, September and October 1989.

Species	System	Sample size	b 2 SE*		a 2 SE*		Adjusted R	Condition factor
Bull trout	Blue Grave	6	3.02	0.14	-5.04	0.30	1.00	1.002
Arctic grayling	Colt	5	3.03	0.06	-5.66	0.10	1.00	1.003
	Graham	6	3.02	0.24	-5.19	0.56	0.99	0.850
	Moberly	15	3.09	0.16	-5.14	0.30	0.99	1.097
Lake whitefish	Moberly	5	2.99	1.00	-4.88	2.52	0.90	1.218
Mountain whitefish	Chowade	16	3.43	0.35	-5.95	0.78	0.97	1.074
	Colt	20	3.07	0.12	-5.81	0.24	0.99	0.906
	Graham	59	3.06	0.10	-5.20	0.22	0.98	0.861
	Kobes	8	3.04	0.18	-5.12	0.36	0.99	0.896
	Moberly	42	3.17	0.10	-5.36	0.22	0.99	1.078
Northern pike	Moberly	17	3.13	0.12	-5.51	0.30	0.99	0.659
Rainbow trout	Colt	4	3.04	0.12	-5.03	0.24	1.00	1.110
	Lynx	10	2.98	0.18	-4.90	0.38	0.99	1.175
	Maurice	35	3.02	0.08	-4.99	0.16	0.99	1.143

* Regression equation: $\log(W) = \log(a) + b \cdot \log(L)$ Where W = weight (g) and L = length (mm)
** Condition (K) = W/L^3

Mountain whitefish were clearly the most abundant (3 fish·100 m^{-2}) of the sportfish. This species was found in all reaches except for the slow glide habitats of Reach 5 just below Moberly Lake. Although no mountain whitefish were caught in the two small sets made in Reach 4, the area sampled was to small to definitively exclude the presence of this species. The Moberly River sampling done by RRCS (1979) in 1974 and 1975 showed that the distribution of mountain whitefish extended to the 125 km mark of the river, which includes Reach 4.

The catch of mountain whitefish in Moberly River changed from mainly juveniles in September to adults in October. During the initial September survey, average size of the mountain whitefish caught was 104 mm (n = 47, s = 55.7) and consisted mainly of age 0+ and 1+ fish. In October samples the average size of captured mountain whitefish increased to 262 mm (n = 36, s = 60.6) with ages from 2 to 6 years. In addition to this increase in size, several of the mountain whitefish caught expressed milt when handled indicating that they were close to spawning.

The higher fish densities observed in October may have been due to several factors. During the September survey, water levels were still high and prevented effective sampling of many of the deeper pool and glide habitats where adults may have resided. With the lower water levels during the October session, many of these areas were more readily accessible to seines and therefore the proportion of adult fish caught may have increased. Alternatively, it is possible that many of these adult whitefish were migrants from the Peace River, entering the Moberly River to spawn.

The extent with which the Moberly River is used for spawning by Mountain whitefish could not be determined from the current study. The October survey of Moberly River was restricted to areas in Reach 2, and did not extend to the remainder of the system. However the results of a dip net study done by RRCS (1979) in 1975 suggested that egg deposition by mountain whitefish was limited to a section of river from 16 km to 75 km upstream of the Peace River, an area roughly corresponding to our Reach 2. The dip net study did not extend into Reaches 3, 4 or 5. Thus, determining the size and location(s) of the whitefish spawning grounds will require further study.

Also caught in the Moberly River, but only in Reaches 1 to 3, were a number of juvenile Arctic grayling (Table 17). Catches were the greatest in the lowest reach and successively declined in Reaches 2 and 3. This pattern is consistent with that reported by RRCS (1979). The Arctic grayling sampled averaged only 79 mm in length and scale analysis showed them to be mainly young of the year, although a few 1 year old fish were caught. Apparently the lower reaches of the Moberly River serve as rearing habitat for juvenile Arctic grayling. The absence of adults may be explained by the fact that these fish generally prefer to occupy larger river systems, only ascending the smaller tributaries in spring to spawn. The presence of Arctic grayling fry reported by RRCS (1979) in Reach 2 (km 69) strongly suggests that Arctic grayling adults ascend the Moberly River in spring to spawn and are probably only found in the system during that time of the year. Alternatively, but less likely, the larger adults may have been present in pool and riffle habitats that could not be effectively seined with the 18 x 2 m net used.

Table 17
Summary of seine catches (fish·100 m^{-2}) in the Moberly River, September and October, 1989.

	Reach					
Species	1	2	3	4	5	Mean
Mountain whitefish	7.4	3.5	3.8	-	-	2.9
Arctic grayling	2.1	1.4	0.2	-	-	1.1
Northern pike	0.5	<0.1	1.7	-	2.2	0.7
Burbot	0.5	0.2	0.2	-	-	0.1
Lake whitefish	-	-	-	-	0.6	0.1
Minnows (general)	21.7	2.3	12.4	250	2.9	6.5
Sculpins (general)	-	0.6	1.9	-	2.5	1.1
Suckers (general)	19.0	2.4	2.5	125	0.4	3.6
All species	51.3	10.5	22.9	375	9.0	16.7
Area sampled (m^2)	189	3,095	565	40	815	

Residents report good fishing for Arctic grayling (despite the low catches made during this study) and mountain whitefish on the Moberly River in the vicinity of the first bridge 45 km upstream of the Peace River at certain times of the year.

Northern pike were caught in all reaches sampled, but were only found in high numbers in the slow glide and slough habitats of reaches 3 and 5 where an abundance of submergent vegetation exists. The pike in these two regions ranged from 115 to 660 mm in length and from 0+ (young of the year) to 9 years in age (Table 18). The few pike caught in reaches 1 and 2 were juvenile and generally associated with cover along the stream margins.

Table 18.
Mean length, standard deviation, and range of fish sampled from the Moberly River during September and October, 1989.

Species	n	Mean Length (mm)	Stdev. (mm)	Min. Length (mm)	Max. Length (mm)
Redside shiner	65	44.6	16.9	23	109
Largescale sucker	4	140	69.0	81	227
Cottids	113	49.7	18.0	28	98
Northern squawfish	3	239	6.6	232	245
Longnose sucker	38	100	118	19	375
Arctic grayling	31	78.6	50.0	22	195
White sucker	33	134	125	27	395
Northern pike	25	277	177	115	660
Sucker (UID)	10	37.6	6.1	28	45
Lake whitefish	5	319	28.4	290	360
Burbot	5	80.2	5.8	74	86
Peamouth	4	44.2	16.4	42	81
Mountain whitefish	86	173	97.2	35	360

The only sportfish caught in Reach 5, aside from northern pike, were lake whitefish. They ranged from 290 to 360 mm in length and were primarily 5 and 6 years of age. Whether these fish reside in this area permanently or are simply transitory is not known. Lake whitefish generally spawn during the fall (Scott and Crossman 1973), but none of the fish sampled expressed milt or eggs when handled.

A few juvenile burbot, ranging in length from 74 to 86 mm, were captured in Reaches 1 to 3. The burbot were generally associated with aquatic vegetation and other cover along the stream margins. No adults were caught.

Non sportfish species captured in Moberly River included: northern squawfish, redside shiners, sculpins, longnose suckers, white suckers and largescale suckers. Redside shiners were caught in all reaches sampled and were the most numerous of all species caught (overall catch density = 6.3 fish$\cdot$100 m^{-2}). This is contrary to the findings of RRCS (1979) who reported lake chub to be the most numerous of the minnows - redside shiners being found only in moderate to low numbers.

Northern squawfish and peamouth were found only in the lowest reach (catch density = 2.6 and 3.7 fish$\cdot$100 m^{-2} respectively). The distribution of northern squawfish in the Moberly River is consistent with data reported by RRCS (1979). However they did not report collecting any peamouth in the Moberly River.

The catch density of suckers was greatest in the lowest reach and successively declined in the upper reaches (Table 17). The exception to this trend was in Reach 4 where, in two 20 m^2 seine sets, very high densities of suckers were found. Whether or not this is representative of the reach in general cannot be determined. Nevertheless, the overall pattern of sucker distribution in the Moberly River is similar to that reported by RRCS (1979).

3.2.2.2 Wilder Creek

Very few fish were caught in Wilder Creek when it was surveyed on September 12, 1989. The only species caught were peamouth which were found in a beaver pond located in the upper part of Reach 1. From three seine sets made in this area, the catch density was calculated to be 130 fish·100 m^{-2}. The fish ranged in size from 32 to 53 mm long and averaged 41.8 mm ($n = 10$, $s = 6.7$ mm). Peamouth were largely absent from the lower portions of Reach 1, nor were there any fish caught in the beaver pond habitats of Reach 2, either by seine or electroshocker.

The apparent absence of fish in Wilder Creek is probably due to the low discharge rate and water levels of the system as well as its steep gradient. The estimated maximum flow rate of the creek was only 0.04 $m^3{\cdot}s^{-1}$ when it was surveyed on September 12, 1989. Although there were a number of pools throughout Reach 1, they were generally small and rarely exceeded 0.2 m in depth. The upper parts of Reach 1 and the lower part of Reach 2 had several large beaver ponds with depths up to 1.5 m, but they may have been inaccessible to fish because of the relatively steep gradient (5%) in the middle of Reach 1 and the extensive series of beaver dams downstream.

The low productivity of Wilder Creek observed in the current survey is in accordance with the observations made by RRCS (1979) in 1974 and 1975. However, unlike the present survey, RRCS only found flathead chub in the system rather than the peamouth species.

3.2.2.3 Cache Creek

Seven fish species were caught by beach seine in Cache Creek between September 13 and 14, 1989 (Table 19). During the survey, the creek had a very low flow rate (a maximum of 0.07 $m^3{\cdot}s^{-1}$) and, in some sections, there was almost no surface flow. There were, however, large beaver ponds in Reach 3 and several pools (average maximum depth of 0.5 m) throughout Reaches 1 and 2 which provided fish habitat.

Table 19.
Summary of beach seine catches (fish·100 m^{-2})
in Cache Creek, September 13-14, 1989.

Species/group	Reach 1	Reach 2	Reach 3	Total
Northern squawfish & lake chub	151	157	192	162
Longnose sucker & longnose dace	308	19	5	75
Largescale sucker	23	-	2	5
Redside shiner	17	43	-	31
Arctic grayling	-	2	3	2
All species	500	221	202	275
Area sampled (m^2)	82	257	66	405

Overall, northern squawfish and lake chub were the most abundant species encountered. Large catches, averaging 162 fish·m^{-2}, were found in both the pool and beaver pond habitats located throughout the 31 km of creek surveyed (Table 19). Longnose suckers were also present in large numbers, particularly in Reach 1 (308 fish·100·m^{-2}). Catch densities however, appeared to decrease in a successive fashion in Reaches 2 and 3 (Table 19). Redside shiners were found only in Reaches 1 and 2, catch densities being greater in Reach 2 than in Reach 1. Largescale suckers were also caught, but appeared to be restricted to reaches 1 and 3 where they were found in relatively low numbers.

The only sportfish captured in Cache Creek were juvenile Arctic grayling which were only present in low numbers (Table 19). They averaged 48.3 mm in length and were young of the year. Their distribution was restricted to the beaver pond and pool habitats of Reaches 2 and 3. No adult Arctic grayling were collected. It appears likely that adults rear in the Peace River and enter Cache Creek only for spawning.

In their 1974/75 survey of Cache Creek, RRCS (1979) reported aggregations of mountain whitefish juveniles in the lower part of Reach 1. Due to low fall flows, this species probably does not spawn in the system. It seems more likely that juveniles from the Peace River migrate into the lower reaches to rear. However, mountain whitefish were not found in Cache Creek during the 1989 surveys.

The September 14 and 15, 1989 samples and sampling conducted by RRCS (1979) suggest that few sportfish utilize Cache Creek for rearing during the low flow periods of late summer. Further, sportfish species probably do not utilize

Cache Creek during the winter as water levels drop much further. The fact that no sportfish were caught at all during the spring survey does not however preclude Cache Creek as Arctic grayling spawning habitat. These fish typically spawn soon after ice out (Scott and Crossman 1973) and had probably returned to the Peace River mainstem by the time of the June survey. Low numbers of juvenile Arctic grayling in the fall samples suggests a small number of adults spawn in the system. Further, the distribution of these juveniles suggests that spawning may only occur in Reaches 2 and 3.

The fish caught in Cache Creek were generally small, the largest being a juvenile sucker measuring 121 mm (Table 20). The small size of the fish captured may have been a consequence of the stream's small size.

Table 20
Mean length, standard deviation, and range of fish sampled from Cache Creek, September 13 - 14, 1989.

Species	n	Mean Length (mm)	Stdev. (mm)	Min. Length (mm)	Max. Length (mm)
Northern squawfish	45	59.1	21.8	25	95
Longnose sucker	34	61.7	21.3	31	121
Largescale sucker	2	67.5	16.2	56	79
Redside shiner	20	37.0	14.5	25	95
Arctic grayling	4	48.3	6.8	39	55

3.2.2.4 Farrell Creek

A total of 13 seine sets averaging 30 m^2, was made throughout the lower 21 km of Farrell creek on September 15 and 16 when water temperature throughout the system was 10.4°C. Redside shiners were the most abundant of the six species of fish sampled, with catches that averaged 45 fish·100 m^{-2} (Table 21). Catches of the other five species (largescale suckers, northern squawfish, longnose suckers, sculpins and mountain whitefish) were much lower. One juvenile mountain whitefish, the only sportfish encountered, was caught in Reach 1.

Data collected during a bioreconnaissance survey of Farrell Creek carried out on June 9 & 11, 1989 shows that species composition and catch densities do not change dramatically between spring and fall. Noted exceptions are the absence of lake chub during the fall and the presence of walleye during spring. Due to their low numbers however, it is possible that these differences simply reflect sample error. Of note as well was the low density of mountain whitefish that were caught. It would appear that few mountain whitefish frequent the system regardless of season.

Table 21.
Summary of beach seine catches (fish·100 m^{-2} set) in Farrell Creek June and September, 1989.

		Reach		
Date	Species	1	2	All
June 9, 11	Mountain whitefish	1	0	<1
	Walleye	<1	0	<1
	Redside shiner	34	27	31
	Northern squawfish	0	3	1
	Lake chub	0	2	1
	Suckers	16	4	11
	All species	51	36	45
	Area sampled (m^2)	255	189	444
Sept. 15, 16	Mountain whitefish	<1	0	<1
	Redside shiner	33	89	45
	Northern squawfish	1	17	4
	Longnose sucker	6	3	5
	Largescale sucker	3	34	9
	Cottids	1	3	2
	All species	45	146	66
	Area sampled (m^2)	385	102	487

All species, with the exception of suckers, were most abundant in pool habitats. The suckers were found principally in glides.

Species composition and relative numbers in the lower section of Farrell Creek during the current study represent a dramatic change from that reported by RRCS (1979) during their fall (October) 1974 study. They describe water temperatures of 0-4°C, found mountain whitefish in large numbers, and also noted the presence of Arctic grayling and rainbow trout while electroshocking, but only in very low numbers. A migration of Arctic grayling which were presumably spawning was also observed by RRCS in May and June, 1975. Although RRCS (1979) did note the presence of redside shiners in the lower 20 km of the creek, their relative abundance was considerably lower than that observed in this study. The only species found in comparable numbers were the longnose and largescale suckers. The ratio of longnose to largescale suckers was approximately 5:1 for both studies.

Species composition and relative numbers during the spring (May) 1975 study however, was generally more comparable to that observed during the 1989 spring

Species composition and relative numbers during the spring (May) 1975 study however, was generally more comparable to that observed during the 1989 spring survey. The main differences of note between the two studies are the absence of redside shiners and presence of burbot in the system when sampled by RRCS in 1975. Very few mountain whitefish were caught during the two surveys.

The September 15-16 sampling, although limited, is probably fairly representative of the species composition and fish size in pool and glide habitat. Low water levels allowed for effective use of the beach seine in these two types of habitat, although cottids, which are often well down in the substrate, were probably in higher abundance than the beach seine sets suggest (Parley et al. 1989).

During the June reconnaissance, a pair of spawned out walleye were collected in Reach 1 of Farrell Creek. They weighed 675 and 790 g and measured 370 and 383 mm respectively. It is not known if they spawned there or had migrated in after spawning elsewhere. However, it seems unlikely that there is a spawning population in this system: RRCS (1979) collected only one mature male walleye from their May 18 - June 28, 1975 fence operation on Farrell Creek.

Table 22
Mean length, standard deviation, and range of fish sampled from Farrell Creek September 15 - 16, 1989.

Species	n	Mean Length (mm)	Stdev. (mm)	Min. Length (mm)	Max. Length (mm)
Northern squawfish	15	118.	66.4	35	235
Longnose sucker	10	38.0	8.8	22	47
Largescale sucker	13	47.0	30.6	33	148
Redside shiner	55	60.0	31.6	24	108
Cottids	4	39.5	4.8	35	45
Mountain whitefish	1	75.0	-	-	-

Sampling during the spring and fall of 1989 indicates that few sportfish utilize the lower 21 km of Farrell Creek for either spawning or rearing. It also possible (although unlikely) that small numbers of walleye and perhaps mountain whitefish may spawn in the creek. (Mountain whitefish juveniles may also move in from the Peace River to rear). Although none were caught during the 1989 surveys, Arctic grayling do appear to spawn in the system, as they were captured in the spring of 1975 at the RRCS fence (RRCS 1979). During their October 1974 survey, RRCS also collected two rainbow trout in the lower river in addition

3.2.2.5 Lynx Creek

Lynx Creek was one of two Peace River tributaries sampled which contain significant numbers of rainbow trout (Tables 14 & 23). It was sampled June 9 - 10, 1989 for spawning sportfish and again under low flow conditions on September 20 and October 16, 1989.

Table 23.
Beach seine catches (fish·100 m^{-2}) and electrofishing results (fish·100 m^{-2}) in Lynx Creek, June and September / October 16, 1989.

Reach	Habitat Type	Sample Tech.*	Sample Area (m^2)	Rainbow Trout	Mountain Whitefish	Longnose Sucker	Northern Squawfish	Redside Shiner	Cottids
June 9, 10									
1	Glide	EL	45	-	-	-	-	2	4
1	Riffle	EL	60	2	-	2	-	-	5
2	Glide	EL	72	3	3	1	-	-	-
2	Pool	SN	40	5	28	3	-	-	-
4	Glide	EL	68	1	-	-	-	-	-
4	Riffle	EL	42	7	-	-	-	-	-
4	Pool	SN	90	11	-	-	-	-	-
September 17, 20 & October 16									
1	Glide	EL	34	-	-	52	17	6	-
1	Riffle	EL	44	5	-	16	2	-	2
2	Glide	EL	25	4	-	16	16	-	4
2	Riffle	EL	11	-	-	9	-	-	-
2	Pool	EL	17	23	-	46	109	-	-
3	Glide	SN	16	6	-	13	69	-	-
3	Pool	SN	38	9	-	9	29	-	-
5	Pool	SN	12	17	-	-	-	-	-
5	All	VE	2000	2	-	-	-	-	-

* EL = Electroshocker; SN = Beach Seine; VE = Visual Estimate

Catch densities from beach seining are not strictly comparable to the densities obtained by multiple removal electroshocking. However, no one sampling technique can be used in all areas. Combined samples suggest that rainbow densities are greater above the Brenot Creek confluence. Combined spring/fall catches of rainbow trout made in 348 m^2 of stream below the confluence was 3 fish·100 m^{-2} (Reaches 1 and 2; Table 24). Above the confluence and upstream to the first water fall, a combined rainbow trout catch density of 7 fish·100 m^{-2} was made in 254 m^2 of stream (Reach 3 and lower 2.5 km of Reach 4). The difference appears to be related to high turbidities introduced by Brenot Creek.

Table 24.
Seine and electroshocker catches (fish·100 m^{-2})
in Lynx Creek, June and September / October, 1989.

Reach	Sample* Area (m^2)	Rainbow Trout	Mountain Whitefish	Longnose Sucker	Northern Squawfish	Redside Shiner	Cottids
June 9, 10							
1	105	1	0	1	0	<1	5
2	112	4	28	4	0	0	0
4	200	7	0	0	0	0	0
September 17, 10 and October 16.							
1	78	3	0	32	9	3	1
2	53	9	0	25	43	0	1
3	54	9	0	10	44	0	1
5*	2,010	2	0	0	0	0	0

* All sampling techniques combined.

Using the rainbow trout catch density of 3 fish·100 m^{-2} sampled below the Brenot Creek confluence, 14,400 m^2 in Reach 1 (Table 12), 38,600 m^2 in Reach 2 and 1,650 m^2 in Reach 3 below Brenot Creek, this section of creek potentially contained 1,700 rainbow trout juveniles during the fall. The section from Brenot Creek upstream to the first water fall includes 38,760 m^2 and had an estimated 2,700 rainbow trout (based on a rainbow trout catch density of 7 fish·100 m^{-2}). Total juvenile population in the accessible portion of Lynx Creek was thus estimated to be about 4,500 rainbow trout during the fall of 1989.

Rainbow trout were observed throughout Reach 4, despite its steep canyonous nature and the series of impassable waterfalls ranging from 1 to 4 m in height in the middle of the reach. Beach seine catches of rainbow trout averaging 11 fish·100 m^{-2} were made in a pool habitat and, by electroshocker, densities of 7 fish·100 m^{-2} and 1 fish·100 m^{-2} were found in riffle and glide habitats, respectively. Overall, rainbow trout catch densities averaged 7 fish·100 m^{-2}. No other species were observed in Reach 4.

No fish were caught in a series of seine sets made in a beaver pond at the 17 km mark of Reach 5 on September 17, 1989. However, rainbow trout were observed in the lower portion of the reach at kilometer 14. Low turbidity facilitated visual counts of rainbow trout along this section of the reach. Along an 800 m long section of the creek, 39 rainbow trout were observed (2 fish·100 m^{-2}). One pool which was beach seined contained trout densities of 10 fish·100 m^{-2}. No other species were captured in Reach 5.

The rainbow trout sampled averaged 124 mm in length (Table 25) and were mainly age 0+ (young of the year) and 1+ fish. A few rainbow trout aged 2 and 3 years were also caught. However, none of the trout sampled or observed exceeded the minimum sports fishing harvest size of 300 mm. The average sizes of age 0+ and 1+ rainbow trout were virtually identical to those recorded for this species in Maurice Creek.

Table 25
Mean length, standard deviation, and range of fish sampled from Lynx Creek, September 17 - October 16, 1989.

Species	n	Mean Length (mm)	Stdev. (mm)	Min. Length (mm)	Max. Length (mm)
Northern squawfish	47	77.3	12.3	47	111
Longnose sucker	40	105.4	43.6	33	220
Redside shiner	2	87.5	2.1	86	89
Sculpins	2	71.5	37.5	45	98
Rainbow trout	12	124.3	42.9	59	198

In September and October 1974 (RRCS 1979) large numbers of juvenile mountain whitefish were found in the lower sections (0 - 1.6 km) of Lynx Creek. No whitefish were captured in this area in 1989. One explanation may be water temperature, which had dropped to 0.5°C by October 16, 1989 but was still 4.0°C when RRCS sampled the creek on October 28, 1974. However, during a preliminary survey done on June 9 and 10, 1989, large numbers of mountain whitefish were caught in the lower reaches of the creek, particularly in Reach 2 where mountain whitefish densities approached 28 fish·100 m^{-2}. Ninety percent of the whitefish caught in Reach 2 were 2 or more years of age. They ranged in size from 79 to 115 mm and averaged 98 mm (n = 4). Thus it would appear that whitefish may rear in Lynx creek during spring and then later leave the system during the later part of summer. The outward migration may be in response to reduced stream flows later in the year. Whether mountain whitefish utilize Lynx creek over the winter is at present unknown, but it does seem unlikely as water levels probably continue to decline during the winter.

Four other species of fish were sampled from Lynx Creek during September and October, 1989, but only below Reach 4 (Table 23). Longnose suckers were the most abundant species in Reach 1, occupying both glide and riffle habitats. A number of longnose suckers were also found in Reach 3, with a particularly large number occupying pool habitats. By far the most numerous of the species found in Reach 3 were northern squawfish. Northern squawfish were also observed in modest numbers in the glide and riffle habitats of Reach 1. Redside shiners were only collected from the glide habitats of Reach 1 while cottids were found in low numbers in both reaches.

3.2.2.6 Maurice Creek

Maurice Creek was sampled both during the spring (June 9 & 11, 1989) and fall (September 20 and October 9 & 10, 1989). The results suggest that the system is an important spawning and early rearing habitat for rainbow trout from the Peace River mainstem. However, no spawners were observed.

As in Cache and Lynx Creeks, the freshet was well over by the time of the June samples. Sport fish that spawned in the system may have returned to the Peace River as none were captured. Spring sampling was conducted at 10, 7, 4 km and through out a 700 m stretch of creek at the 0.3 km mark. No fish were captured in 464 m^2 of habitat sampled by electroshocking and beach seine at the 10, 7 and 4 km sites. These sites were with in the section of creek designated as Reach 2 and were above an impassable water fall (3 km mark). A total of 6 rainbow trout were caught in 377 m^2 of habitat in Reach 1 (2 fish·100 m^{-2}) sampled by electroshocker and beach seine in Reach 1. All of the rainbow were juveniles except for one individual which measured approximately 250 mm long, although it appeared to be immature. The only other sportfish captured in June were a few juvenile mountain whitefish, including one individual 250 mm in length.

Of all the species captured during the spring survey, suckers and redside shiners were the most common. Their distribution was primarily restricted to the pool habitat of Reach 1.

During the fall, sites in Reaches 1 and 2 below the falls, and at a site 7.5 km above the falls were sampled (Table 26). No fish were collected above the falls.

Table 26.
Beach seine catches and electrofishing results
in Maurice Creek, June, September and October, 1989.

Reach	Habitat Type	Sample Tech*	Sample Area (m^2)	Rainbow Trout	Longnose Sucker	Largescale Sucker	Mountain Whitefish	Redside Shiner	Cottids
June 10, 11									
1	Glide	SN	130	3	<1	-	<1	-	<1
1	Pool	SN	50	4	4	72	-	54	-
1	Glide	EL	88	-	-	-	1	-	1
1	Riffle	EL	109	-	1	-	-	-	3
2**	All	EL/SN	464	-	-	-	-	-	-
September 20, October 9, 10									
1	Glide	SN	15	47	7	-	20	-	-
1	Pool	SN	16	-	6	-	-	-	6
2	Glide	EL	44	55	5	-	-	-	46
2	Riffle	EL	44	61	2	-	-	-	127
2	Pool	SN	62	21	2	-	-	-	3
2**	Riffle	EL	59	-	-	-	-	-	-

(-) Absence of fish.
* EL = Electroshocker: SN = Beach Seine.
** Sample sites above impassable water fall at the 3 km mark.

Only four fish species were collected from Maurice Creek during the fall survey (Table 26). Rainbow trout were by far the most abundant species in Reach 2 and, next to cottids, the second most abundant in Reach 1. Only a few mountain whitefish juveniles (age 0+) were collected. Their distribution appeared to be restricted to the lower sections of Reach 1. The absence of redside shiners and large scale suckers suggests that both species move out of the system over the course of the summer. What triggers this outward migration is unknown. However, there is an apparent correlation between the movement of these two species and the increased abundance of rainbow trout.

Fall sampling indicated the Maurice Creek had the highest densities of rainbow trout in the study area. Rainbow trout densities averaged 39 fish·100 m^{-2} in Maurice Creek (Table 27) compared to the average density of 7 fish·100 m^{-2} in Lynx Creek (Table 24), where the fish were of a similar size. Thus, on the basis of densities alone, Maurice Creek appears to be a more important rearing area for rainbow trout from the Peace River. The higher concentrations of rainbow trout may be related to the lower numbers of suckers and minnows that were found in comparison to the other creeks such as Cache, Farrell and Lynx Creeks.

Table 27
Catches (fish·100 m^{-2}) from electroshocking and seining in Maurice Creek, September 20 and October 9 & 10, 1989.

Reach	Sample area (m^2)	Rainbow trout	Longnose sucker	Mountain whitefish	Sculpins
1	31	23	6	10	3
2	150	43	3	0	52
Both	181	39	3	2	44

In total, 12,600 rainbow trout juveniles were estimated to be rearing in the 3 km of Reaches 1 and 2 during the fall. This compares to an estimated 650 rainbow trout during the spring, suggesting that most of the juveniles migrate out of Maurice Creek come winter. These population estimates are based on the 23,400 m^2 of Reach 1 (Table 13) and 8,840 m^2 in the accessible portion of Reach 2 as well as average densities of 39 fish·100 m^{-2} (Table 27) during the fall and 2 fish·100 m^{-2} in spring.

All of the rainbow trout sampled from Maurice Creek were juveniles ranging in age from 0 to 1+ years. Average size for each age group was virtually identical to that recorded for the rainbow trout sampled in Lynx Creek. Among the rainbow trout samples analyzed, 64% were 0+ and 36% were 1+. The three mountain whitefish caught in Reach 1 were also juveniles (age 0+) and averaged 96.7 mm (Table 28). The few longnose suckers that were sampled were similar in size (95.6 mm) to those caught in Lynx Creek (105 mm), but were relatively large when compared to those of caught in Farrell (38.0 mm) and Cache Creeks (61.7 mm).

Table 28
Mean size of fish sampled from Maurice Creek
September 20 - October 10, 1989.

Species	n	Mean Length (mm)	Stdev. (mm)	Min. Length (mm)	Max. Length (mm)
Longnose sucker	5	95.6	35.3	61	146
Mountain whitefish	3	96.7	7.8	88	103
Cottids	41	60.6	21.6	30	90
Rainbow trout	64	76.9	26.4	35	140

3.2.3 Halfway River Tributaries

3.2.3.1 Cameron River

Seven species of fish, including two sportfish species, were collected by 5.5 x 1 m beach seine from the lower 5 km of Cameron River (Table 29). Suckers and minnows contributed most of the catch, although juvenile Arctic grayling and mountain whitefish were also caught in small numbers (4 and 3 fish·100 m^{-2} respectively). The Arctic grayling samples ranged in size from 45 to 61 mm and were mostly aged 0+ (the largest fish caught was aged at 1+ years). The mountain whitefish samples ranged in size from 58 to 120 mm and were also comprised mainly of age 0+ and 1+ fish (Table 30).

Table 29.
Beach seine catches (fish·100 m^{-2}) in the Cameron River, October 7, 1989.

	Habitat		
Species	Pool	Glide	Combined
Northern squawfish	10	0	8
Longnose sucker	3	5	3
Largescale sucker	62	58	61
Redside shiner	27	2	21
Flathead chub	4	3	4
Arctic grayling	3	2	3
Mountain whitefish	3	5	4
Area sampled (m^2)	209	60	269

Largescale suckers were the most abundant species sampled (average catch = 62 fish·100 m^{-2}) followed by redside shiner (average catch = 21 fish·100 m^{-2}). Small numbers of flathead chub, northern squawfish and longnose suckers were also encountered. Longnose suckers were the largest of the samples with lengths up to 262 mm. All of the other species captured were less than 120 mm in length.

Table 30.
Mean size of fish sampled
from the Cameron River October 7, 1989.

Species	n	Mean Length (mm)	Stdev. (mm)	Min. Length (mm)	Max. Length (mm)
Northern squawfish	7	47.9	22.3	28	85
Longnose sucker	8	103	98.1	22	262
Largescale sucker	14	51.1	13.6	29	75
Redside shiner	11	63.5	21.4	35	108
Arctic grayling	2	53.0	11.3	45	61
Flathead chub	5	69.8	19.7	38	92
Mountain whitefish	6	92.0	23.2	58	120

The average depth of the pool section surveyed (depth = 1.75 m) exceeded the range of the small seine. It is possible that other fish species or fish of a greater size occupied this deeper habitat.

3.2.3.2 Ground Birch Creek

Seven species of fish were sampled from the lower 5 km of Ground Birch Creek on October 6, 1989 using a 5.5 x 1 m seine (Table 31). Water temperatures were 6°C and only six sportfish (one juvenile Arctic grayling and five juvenile mountain whitefish) were captured in the 12 sets that were made in the two reaches. Northern squawfish were the most numerous species sampled, followed by longnose sucker, redside shiner, cottids, and largescale sucker. Bull trout and lake chub which were reported in Ground Birch Creek by RRCS (1979) were not seen in 1989.

Table 31.
Summary of beach seine catches (fish·100 m^{-2}set)
in Ground Birch Creek, October 6, 1989.

Species	Reach 1	Reach 2	Reach Combined
Arctic grayling	0	1	<1
Mountain whitefish	0	3	1
Northern squawfish	9	23	16
Redside shiner	14	6	10
Cottids	6	13	10
Longnose sucker	2	19	11
Largescale sucker	0	1	<1
Sample Area (m^2)	117	104	221

Most of the fish sampled were small in size, although the longnose suckers were up to 273 mm in length (Table 32). Despite the limited sample size, analysis of the mountain whitefish scale data suggests that growth in this creek may be quite slow in comparison to the other Halfway tributaries surveyed. Average size of the age 0+ mountain whitefish caught was comparable to those caught in the other streams surveyed, but the 1+ fish were considerably smaller than those found elsewhere (88.5 mm mean fork length).

Table 32.
Mean length, standard deviation, and range of fish sampled
from Ground Birch Creek, October 6, 1989.

Species	n	Age (yr)	Mean Length (mm)	Stdev. (mm)	Min. Length (mm)	Max. Length (mm)
Northern squawfish	15		70.3	27.6	23	105
Longnose sucker	5		108	94.0	39	273
Largescale sucker	1		100	-	100	100
Redside shiner	14		52.4	21.4	27	93
Cottids	9		44.1	14.9	29	73
Mountain whitefish	3	0	74.3	1.2	73	75
" "	2	1	115	0	114	115

3.2.3.3 Kobes Creek

The sites sampled in Kobes Creek had low fish densities (Table 33) but the species composition was more complex than that observed in 1974 (RRCS 1979). Redside shiners were most numerous followed by longnose suckers, mountain whitefish, largescale suckers, cottids and northern squawfish. Mountain whitefish and cottids were captured in the electroshocking sites near the mouth while the other species were captured all the way upstream to the limit of the survey at 5 km.

Table 33.
Densities (fish·100 m^{-2}) of fish from electroshocker and beach seine catches in Kobes Creek September 18 and 26, 1989.

Habitat	Sample Method	Sample Area (m^2)	Mountain whitefish	Longnose sucker	Largescale sucker	Northern squawfish	Redside shiner	Cottids
Glide	Shocker	94	5	7	1	0	0	4
Riffle	Shocker	37	5	8	0	0	0	5
Glide	Seine	115	0	4	1	3	7	0
Pool	Seine	70	0	0	4	2	27	0
All	All	316	3	5	2	1	9	2

Most of the fish caught were quite small, the maximum size being 178 mm for a longnose sucker caught near the Halfway River confluence (Table 34).

Table 34.
Mean length, standard deviation, and range of fish sampled from Kobes Creek, September 18 and 26, 1989.

Species	n	Mean Length (mm)	Stdev. (mm)	Min. Length (mm)	Max. Length (mm)
Longnose sucker	14	60.1	55.7	20	178
Mountain whitefish	8	91.1	30.3	56	134
Cottids	4	63.0	17.8	40	79
Largescale sucker	5	45.2	13.3	67	36
Redside shiner	17	47.2	27.4	19	92
Northern squawfish	4	64.5	20.7	48	91

3.2.3.4 Graham River

Mountain whitefish, Arctic grayling, rainbow trout and bull trout were found in high numbers in the lower reaches of the Graham River. Further upstream, catches declined and both lower temperatures and steeper gradients were observed.

Six species were observed in the lower reach of the Graham River in a series of 10 sets, each averaging 100 m^2 in area (Table 35). Mountain whitefish were the most abundant of the four sportfish species sampled. Catches of of 12.8 fish·100 m^{-2} were made in the pool and glide habitats of the lower 10 km of river. Visual counts of up to 4.2 fish·m^{-1} of river bank were made along some stretches of river. The other sportfish species, Arctic grayling, bull trout, and rainbow trout, were only caught in small numbers. In addition to the sportfish, white suckers and cottids were also sampled. RRCS (1979) sampled this area in early November 1979 and reported catch compositions similar to that observed in the present study. The presence of these fish late in the year suggests they may overwinter nearby.

Table 35.
Summary of beach seine catches (fish·100 m^{-2} set)
in Reach 1 of the Graham River, October 4, 1989.

Species	Pool	Glide	Combined
Arctic grayling	0.1	1.2	0.6
Rainbow trout	0.1	0.0	0.1
Bull trout	0.1	0.2	0.2
White sucker	0.0	0.5	0.2
Cottids	0.6	0.0	0.4
Mountain whitefish	12.8	1.3	12.8
Sample Area (m^2)	542	145	687

A 43 m^2 section of riffle, electroshocked using the depletion-removal method (Seber LeCren 1967), had cottid densities of 9 fish·100 m^{-2}.

The beach seine used for sampling was only efficient in sampling slower glide and pool habitat <2 m deep. Fish associated with deeper pools, fast bouldery glide and organic debris could not be sampled effectively. Fish that were associated with that type of habitat may have been present in higher numbers in the system than the catch data suggest.

Sampling in Reach 2 at the 32 km mark included a 200 m snorkle float, three seine set covering 750 m^2, and some electroshocking. Only the electroshocking, which was in a small side channel, produced fish (9 fish·100 m^{-2}).

Reach 3 was sampled near 65 km, about 4 km south of Crying Girl Prairie. Two sets with a 17 m seine revealed mountain whitefish densities of 0.7 fish·100 m^{-2}. However, no fish were observed in a subsequent snorkle survey of 300 m in pool and riffle habitat.

In Reach 4, just below Christina Falls, a 300 m snorkle float was made. Riffle and pool habitats to a depth of 3.5 m were examined but no fish were observed. Water temperature in this area was 3.2°C.

Fish of all species sampled from the Graham River were large relative to those sampled from the smaller systems (Table 36). Of the mountain whitefish sampled, approximately half were greater than 150 mm in length, their ages ranging from 2+ to 4+. The Arctic grayling and rainbow trout caught in the Graham River were the largest of all the systems surveyed, the maximum recorded age for each species being 4+ years, respectively.

Table 36.
Size of fish sampled from the lower Graham River
September 18 and 26, 1989.

Species	n	Mean Length (mm)	Stdev. (mm)	Min. Length (mm)	Max. Length (mm)
Mountain whitefish	87	111	63.0	22	300
Rainbow trout	1	310	-	310	310
Arctic grayling	7	246	108	74	335
Bull trout	2	302	67.2	255	350
White sucker	2	395	7.1	390	400
Cottids	1	82	-	82	82

Juvenile sportfish rearing in the Graham River included a large number of juvenile mountain whitefish (age 0+ and 1+) as well as Arctic grayling aged 0+ and 1+ (estimated from length data) which were seen in lower numbers.

Despite a stable channel form and extensive areas of good spawning gravel, few juvenile rainbow trout were found in the Graham River. This may be an artifact of the sampling regime but juvenile rainbow trout may rear elsewhere. One possible rearing area could be Colt Creek, a major tributary of the Graham River. As indicated in the section following, a number of juvenile rainbow trout were found in Colt creek.

3.2.3.5 Colt Creek.

Colt Creek was surveyed at three different sites: near its confluence with the Graham River, and at points 3 and 15 km further upstream. Five fish species were caught, of which three were sportfish - Arctic grayling, rainbow trout and mountain whitefish. Mountain whitefish were the most numerous sportfish, with an average catch density of 21 fish·100 m^{-2}. Arctic grayling and rainbow trout were caught in fewer numbers, catch densities for both species being identical at 3 fish·100 m^{-2}. While mountain whitefish were collected at all three sample sites, the Arctic grayling and rainbow trout were caught only in the two upstream sites. The higher overall fish densities observed in Colt Creek may be a reflection of water temperatures which were about 2°C warmer than adjacent waters of Graham River.

The mountain whitefish samples ranged in size from 81 to 182 mm and were from 0+ to 3+ years of age, suggesting a comparable growth rate to most of the other streams surveyed in the region. Similar size ranges were observed among the Arctic grayling and rainbow trout that were caught. Analysis of the scales collected from the Arctic grayling showed that these fish were primarily 0+ and 1+ years of age as were the rainbow trout.

Cottids and longnose suckers comprised the remainder of the catch. Cottids were found at all three sample sites. Fish density, as determined by the multiple removal electroshocking, was estimated to be 47 fish·100 m^{-2} at the 3 km site. Longnose suckers were much less prevalent, being found only at the mouth of the creek and at a density of 27 fish·100 m^{-2}.

3.2.3.6 Horseshoe Creek.

Few fish were caught on September 27 when Horseshoe Creek was sampled at a location 500 m above its mouth. Water temperature in this area was 9.5°C and a total of 6 seine sets, each covering average area of 30 m^2 was completed yet the catch totalled only two juvenile mountain whitefish and one slimy sculpin.

Additional seine sets were made the next day at another site 16 km further upstream. At this second site, several pool and glide habitats were isolated and electroshocked. Temperature here was only 6.5°C and only cottids were collected. An additional 100 m section of creek was randomly electroshocked but again only cottids were found.

Interestingly, residents of the area report that rainbow trout and large Arctic graying can be found in Horseshoe Creek. As the stream offers an abundance of habitat suitable for these and other salmonid species, their absence from this creek during the fall survey suggests the habitat may be used in spring and early summer when water temperatures are higher.

3.2.3.7 Blue Grave Creek

Blue Grave Creek was sampled 500 m from its confluence with the Halfway River, on September 27. Water temperature was 10°C, and a large number of mountain whitefish were caught by beach seine. From five sets averaging 22 m^2

in area, fish density was estimated to be 17 fish·100 m^{-2}. In addition to the mountain whitefish, one 43 mm rainbow trout and a few slimy sculpins were caught. Sculpin density was estimated at 5 fish·100 m^{-2} which is likely to be low since sculpins generally associate themselves with cobble substrates, therefore making them difficult to capture by beach seine.

Blue Grave Creek was also sampled at a second site, 20 km further upstream. The water there was 6.5°C and no fish were caught by beach seine nor were fish caught in pool and riffle habitats that were isolated and electroshocked. However, when a 100 m section of stream was randomly electroshocked, six bull trout were collected along with one slimy sculpin. The bull trout ranged in size from 59 mm to a three year old, 350 mm specimen.

3.2.3.8 Chowade River

The Chowade River was sampled at three locations on October 11, 1989. The first of these was at 42 km from the mouth. There water temperature was 4°C, and a 50 m section of stream was examined by snorkeling. Despite the clear visibility (approximately 10 m) no fish were observed along the cut banks of the stream or under a nearby logjam. A 100 m^2 set made by beach seine also failed to capture any fish. Thus, it would appear that few fish inhabit this particular area of stream in the late fall.

Visual counts were made by snorkle float at 20 km on the Chowade River. Water temperature in the area was 5°C. Few fish were observed within a 150 m section of glide except in a small 2 m deep pool created by a permanent logjam where approximately 60 mountain whitefish were found.

At 1 km above the Halfway River, large numbers of mountain whitefish were caught by beach seine. From the two sets made in pool habitats, fish density was estimated at 10 fish·100 m^{-2}. In addition to the mountain whitefish, Arctic grayling, rainbow trout and bull trout were also caught, although in considerably lower numbers. Water temperature in this area was 6°C. The increase of fish densities with water temperatures along the length of this system suggest that fish may have been moving our of, or at least down to the lower reaches for the winter.

Mountain whitefish sampled in Reach 1 of the Chowade River ranged from 64 to 334 mm in length (Table 37). Not all fish were analyzed, but age ranged from 0 to four years among those fish aged with the mean length of the four year old fish being 204 mm. The two rainbow trout sampled were 266 and 292 mm in length with ages of 3 and 4, respectively.

Table 37.
Fish sampled from the lower Chowade River, October 11, 1989.

Species	n	Mean Length (mm)	Stdev. (mm)	Min. Length (mm)	Max. Length (mm)
Mountain whitefish	41	164	55.3	59	334
Rainbow trout	2	279		266	292
Arctic grayling	2	198		153	242
Bull trout	1	185			

3.2.3.9 Cypress Creek.

Local residents report that Cypress Creek supports reasonably good angling. However, fish usage appears to be seasonal in nature. October 1989 sampling revealed a few juvenile whitefish and cottids rearing near the mouth but no fish were seen in the remainder of the system.

Upper Cypress Creek was sampled at points 14, 27 and 36 km above its mouth. In Reach 3 near the 36 km mark, a 200 m section of stream, comprised of slow glide and pool habitats, was floated by diver. No fish were observed. Similarly, no fish were observed in Reach 2 when a 100 m section of the steam was floated by diver at the 25 km mark. Water temperature at both float sites was 3.5°C. Further downstream, the temperature increased to 5°C but the four sets made by beach seine in shallow pools of Reach 1 near the 14 km mark also failed to reveal the presence of fish.

No fish were caught when a 100 m section of stream at 1.5 km in Reach 1 was randomly electroshocked, but four sets made by beach seine through shallow pools (each averaging 8 m^2 in area) did yield two juvenile mountain whitefish and three slimy sculpins. Thus, it would appear that Cypress Creek supports very few fish at this time of year, despite the apparent abundance of suitable habitat.

3.2.4 Limits to Fish Production

The fish and habitat investigations completed during 1989 are sufficient to support a general overview of the region's fish populations. The data are not comprehensive enough to allow detailed analysis of each of the 15 tributaries investigated. However, by grouping them together, a few comments can be made on apparent limits to fish production in the Site C reservoir area.

3.2.4.1 Reservoir

Fish productivity within the reservoir appears likely to be limited by three factors: low summer temperatures, rapid flushing, and an absence of suitable spawning habitats. The problems of temperature and flushing are probably unavoidable in a reservoir of this type although warmer temperatures may occur in the inlet arms created by the Halfway River, Moberly River, and Cache Creek.

Spawning habitats for sportfish appear to be extremely limited within the reservoir. Existing cobble and gravel areas, other than the west end of Reach 4, will become too deep and in many areas will be covered by silt. Higher up, near the full service level, there appears to be little of the rock or gravel these species typically require.

3.2.4.2 Mainstems

The Moberly and Halfway Rivers differ substantially in size and many physical aspects but both have highly variable discharges, low winter flows and poor water quality during spring. Fish densities are however, much higher in the Moberly River which suggests that its more varied character presents fewer limiting factors to fish production.

Halfway River

Overall limits to fish productivity in the Halfway River are difficult to assess at this time as the fish populations are still poorly understood; particularly in regard to the life stages using the mainstem. Information collected by RRCS (1979) and Pattendon et al. (1990) confirms that adult sportfish are found in the river and appear to migrate over most of its length. There are however little data available on its importance in rearing, spawning and over wintering.

Habitat surveys conducted in 1989 suggest that spring spawning is probably limited by discharge variability and by extreme silt loads. By fall, the silt and turbidity have decreased substantially but are still quite high. In addition, although there are numerous areas of gravel and cobble substrates, the interstices generally contain large quantities of sand and silt. These factors, together with the rapidly declining temperatures and water levels suggest that fall spawning by species such as bull trout is unlikely. Overwintering opportunities also appear to be limiting fish populations in the Halfway River. There are some deeper holes and groundwater seepages apparent along the sandstone outcrops near the Graham River and a few more near the lower powerline crossing, but these are exceptions. The remainder of the system is of nearly constant grade with few pool areas likely to provide refuge during the low water levels of late winter. The significance of the lack of over wintering habitat is difficult to assess at this stage.

Tagging studies (Pattendon et al. 1990) suggest that fish may overwinter or rear in downstream areas using the Halfway River only as a corridor to spawning and rearing habitats in the mountain tributaries. However, RRCS (1979) reported that mountain whitefish overwintered in the Halfway River. Similarly, the importance and limitations of the Halfway River as rearing habitat is difficult to assess. Certainly there are fish in the river, and there appear to be few juveniles, but there are few data to indicate whether the fish are all transient or what the overall densities are. However, the physical habitat suggests that low water temperatures, high silt loads and system instability are likely to limit rearing success.

Moberly River
The Moberly River has a highly variable flow regime like the Halfway River but supports both adult and juvenile fishes. In addition, it may be used by spawners from the Peace River mainstem including Arctic grayling (spring) and mountain whitefish (fall). The difference appears to be attributable two factors. First, the high turbidity and silt load which accompany spring freshet decline later in the year so that there are extensive areas of clean gravel. Second, the system contains varied habitats ranging from slow moving glides, pools and back channels through fast moving gravel riffles. As a result, there appears to be more refuge for both over wintering and freshet. None the less, fish densities are not particularly high and more information is required to determine the distribution of rearing and spawning adult fishes, to determine how the various habitats are being used, and which ones are likely to limit fish production. In particular, the significance of spawning habitats in the lower half of Reach 1. The biophysical reconnaissance suggests that there is additional suitable habitat in higher reaches but there is no information available on whether these areas are already used to capacity, or if particular habitat types limit resident fish in the Moberly system or spawners from the Peace River mainstem.

3.2.4.3 Plateau Tributaries
Many of the plateau tributaries that were examined appeared to be poor sportfish habitat. Wilder Creek, Farrell Creek, Cache Creek, Kobes Creek, Ground Birch Creek and the Cameron River all had very low densities of sportfish. These systems had high silt loads and high summer water temperatures, as well as reduced flows in late summer and fall. Given the low water levels and apparent absence of groundwater inputs, opportunities for overwintering appear to be severely limited. Maurice and Lynx Creeks do support sportfish but they share many of the same characteristics and there appear to be severe limits to their productivity.

Substrates in the plateau tributaries appeared to be highly unstable with large amounts of erosion and bed movement occurring every year. The high proportion of fine material (silt and sand) coupled with this instability severely limits sportfish which are typically substrate spawners.

The plateau tributaries being relatively small are ungauged. However the discharges appear to be even more variable than those of the Halfway and Moberly systems. Sudden discharge peaks follow snowmelt as well as severe rain squalls which can occur at any time from April through October. The problem is accentuated by the lack of storage in the system. Freshet events start and finish soon after rainfalls.

Fish populations in Maurice and Lynx creeks, the only tributaries of the Peace mainstem which support rainbow trout, seem to have the same problems as those in the other plateau tributaries but to a lesser extent. On Lynx Creek, rainbow trout were found rearing throughout Reaches 1-4. However, most of the fish were 0+ - 1+ in age and average size was only 124 mm. The spawning gravel is not particularly good as it has a large silt fraction, and by late summer few of the pools could accommodate larger fish. Cover, generally considered essential to rearing trout, is almost completely lacking. There are a few areas of groundwater upwelling, particularly in the major tributary Brenot Creek but these filter through the overburden and carry large amounts of silt into the system.

Maurice Creek, although generally similar to the other plateau tributaries, lies at the western limit of the plateau. From three to five kilometers above the mouth, a series of water falls mark the system's passage over the sandstone and siltstone edge of the foothills. As a result, large areas of otherwise serviceable rearing habitat are isolated above the falls. Silt and water quality problems are not as severe as some of the other systems but the spawning substrates are generally limited to a small portion of Reach 1 as Reach 2 contains <10% gravel and an equal amount of fines.

3.2.4.4 Mountain Tributaries

Of the tributaries examined during the study, the mountain tributaries in the upper Halfway area appeared to be the most suitable as sportfish habitat, particularly for Arctic grayling, rainbow trout and possibly bull trout. The Graham River, Cypress Creek, Blue Grave Creek, Horseshoe Creek, and the upper Chowade River were mainly clear, cool water systems as these species prefer. However, only a few sportfish were captured. Given their altitude, it is possible that these systems are used only seasonally. In that case, the low fish numbers observed in September and October 1989 may represent the late season as the fish migrated out with falling water temperatures or water levels. Certainly there were more fish in the lower reaches of these systems where water temperatures were somewhat higher (5-6°C vs 3-4°C).

Potential limits to fish production in the mountain tributaries could include:

- Altitude (short season and limited benthic productivity).
- Water quality (either in terms of productivity or toxicity).
- Overwintering habitat. All of the systems appeared to have deeps pools and cover sufficient to provide overwintering. However the fish may either leave the system completely or may key on warmer groundwater seepages in the lower reaches of these streams. Certainly late season aggregations were noted in the Graham, Chowade and Blue Grave systems.

Further investigation will be required to determine if these areas actually have low populations of these species and what factors may limit their populations.

3.3 MITIGATION AND ENHANCEMENT OPPORTUNITIES

The development of the Site C dam will result in major impacts on the aquatic habitats of the Peace River. The following sections provide a preliminary outline of techniques which could be used either to mitigate the impacts or to compensate for them. In general, the discussion focuses on the limits to production identified in 3.2.2. above and some of the means which can be used to remove them. The first section examines techniques which could be used to boost productivity within the reservoir itself. This is followed by a discussion of some of the off-site mitigation opportunities which exist in the tributaries.

3.3.1 Reservoir

The productivity of a Site C reservoir is likely to be limited by low temperatures and high flushing rates (RRCS 1979). In addition, many sport species are likely to be limited by a scarcity of suitable spawning substrates. None the less, although the physical characteristic of the reservoir are difficult to alter, there are techniques which can be used to mitigate or compensate for changes in fish production.

Spawning and Incubation

Spawning and incubation habitats can be augmented by hatchery operations or by habitat creation. The biggest problem from a planning perspective appears to lie in identifying the species to be assisted. RRCS (1979) suggested that the reservoir would support walleye and Arctic grayling. However, since that time it has become apparent that Arctic grayling, such as those in Williston Lake, can not support the intensive fisheries likely to follow impoundment. Unassisted, walleye success also appears doubtful due to the low water temperatures and lack of substrates (Hammond 1987). Rainbow trout may be a better prospect (Hammond 1987) but spawning and rearing habitats in Maurice and Lynx Creeks appear limited and hatchery operations in Dinosaur Lake have proved a mixed success (Stone 1987).

Some of the approaches which may be taken to increase the supply of spawning habitat for reef and littoral spawners are outlined below.

a). Where gravel substrates are known to exist in littoral or shallow depths, clearing and scarification should be used to create spawning reefs. This is however, likely to be successful only in areas which are well flushed and unlikely to slump or be silted over.

b). Rock used to provide bank stabilization, such as along highway alignments, bridges, etc., should be placed in a manner which will keep the outside face well flushed. This type of rip-rap placement forms a good spawning substrate for species such as walleye (Michaletz 1986).

c). Where littoral spawning habitats, such as the rip rap mentioned above are used, reservoir operations should be planned to ensure that incubating eggs or alevins are not de-watered during critical stages.

d). In the absence of suitable spawning or incubation conditions and habitat, hatchery incubation could be considered.

Stream spawners

The development of resident populations of stream spawning fish within the reservoir is likely to require some form of incubation or artificial habitat. Opportunities for improving natural spawning habitats for these fish within the reservoir appear limited. At most locations substrates, water quality and quantities are unsatisfactory for most forms of fish culture.

At the Peace Canyon dam many kokanee die unspawned every year (Pattendon et al. 1990). It appears that these fish are almost all strays from upstream areas which are trying to get back over the dam. Given some form of artificial incubation, these fish could make a substantial contribution to reservoir productivity either as forage for larger piscivours or as sportfish in their own right. Options for kokanee enhancement are discussed further in following sections.

Hatchery

Maintenance of sportfish populations large enough to supply interesting angling opportunities on the Site C reservoir may require hatchery assistance. Hatcheries could be used to:

a). Supplement natural rainbow trout spawning which appears to be limited by marginal habitat quality in Lynx and Maurice Creeks.

b). Incubate kokanee and assist in the development of a resident population in the Site C reservoir. Kokanee from upstream are now rearing in the Peace River below the Peace Canyon dam (Pattendon et al. 1990). Although conditions for kokanee in the study area may improve following impoundment, the population is limited to individuals immigrating from upstream areas. No natural spawning has been observed downstream of the Site 1 dam.

c). Provide hatchery support for Arctic grayling populations. Some experimentation would be required to determine whether fry or fingerlings are best suited have better success in the reservoir. Both have shown promise in other areas (Kindschi and Barrows 1990).

d). Incubate and rear walleye. Raising walleye to at least the fingerling stage would also increase stocking success by decreasing losses due to low temperatures during early rearing (Smith and Koenst 1975, Loadman et al. 1989). However a supply of 15 - 20°C water would be required.

Productivity

The productivity of the Site C reservoir is expected to be restricted by low temperatures and high flushing rates (RRCS 1979). High flushing rates tend to limit primary and secondary productivity while cool temperatures limit feeding and growth in fish.

Water temperatures within the Site C reservoir are likely to be only slightly warmer than those in Dinosaur Lake where a summer maximum of 12-13°C was observed (Hammond 1987). This is likely to minimize walleye success within the reservoir (Hammond 1987) as walleye growth requires temperatures >12°C (Kelso 1972). However, walleye should not be totally discounted as they currently rear in the Peace system which is probably 1-2°C cooler than the proposed reservoir. This suggests that the Peace River walleye stocks: may be better adapted to low temperatures than those examined by Kelso; are occupying warmer microhabitats rather than the thalweg; or that temperature effects are most detrimental to walleye at juvenile and incubation stages. Difficulties might also be overcome by focusing mitigation in the inlet arms which are likely to be somewhat warmer in summer, by aligning rip-rap bank protection for highways and bridge abutments to create downstream backwaters, or through hatchery incubation and rearing.

During the summer months, reservoir tributaries are likely to be much warmer and more productive than the reservoir itself. To maximize the utilization of this warmer water, the tributary side of rip rapped highway alignments in inlet areas could be used as current deflectors to create higher productivity backwaters.

Fertilization has been shown to increase the productivity of some lakes including a number of regulated systems (Hyatt and Stockner 1985). The technique may be useful in increasing productivity of the proposed reservoir's Moberly Arm. Summer nutrient samples in Moberly Lake suggest the Moberly River is oligotrophic (Slaney and Lewynsky in prep). In addition, the Moberly arm is likely to have the longest residence time of any part of the reservoir, particularly during July and August when the discharge of the Moberly River declines (Figure 12). In contrast, applying nutrients to the Peace River or the Halfway Inlet arm would be difficult due to the high flushing rates and the volumes of water involved. Even if nutrients were added upstream in Dinosaur Lake, mixing at Site 1 dam may limit their effectiveness.

Regulation
It may also be necessary to monitor the fishery closely and alter angling regulations. For example, following impoundment, Arctic grayling may become particularly susceptible to angling. Although the Arctic grayling collapse in Williston Lake may have been an inevitable result of reservoir aging, limiting daily takes may either prolong or reverse the process.

3.3.2 Major Tributaries

The factors limiting fish production in the major Peace River tributaries have, for the most part, not been determined. Some of the more obvious problems include instability, poor water quality, lack of spawning and incubation habitat, low productivity, and lack of overwintering habitat but with the limited information available, it is difficult to establish the importance of these factors. For example, it appears that there is little deep water suitable for winter refuge in the Halfway system. However, as fish are known to migrate to the Peace mainstem (Pattendon et al. 1990) which has relatively large amounts of over wintering habitat, there is no indication that the shortage of over wintering habitat in the Halfway River actually limits the fish population. Given this uncertainty, much more life history information will be required before the relative merits of enhancement techniques can be discussed in any detail.

The Halfway and Moberly rivers are instable, both in terms of their hydrologic regimes (peak daily flows >70 times minimum daily flows), and in terms of substrate movement. These factors are detrimental to fish production, particularly for substrate spawners. As the mainstem rivers are too large to be tackled effectively, abandoned side channels could be improved and protected to provide spawning and early rearing habitats. This technique has had little application to trout or grayling but has been effective in enhancing chum and coho (Sheng et al. 1990). On the Moberly River, side channel enhancement could prove an effective adjunct to kokanee introductions.

Overwintering habitats are, as noted previously, quite scarce in the Halfway River and in the lower Moberly River. Although the importance of these habitats has not been confirmed it appears that this type of habitat may limit fish production. A few groundwater seepages were observed during 1989 which could be channelized to provide additional winter habitat if required. A search for additional groundwater sources is also recommended.

The Moberly River appeared to support high numbers of both northern pike and mountain whitefish. However both of these species are probably not fished to their full potential due to the remoteness and inaccessibility of much of the system. Northern pike were abundant in the slow glide and slough habitat of Reaches 3 and 5. This species likely receives little fishing pressure in this area, particularly in Reach 3, due to the difficult access. However an attempt to enhance pike in this area would probably be of little value as the stocks do not seem to be fished to their potential at the present time. A road into the Reach 3 along with a boat launch and possibly a campsite would be one method of increasing the fishing potential and use of this system. Increasing access into this area may be controversial, however, as there would be increased pressure on other wildlife as well.

3.3.3 Plateau Tributaries

There appears little opportunity for enhancement or mitigation in most of these systems due to the high silt loads, bed movement, and high summer water temperatures, and low discharges during late summer and winter. The root problem is that there is little water storage; spring freshet and storm run-off are discharged almost immediately. This is compounded by the fine, unstable substrates. Structures such as storage dams or excavated pools are likely to be rapidly filled by bed material. Finally, techniques such as side channel enhancement, which provide stable refugia in unstable systems, would be difficult to apply due to the canyonous, single thread nature of these channels. The only exceptions to this pattern are Lynx and Maurice Creeks which are on the edge of the Plateau region, have existing sportfish populations, and appear to have some potential for increased rearing by juvenile rainbow trout.

The rainbow trout found in Lynx Creek were found all the way up to the waterfalls in Reach 4. The fish in Reach 4 are above impassable falls and appear to be a resident population but those further down may be from the Peace River population. Rearing opportunities for these fish appeared to be limited as in the other Plateau tributaries. However groundwater seepages from springs in Brenot Creek may provide a means of augmenting overwintering capability and summer rearing. At present these springs are flowing through a slump area and carry large amounts of silt. The springs should be investigated to establish the feasibility of channelizing the flow to provide improved habitats. Other possibilities, such as improving spawning conditions, appear to be limited by silt loads and bed movement.

Maurice Creek also had substantial numbers of rainbow trout juveniles below a waterfall 3 km from the mouth. Unlike the population in Lynx Creek, however, most of the rainbow trout appeared to be juveniles with very few adults being caught. Although more study needs to be done on this population, from the limited amount of sampling conducted, it appears that adults in the Peace River use Maurice Creek for spawning. Some of the juveniles subsequently rear in the system. One possibility for enhancement would be a headwaters stocking program to utilize the habitat above the falls for rainbow trout which would eventually migrate into the proposed reservoir. The total amount of suitable habitat above the falls is unknown but even at low densities, the 15 km of stream could rear a significant number of juvenile rainbow trout.

Other enhancement possibilities in Maurice Creek would be to remove the falls or to establish a resident rainbow trout population above the falls. Neither appears feasible. Clearing the obstructions would be fairly expensive as the five sets of falls vary in height between 2.5 and 30 m and would have to be removed. The potential production of trout in the upper reaches of this small system would probably not warrant the expense that would be required for such an undertaking. However, if a particularly successful stocking program demonstrates high habitat capability, fish passage should be investigated. The upper Reaches of Maurice Creek could be colonized with a resident rainbow trout population. However it is unlikely that this introduced population would provide many angling opportunities due to the difficulty of access to the area. In addition, the fish are unlikely to grow very large before emigrating out of the area.

3.3.4 Mountain Tributaries

As noted previously, the streams in the upper Halfway area appeared to be most suitable as sportfish habitat. The Graham River, Cypress Creek, Blue Grave Creek, Horseshoe Creek and the upper Chowade River were mainly clear, cool water systems that bull trout and rainbow trout prefer, however, few fish were captured. Further investigations should to be conducted to verify that these areas actually have low sportfish populations and what may limit their production. These streams may provide an opportunity for the enhancement.

At present, most of the upper Halfway tributaries, except the lower Graham River, receive little fishing pressure. A popular campground exists at the confluence of the Graham and Halfway Rivers. Enhancement of rainbow trout and Arctic grayling in the lower reach of the Graham River would likely be most beneficial.

PART IV

SUMMARY

4.1 CONCLUSIONS

There are still many areas to be investigated but the 1989 surveys are sufficient to support some preliminary conclusions.

4.1.1 Habitat Inundation

The composition of the aquatic habitats which will be flooded by the Site C development is summarized in Table 38. In general, the inundated tributary habitat is similar to that in the adjoining reaches and losses of unique habitat types are minimal. The more significant losses include:

- Shallow glide habitats in the Moberly River which are used by spawning mountain whitefish and possibly Arctic grayling.
- Shallow pool and glide habitat used by rainbow trout in Maurice Creek.
- Spawning habitats in Lynx Creek.

Altered habitats in Wilder, Cache, Halfway and Farrell systems appear to be less significant in terms of fish production.

4.1.2 Fish Populations

a. The Plateau tributaries, particularly Cache Creek, Wilder Creek, Farrell Creek, Cameron River and Ground Birch Creek appear to have very few sportfish and relatively high densities of suckers and minnows. Production of sportfish in these systems appears to be limited by the high silt loads and instability in the spring followed by high water temperatures and low flows during summer.

b. Lynx Creek appeared to contain two populations of rainbow trout. In the upstream areas, which are inaccessible to Peace River fish, there is a resident population of small rainbow trout. In the lower reaches, juvenile rainbow trout appear to rear for up to three years before moving out to the Peace mainstem. Habitat capacity in this area appears to be quite limited due in part, to the large amounts of silt flowing out of Brenot Creek.

Table 38
Summary of habitat areas[1] to be alienated by a Site C reservoir.

Habitat type		Peace	Moberly	Wilder[4]	Cache	Halfway	Farrell	Lynx[4]	Maurice
Glide	(<1 m)[2]	631	134		-	47.4	3.26		0.148
Glide	(>1 m)	20,500	-		-	518	-		-
GRC[3]	(<1 m)	-	44.3		24.3	-	1.68		3.82
GRC	(>1 m)	-	8.68		-	-	- -		-
Pool	(<1 m)	902	0.970		9.02	8.38	3.86		1.29
Pool	(>1 m)	389	-		0.225	-	0.240		-
Riffle		3,010	95.1		-	595	4.53		-
Rapid & Cascade		-	15.3		-	-	-		-
Slough		-	-		9.15	-	-		-
Total		25,400	289	-	42.6	1,170	13.6	-	5.25

1 - m^2 x 1,000 during September, 1989.
2 - Mean maximum depth.
3 - Glide riffle complex. Individual features too small to separate at survey scale.
4 - Revisions required. Will be included in final draft.

c. Maurice Creek contained the highest densities of rainbow trout of all the tributaries examined. No fish were found above a series of falls located between 3 and 4.6 km from the mouth.

d. Mature mountain whitefish were captured from the Moberly River in early October where few adults had been caught previously in early September. In addition, juvenile Arctic grayling were captured although few adults were observed. The Moberly River appears to be an important spawning area for these species. Moderate densities of northern pike were found in Reaches 3 and 5.

e. The clear water tributaries to the upper Halfway River, which included the Graham River, Chowade River, Blue Grave Creek, Horseshoe Creek and Cypress Creek, appeared to contain few rainbow trout and Arctic grayling. Although sampling was late in the year, it is not readily apparent why there were such low catches of these two species in these systems since the habitat appeared suitable. The Graham River and the lower Chowade River appeared to have substantial populations of mountain whitefish.

4.1.3 Enhancement/Mitigation Potential

a. Spawning and rearing habitats within the Site C reservoir are likely to be limited. The possibility of increasing fish utilization of the reservoir's inlet arms, particularly the Moberly Arm should be investigated along with opportunities to take advantage of any rock or gravel structures which are required during reservoir construction or operation.

b. Sportfish, particularly Arctic grayling, rainbow trout or walleye are likely to require hatchery support. Hatchery incubation would compensate for the lack of spawning habitat. Perhaps more importantly, warmer hatchery environments would encourage growth at critical juvenile stages which are likely to be impaired by low temperatures in the reservoir.

c. Kokanee from upstream areas currently rear in the Site C segment of the Peace River. Although these fish could be successful in the proposed reservoir, the population is not self perpetuating as no spawning has been observed. Development of spawning or incubation facilities could contribute an important sport or forage species to the reservoir.

d. Productivity of the Site C reservoir is likely to be limited by low water temperatures and high flushing rates. It is unlikely that substantial changes can be made in mainstem areas. However, it may be possible to increase production through summer fertilization of the Moberly arm which will have a much lower flushing rate.

e. Spawning success in the Moberly River appears to be limited by channel instability and poor water quality during freshet flows. Spawning habitats may be further constrained by impoundment which would inundate large areas of the shallow glide habitat currently used by whitefish and possibly Arctic grayling. It may be possible to mitigate the habitat loss through side channel development.

f. Although the Moberly River has populations of sportfish in the reaches between the Peace River and Moberly Lake, there is little access and no facilities for fishermen. Reach 3 appears to have an abundance of northern pike that is not fished. A road into the Reach 3 along with a boat launch and possibly a campsite would be one method of increasing the angling potential and use of this system. As Reach 3 is mainly slow flowing glide, it may also be an area of interest to canoeists.

g. Because of substrate instability and lack of water storage, mitigation or enhancement would be extremely difficult on the plateau systems including Cache, Cameron, Colt, Kobes, Farrell, and Wilder creeks.

h. There appears to be a large area of moderate quality habitat above the waterfalls of Maurice Creek which could be stocked with rainbow trout. The trout are unlikely to residualize there but downstream emigration would contribute to stocks in the Peace River.

i. The enhancement potential of Lynx Creek is limited due to the small base flow and heavy silt load. Some improvement could however be made by piping the Brenot Creek springs away from significant silt sources.

4.2 RECOMMENDED FUTURE STUDIES

Some of the problems worthy of further attention are listed below.

a. Characteristics of reservoir inlet arms.
One of the biggest restrictions to summer fish production in the Site C reservoir is likely to be low water temperature. As the tributaries are likely to be much warmer, some work should be done to examine the thermal regimes in these areas and how they can best be used. It may be that the warm water will merely form a thin lens over colder Peace River

water. None the less, the distribution of warm water may have important enhancement implications.

Flow rates and characteristics of the Moberly arm should be given particular attention and the feasibility of enhancing production through fertilization should be investigated.

b. Overwintering habitats

Biophysical observations made during this survey support the RRCS (1979) hypothesis that a lack overwintering habitat severely limits fish populations in Peace River tributaries. The summer/fall surveys did reveal a few deep water refugia but we were unable to identify groundwater sources which might also provide refuge. A few obvious seepages on high banks were noted but those within the watercourses could not be detected. A winter overflight of the study area should be conducted to look for possible ground water supported refuges, or areas where seepages could be developed to provide refuges. Small seepages are likely to be covered by ice and snow. However, seepages large enough to support enhancement/mitigation projects are often visible as open water areas or major ice buildups.

Groundwater sources on Brenot Creek should also be investigated. At present, these seepages are a major source of the silt which limits fish production in this system. The springs are small and the surrounding soils are very unstable. However, it may be that the groundwater can be diverted into pools either to provide overwintering/rearing habitat or to allow the silt to settle.

c. Moberly River

The 1989 tributary survey, plus the work completed by Pattendon et al. and RRCS, suggests that this system is a significant spawning area for Peace River populations such as mountain whitefish and possibly several other species. It also has a high mitigation potential because access is currently restricted and angling opportunities could be created close to Fort St. John.

As on the upper Halfway tributaries, our 1989 work concentrated on biophysical survey and lightweight sampling techniques which were not particularly effective in deep pool habitats. These habitats, which are likely to support most of the sport sized fish, should be investigated in more detail, particularly during spring and fall spawning periods.

d. Walleye stock characteristics
The microhabitat preferences and thermal responses of Peace River walleye should be investigated in detail. The literature suggests that the proposed reservoir may be too cold for this species. However, as the river is presently cooler than the proposed reservoir yet supports a moderate walleye population, there is reason to suspect that walleye of the Peace River have adapted to cool temperatures. This characteristic should be investigated further before mitigation plans are finalized.

ACKNOWLEDGEMENTS

Thanks to all of the people who assisted with the project. Steve Hiebert and Len Eklund assisted with the field operations. Scale samples were aged by Gary Birch. Ted Down, MOE Fort St. John, provided background data on many of the study systems.

Hugh Smith and Glen Singleton served as Program Coordinators for B.C. Hydro and provided both help and direction. The report was reviewed by Gary Ash and Melody Farrell. Their helpful comments were much appreciated.

LITERATURE CITED

Atmospheric Environment Service (EAU). 1982. Canadian Climate Normals: Temperature and Precipitation 1951 - 1980, British Columbia. Environment Canada, UDC:551-582(711).

Carl, G.C., W.A. Clemens and C.C. Lindsey. 1977. The fresh-water fishes of British Columbia. B.C. Provincial Museum. Handbook No. 5. 192 p.

Department of Fisheries and Oceans, and Ministry of Environment and Parks (DFO/MOEP) 1987. Stream Survey Field Guide. Fish Habitat Inventory and Information Program.

Hammond, R.J. (1986). Peace River Creel census, 1985. MOE Recreational Fisheries Branch, Rept. No. PCE 05.

Hammond, R.J. (1987). Habitat suitability of the proposed Site C reservoir for walleye *(Stizostedium vitreum)* and rainbow trout *(Salmo gairdneri)*. MOE Recreational Fisheries Branch, Rept. No. PCE 16.

Hyatt, K.D., and J.G. Stockner, 1985. Response of sockeye salmon *(Oncorhynchus nerka)* to fertilization of British Columbia coastal lakes. Can. J. Fish. Aquat. Sci. 442: 320 - 331.

Kelso, J.R.M. 1972. Conversion, maintenance, and assimilation for walleye *(Stizostedium vitreum vitreum)*, as affected by size, diet, and temperature. J. Fish. Res. Bd. Can. 29: 1181 - 1192

Kindischi, G.A. and. F.T. Barrows. 1990. Diets for the intensive culture of Arctic grayling in Montana. Prog. Fish-Cult. 52: 99 - 91.

Loadman, N.L., J.A. Mathias, and G.E.E. Moodie. 1989. Method for the intensive culture of walleye. Prog. Fish-Cult. 51: 1 - 9.

McPhail J.D., and C.C. Lindsey. 1970. Freshwater fishes of northwestern Canada and Alaska. Fish. Res. Bd. Can. Bull. 173. 381 p.

Michaletz, P.H. 1986. Utilization of rip-rap by spawning walleyes in Lake Francis Case near Chamberlain, South Dakota, 1985. South Dakota Dept. Game, Fish and Parks. Rept. 86-2. 28 p.

Parsley, M.J., D.E. Palmer and R.W. Burkhart. 1989. Variation in capture efficiency of a beach seine for small fishes. N.A. J. Fish. Mgmt. 9:239 - 244.

Pattendon, R., C. McLeod, G. Ash and K.K. English. 1990. Peace River Site C Hydroelectric Development preconstruction fisheries studies: Fish movements and population status. Prep. by R.L. & L. Environmental Serv. Ltd. and LGL Limited for B.C. Hydro, Vancouver, B.C.

Renewable Resources Consulting Services Ltd (RRCS) 1979. Peace River Site C Hydro-Electric Development: Fish and aquatic environment. Prep. for Thurber Consultants Ltd., Victoria, B.C.

Scott, W.B., and E.J. Crossman. 1973. Freshwater fishes of Canada. Fish. Res. Bd. Can. Bull. 184. 966 p.

Seber, G.A.F., and E.D. LeCren. 1967. Estimating population parameters from catches large relative to the population . J. Anim. Ecol. 36: 631 - 643.

Sheng, M.D., M. Foy and A.Y. Fedorenko. 1990. Coho salmon enhancement in British Columbia using improved groundwater-fed side channels. Can. MS Rept. Fish. Aquat. Sci. 2071. 81 p.

Slaney, T.L. and V.A. Lewynsky. in prep. Walleye feasibility: Moberly and Gwillim Lakes. Prep. by Aquatic Resources Ltd for B.C. Ministry of Environment, Ft. St. John, B.C.

Smith, L.L. and W.M. Koenst. 1975. Temperature effects on eggs and fry of percoid fishes. U.S. Environ. Protection Agency. Ecol. Res. Ser. EPA-660/3-75-017. 91 p.

Stone, M. 1987. Economic analysis of the Peace Canyon Hatchery. B.C. MOE, Rec. Fish. Br. 45 p + app.

Water Survey of Canada (WSC). 1989. Historical Streamflow Summary: British Columbia to 1988. Environment Canada. En 36-418/1988-7.

Water Survey of Canada (WSC). 1990. Surface Water data: British Columbia - 1989. Environment Canada. En 36-407/1989.

Second draft: subject to revision

APPENDICES

APPENDIX I: Sportfish samples

System	Reach	Habitat type	Species	Age	Length (mm)	Weight (g)	Fulton Condition (K)
Blue Grave	1	.	DV	.	59	2.30	1.12
Blue Grave	1	.	DV	.	64	2.60	0.99
Blue Grave	1	.	DV	.	118	14.85	0.90
Blue Grave	1	.	DV	.	121	16.80	0.95
Blue Grave	1	.	DV	.	117	15.00	0.94
Blue Grave	1	.	DV	3+	350	475.00	1.11
Blue Grave	1	N/A	MW		115		
Blue Grave	1	N/A	MW		52		
Blue Grave	1	N/A	MW		115		
Blue Grave	1	N/A	MW		116		
Blue Grave	1	N/A	MW		100		
Blue Grave	1	N/A	MW		100		
Blue Grave	1	N/A	MW		62		
Blue Grave	1	N/A	MW		65		
Blue Grave	1	N/A	MW		70		
Blue Grave	1	N/A	MW		116		
Blue Grave	1	N/A	MW		117		
Blue Grave	1	N/A	MW		54		
Blue Grave	1	N/A	MW		54		
Blue Grave	1	N/A	MW		118		
Blue Grave	1	N/A	MW		119		
Blue Grave	1	N/A	MW		122		
Blue Grave	1	N/A	MW		74		
Blue Grave	1	N/A	MW		95		
Blue Grave	1	N/A	MW		99		
Blue Grave	1	N/A	MW		118		
Blue Grave	1	N/A	RB		43		
Cache	2	pool	GR		55		
Cache	2	pool	GR		51		
Cache	2	slough	GR		48	1.35	1.22
Cache	2	slough	GR		39	1.05	1.77
Cameron	1	glide	GR	0+	65		
Cameron	1	glide	GR	0+	42		
Cameron	1	glide	GR	0+	44		
Cameron	1	glide	GR		60		
Cameron	1	glide	GR		47		
Cameron	1	pool	GR	0+	58		
Cameron	1	pool	GR	0+	61		
Cameron	1	pool	GR	1+	117		
Cameron	1	pool	GR		45		
Cameron	1	glide	MW	0+	80		
Cameron	1	glide	MW	1+	123		
Cameron	1	glide	MW	1+	114		
Cameron	1	pool	MW	0+	86		

APPENDIX I: Sportfish samples

System	Reach	Habitat type	Species	Age	Length (mm)	Weight (g)	Fulton Condition (K)
Cameron	1	pool	MW	1+	120		
Cameron	1	pool	MW		88		
Cameron	1	pool	MW		83		
Chowade	1	glide	DV		185	250.00	3.95
Chowade	1	glide	GR	1+	153	34.00	0.95
Chowade	1	glide	GR		242	146.00	1.03
Chowade	1	glide	MW	0+	64	1.75	0.67
Chowade	1	glide	MW	1+	113	11.30	0.78
Chowade	1	glide	MW	1+	140	25.80	0.94
Chowade	1	glide	MW	2+	202	81.60	0.99
Chowade	1	glide	MW	2+	129	18.30	0.85
Chowade	1	glide	MW	2+	156	35.60	0.94
Chowade	1	glide	MW	3+	195	84.60	1.14
Chowade	1	glide	MW	3+	208		
Chowade	1	glide	MW	3+	192	63.20	0.89
Chowade	1	glide	MW	3+	187	64.70	0.99
Chowade	1	glide	MW	3+	178	56.00	0.99
Chowade	1	glide	MW	3+	176	58.60	1.07
Chowade	1	glide	MW	4+	204	9.26	0.11
Chowade	1	glide	MW	4+	230	130.00	1.07
Chowade	1	glide	MW	4+	147	182.00	5.73
Chowade	1	glide	MW		210	110.00	1.19
Chowade	1	glide	MW		201		
Chowade	1	glide	MW		165		
Chowade	1	glide	MW		333	430.00	1.16
Chowade	1	glide	MW		191		
Chowade	1	glide	MW		164		
Chowade	1	glide	MW		165		
Chowade	1	glide	MW		110		
Chowade	1	glide	MW		196		
Chowade	1	glide	MW		253		
Chowade	1	glide	MW		174		
Chowade	1	glide	MW		214		
Chowade	1	glide	MW		218		
Chowade	1	glide	MW		208		
Chowade	1	glide	MW		113		
Chowade	1	glide	MW		186		
Chowade	1	glide	MW		177		
Chowade	1	glide	MW		154		
Chowade	1	glide	MW		103		
Chowade	1	glide	MW		100		
Chowade	1	glide	MW		117		
Chowade	1	glide	MW		106		
Chowade	1	glide	MW		135		

APPENDIX I: Sportfish samples

System	Reach	Habitat type	Species	Age	Length (mm)	Weight (g)	Fulton Condition (K)
Chowade	1	glide	MW		59		
Chowade	1	glide	MW		97		
Chowade	1	glide	MW		62		
Chowade	1	glide	RB	3+	266	275.00	1.46
Chowade	1	glide	RB	4+	292	375.00	1.51
Colt	2	pool	GR	0+	92	6.70	0.86
Colt	2	pool	GR	0+	90	6.40	0.88
Colt	2	pool	GR	1+	160	42.10	1.03
Colt	2	pool	GR	1+	161	43.95	1.05
Colt	2	pool	GR	1+	171	52.10	1.04
Colt	2	pool	GR	2+	205	100.00	1.16
Colt	2	pool	MW	0+	81	4.45	0.84
Colt	2	pool	MW	0+	120	16.60	0.96
Colt	2	pool	MW	0+	83	4.95	0.87
Colt	2	pool	MW	1+	111	10.45	0.76
Colt	2	pool	MW	1+	125	17.20	0.88
Colt	2	pool	MW	1+	117	14.40	0.90
Colt	2	pool	MW	1+	111	11.60	0.85
Colt	2	pool	MW	1+	116	14.95	0.96
Colt	2	pool	MW	1+	117	12.80	0.80
Colt	2	pool	MW	1+	105	9.25	0.80
Colt	2	pool	MW	2+	150	31.60	0.94
Colt	2	pool	MW	2+	141	25.45	0.91
Colt	2	pool	MW	2+	182	62.80	1.04
Colt	2	pool	MW	2+	157	38.45	0.99
Colt	2	pool	MW	3+	266	250.00	1.33
Colt	2	pool	MW		116	13.95	0.89
Colt	2	pool	MW		112		
Colt	2	pool	MW		115		
Colt	2	pool	MW		121		
Colt	2	pool	MW		83	4.65	0.81
Colt	2	pool	MW		105	9.90	0.86
Colt	2	pool	MW		123	17.30	0.93
Colt	2	pool	MW		124		
Colt	2	pool	MW		124		
Colt	2	pool	MW		120		
Colt	2	pool	MW		69		
Colt	2	pool	MW		76		
Colt	2	pool	MW		122	14.65	0.81
Colt	2	pool	MW		126		
Colt	2	pool	MW		165		
Colt	2	pool	MW		173		
Colt	2	pool	MW		251		
Colt	2	pool	RB	0+	60	2.60	1.20

APPENDIX I: Sportfish samples

System	Reach	Habitat type	Species	Age	Length (mm)	Weight (g)	Fulton Condition (K)
Colt	2	pool	RB	0+	49	1.30	1.10
Colt	2	pool	RB	1+	167	52.50	1.13
Colt	2	pool	RB	1+	195	84.85	1.14
Colt	2	pool	RB		54	1.55	0.98
Cypress	1	pool	MW		64		
Cypress	1	pool	MW		61		
Cypress	1	pool	MW		62		
Cypress	1	pool	MW		104	8.00	0.71
Farrell	1	pool	MW	0+	75		
Graham	1	pool	DV	.	350	510.00	1.19
Graham	1	pool	DV	.	255	160.00	0.96
Graham	1	glide	GR	3+	280	150.00	0.68
Graham	1	glide	GR	4+	330	325.00	0.90
Graham	1	glide	GR	4+	310	250.00	0.84
Graham	1	glide	GR	4+	335	350.00	0.93
Graham	1	pool	GR		74	3.00	0.74
Graham	1	pool	GR		150	34.20	1.01
Graham	1	glide	MW	0+	68	2.38	0.76
Graham	1	glide	MW	0+	70	2.75	0.80
Graham	1	glide	MW	1+	126	17.50	0.87
Graham	1	glide	MW	1+	107	10.55	0.86
Graham	1	glide	MW	1+	133	18.10	0.77
Graham	1	glide	MW	1+	114	11.15	0.75
Graham	1	glide	MW	1+	116	14.30	0.92
Graham	1	glide	MW	1+	106	9.20	0.77
Graham	1	glide	MW	2+	165	43.00	0.96
Graham	1	glide	MW	2+	150	31.45	0.93
Graham	1	glide	MW	2+	162	40.00	0.94
Graham	1	glide	MW	2+	183	60.00	0.98
Graham	1	glide	MW	3+	194	62.00	0.85
Graham	1	glide	MW	3+	245	164.00	1.12
Graham	1	glide	MW	4+	252	170.00	1.06
Graham	1	glide	MW	5+	285	175.00	0.76
Graham	1	glide	MW		79		
Graham	1	glide	MW		75		
Graham	1	glide	MW		73		
Graham	1	glide	MW		83		
Graham	1	glide	MW		70		
Graham	1	glide	MW		70		
Graham	1	glide	MW		60		
Graham	1	glide	MW		60		
Graham	1	glide	MW		63		
Graham	1	glide	MW		63		
Graham	1	glide	MW		63		

APPENDIX I: Sportfish samples

System	Reach	Habitat type	Species	Age	Length (mm)	Weight (g)	Fulton Condition (K)
Graham	1	glide	MW		65		
Graham	1	glide	MW		65		
Graham	1	glide	MW		66		
Graham	1	glide	MW		66		
Graham	1	glide	MW		67		
Graham	1	glide	MW		68		
Graham	1	glide	MW		69		
Graham	1	glide	MW		106		
Graham	1	glide	MW		240	75.00	0.54
Graham	1	pool	MW	0+	57	1.50	0.81
Graham	1	pool	MW	0+	79	4.45	0.90
Graham	1	pool	MW	0+	57	1.30	0.70
Graham	1	pool	MW	0+	60	1.60	0.74
Graham	1	pool	MW	0+	69	2.45	0.75
Graham	1	pool	MW	1+	127	17.60	0.86
Graham	1	pool	MW	1+	122	14.20	0.78
Graham	1	pool	MW	1+	113	12.25	0.85
Graham	1	pool	MW	2+	175	53.70	1.00
Graham	1	pool	MW	2+	164	42.05	0.95
Graham	1	pool	MW	2+	171	49.30	0.99
Graham	1	pool	MW	3+	195	70.00	0.94
Graham	1	pool	MW	4+	267	125.00	0.66
Graham	1	pool	MW	4+	254	160.00	0.98
Graham	1	pool	MW	4+	300	175.00	0.65
Graham	1	pool	MW	4+	279	150.00	0.69
Graham	1	pool	MW		166	38.45	0.84
Graham	1	pool	MW		191	71.62	1.03
Graham	1	pool	MW		61		
Graham	1	pool	MW		73	2.20	0.57
Graham	1	pool	MW		131	20.10	0.89
Graham	1	pool	MW		22		
Graham	1	pool	MW		60		
Graham	1	pool	MW		60	1.70	0.79
Graham	1	pool	MW		74		
Graham	1	pool	MW		62		
Graham	1	pool	MW		62	1.85	0.78
Graham	1	pool	MW		63	2.05	0.82
Graham	1	pool	MW		64	1.15	0.44
Graham	1	pool	MW		65	2.20	0.80
Graham	1	pool	MW		65	2.05	0.75
Graham	1	pool	MW		66		
Graham	1	pool	MW		66	2.45	0.85
Graham	1	pool	MW		66	2.40	0.83
Graham	1	pool	MW		67		

APPENDIX I: Sportfish samples

System	Reach	Habitat type	Species	Age	Length (mm)	Weight (g)	Fulton Condition (K)
Graham	1	pool	MW		68	2.45	0.78
Graham	1	pool	MW		70		
Graham	1	pool	MW		71		
Graham	1	pool	MW		160	40.05	0.98
Graham	1	pool	MW		115		
Graham	1	pool	MW		75		
Graham	1	pool	MW		82	12.40	2.25
Graham	1	pool	MW		95	7.40	0.86
Graham	1	pool	MW		104		
Graham	1	pool	MW		110		
Graham	1	pool	MW		113		
Graham	1	pool	MW		115	12.55	0.83
Graham	1	pool	MW		119	15.15	0.90
Graham	1	pool	MW		125		
Graham	1	pool	MW		135	21.65	0.88
Graham	1	pool	MW		136		
Graham	3	glide	MW	0+	79	3.35	0.68
Graham	3	glide	MW	0+	67	2.50	0.83
Graham	3	glide	MW	0+	57	1.40	0.76
Graham	3	glide	MW	0+	69	2.50	0.76
Graham	3	glide	MW	0+	76	3.15	0.72
Graham	3	glide	MW	4+	247	147.00	0.98
Graham	3	glide	MW		82	7.15	1.30
Graham	1	pool	RB	4+	310	225.00	0.76
Ground	2	pool	MW	0+	75	3.50	0.83
Ground	2	pool	MW	0+	73	4.80	1.23
Ground	2	pool	MW	0+	75	3.15	0.75
Ground	2	glide	MW	1+	92	6.05	0.78
Ground	2	glide	MW	1+	85	5.20	0.85
Ground Bir	2	glide	GR	0+	76	3.95	0.90
Horseshoe	1	glide	MW		80		
Horseshoe	1	glide	MW		68		
Kobes	1	glide	MW	0+	69	3.00	0.91
Kobes	1	glide	MW	0+	59	2.05	1.00
Kobes	1	glide	MW	0+	72	3.30	0.88
Kobes	1	glide	MW	1+	114	13.20	0.89
Kobes	1	glide	MW	1+	115	12.80	0.84
Kobes	1	glide	MW		56	1.35	0.77
Kobes	1	riffle	MW	1+	134	22.14	0.92
Kobes	1	riffle	MW	1+	110	12.80	0.96
Lynx	1	riffle	RB	0+	59	2.35	1.14
Lynx	1	riffle	RB	1+	119	24.80	1.47
Lynx	3	glide	RB	0+	62	2.90	1.22
Lynx	3	glide	RB		140		

APPENDIX I: Sportfish samples

System	Reach	Habitat type	Species	Age	Length (mm)	Weight (g)	Fulton Condition (K)
Lynx	3	pool	RB	0+	85	7.35	1.20
Lynx	3	pool	RB	1+	113	15.10	1.05
Lynx	3	pool	RB	1+	125	22.25	1.14
Lynx	3	pool	RB	1+	140	31.55	1.15
Lynx	3	pool	RB	1+	124	18.60	0.98
Lynx	3	pool	RB	2+	190	85.00	1.24
Lynx	3	pool	RB	2+	136	31.00	1.23
Lynx	3	pool	RB	2+	198	85.00	1.10
Maurice	1	glide	MW	0+	88	6.20	0.91
Maurice	1	glide	MW	0+	99	8.75	0.90
Maurice	1	glide	MW	0+	103	8.80	0.81
Maurice	1	glide	RB	0+	58	2.55	1.31
Maurice	1	glide	RB	0+	92	8.70	1.12
Maurice	1	glide	RB	0+	91	7.80	1.04
Maurice	1	glide	RB	0+	59	2.15	1.05
Maurice	1	glide	RB	1+	140	27.00	0.98
Maurice	1	glide	RB		93	8.80	1.09
Maurice	1	glide	RB		75	5.10	1.21
Maurice	2	glide	RB		74		
Maurice	2	glide	RB		59		
Maurice	2	glide	RB		112		
Maurice	2	glide	RB		54		
Maurice	2	glide	RB		62		
Maurice	2	glide	RB		60		
Maurice	2	glide	RB		66		
Maurice	2	glide	RB		57		
Maurice	2	glide	RB		62		
Maurice	2	glide	RB		132		
Maurice	2	glide	RB		132		
Maurice	2	glide	RB		57		
Maurice	2	glide	RB		65		
Maurice	2	glide	RB		118		
Maurice	2	glide	RB		70		
Maurice	2	glide	RB		75		
Maurice	2	glide	RB		58		
Maurice	2	pool	RB		59	2.30	1.12
Maurice	2	pool	RB	0+	70	3.75	1.09
Maurice	2	pool	RB	0+	75	4.80	1.14
Maurice	2	pool	RB	0+	68	3.75	1.19
Maurice	2	pool	RB	0+	71	3.50	0.98
Maurice	2	pool	RB	0+	71	3.95	1.10
Maurice	2	pool	RB	0+	48	1.25	1.13
Maurice	2	pool	RB	0+	75	4.40	1.04
Maurice	2	pool	RB	1+	114	17.05	1.15

APPENDIX I: Sportfish samples

System	Reach	Habitat type	Species	Age	Length (mm)	Weight (g)	Fulton Condition (K)
Maurice	2	pool	RB	1+	131	25.80	1.15
Maurice	2	pool	RB	1+	107	13.65	1.11
Maurice	2	pool	RB		62	2.70	1.13
Maurice	2	pool	RB		63	2.80	1.12
Maurice	2	riffle	RB	0+	65	3.60	1.31
Maurice	2	riffle	RB	0+	93	12.00	1.49
Maurice	2	riffle	RB	0+	71	4.25	1.19
Maurice	2	riffle	RB	0+	66	3.55	1.23
Maurice	2	riffle	RB	0+	73	4.50	1.16
Maurice	2	riffle	RB	0+	62	2.50	1.05
Maurice	2	riffle	RB	0+	55	1.80	1.08
Maurice	2	riffle	RB	1+	124	22.10	1.16
Maurice	2	riffle	RB	1+	107	14.10	1.15
Maurice	2	riffle	RB	1+	138	28.65	1.09
Maurice	2	riffle	RB	1+	112	17.15	1.22
Maurice	2	riffle	RB	1+	121	22.00	1.24
Maurice	2	riffle	RB	1+	98	11.45	1.22
Maurice	2	riffle	RB		35	0.50	1.17
Maurice	2	riffle	RB		74		
Maurice	2	riffle	RB		64		
Maurice	2	riffle	RB		63		
Maurice	2	riffle	RB		68		
Maurice	2	riffle	RB		55		
Maurice	2	riffle	RB		38	0.50	0.91
Maurice	2	riffle	RB		74		
Maurice	2	riffle	RB		53		
Maurice	2	riffle	RB		56		
Maurice	2	riffle	RB		42	0.90	1.21
Maurice	2	riffle	RB		44		
Maurice	2	riffle	RB		74		
Maurice	2	riffle	RB		64		
Moberly	1	pool	BB		80		
Moberly	2	glide	BB		86	3.45	0.54
Moberly	2	pool	BB		74		
Moberly	2	pool	BB		75		
Moberly	3	glide	BB		86		
Moberly	1	glide	GR		70		
Moberly	1	glide	GR		91		
Moberly	1	pool	GR		63		
Moberly	1	pool	GR		84		
Moberly	2	glide	GR	1+	180	66.00	1.13
Moberly	2	glide	GR	1+	175	62.00	1.16
Moberly	2	glide	GR	1+	175	60.00	1.12
Moberly	2	glide	GR		95		

APPENDIX I: Sportfish samples

System	Reach	Habitat type	Species	Age	Length (mm)	Weight (g)	Fulton Condition (K)
Moberly	2	glide	GR		68		
Moberly	2	glide	GR		93		
Moberly	2	glide	GR		30		
Moberly	2	glide	GR		76		
Moberly	2	glide	GR		34		
Moberly	2	glide	GR		40		
Moberly	2	glide	GR		30		
Moberly	2	glide	GR		80		
Moberly	2	pool	GR	0+	79	5.90	1.20
Moberly	2	pool	GR	0+	65	3.50	1.27
Moberly	2	pool	GR	1+	195	84.00	1.13
Moberly	2	pool	GR		43	0.90	1.13
Moberly	2	pool	GR		176	60.00	1.10
Moberly	2	pool	GR		35	0.40	0.93
Moberly	2	pool	GR		37	0.60	1.18
Moberly	2	pool	GR		40	0.85	1.33
Moberly	2	pool	GR		45	1.05	1.15
Moberly	2	pool	GR		52	1.65	1.17
Moberly	2	pool	GR		70		
Moberly	2	pool	GR		73		
Moberly	2	pool	GR		22	0.10	0.94
Moberly	2	pool	GR		34	0.20	0.51
Moberly	3	glide	GR		86		
Moberly	5	glide	LW	5+	312	370	1.22
Moberly	5	glide	LW	5+	290	325	1.33
Moberly	5	glide	LW	5+	299	300	1.12
Moberly	5	glide	LW	5+	335	425	1.13
Moberly	5	glide	LW	6+	360	600	1.29
Moberly	1	glide	MW		65		
Moberly	1	glide	MW		70		
Moberly	1	glide	MW		141		
Moberly	1	glide	MW		72		
Moberly	1	glide	MW		64		
Moberly	1	pool	MW		69		
Moberly	1	pool	MW		81		
Moberly	1	pool	MW		91		
Moberly	1	pool	MW		92		
Moberly	1	pool	MW		61		
Moberly	1	pool	MW		55		
Moberly	2	glide	MW	2+	185	70.00	1.11
Moberly	2	glide	MW	2+	210	102.00	1.10
Moberly	2	glide	MW	3+	250	200.00	1.28
Moberly	2	glide	MW	3+	230	156.00	1.28
Moberly	2	glide	MW	4+	290	200.00	0.82

APPENDIX I: Sportfish samples

System	Reach	Habitat type	Species	Age	Length (mm)	Weight (g)	Fulton Condition (K)
Moberly	2	glide	MW	4+	260	210.00	1.19
Moberly	2	glide	MW	4+	245	160.00	1.09
Moberly	2	glide	MW	5+	340	475.00	1.21
Moberly	2	glide	MW	5+	295	350.00	1.36
Moberly	2	glide	MW	5+	255	200.00	1.21
Moberly	2	glide	MW	5+	310	275.00	0.92
Moberly	2	pool	MW	0+	85	5.50	0.90
Moberly	2	pool	MW	0+	90	6.65	0.91
Moberly	2	pool	MW	0+	70	2.85	0.83
Moberly	2	pool	MW	1+	172	54.00	1.06
Moberly	2	pool	MW	1+	155	29.00	0.78
Moberly	2	pool	MW	1+	162	32.00	0.75
Moberly	2	pool	MW	1+	155	30.00	0.81
Moberly	2	pool	MW	1+	137	30.00	1.17
Moberly	2	pool	MW	2+	271	275.00	1.38
Moberly	2	pool	MW	3+	254	220.00	1.34
Moberly	2	pool	MW	3+	230	142.00	1.17
Moberly	2	pool	MW	3+	253	184.00	1.14
Moberly	2	pool	MW	4+	285	325.00	1.40
Moberly	2	pool	MW	5+	330	425.00	1.18
Moberly	2	pool	MW	5+	315	425.00	1.36
Moberly	2	pool	MW	6+	355	700.00	1.56
Moberly	2	pool	MW		355		
Moberly	2	pool	MW		360		
Moberly	2	pool	MW		150		
Moberly	2	pool	MW		73	3.50	0.90
Moberly	2	pool	MW		80	4.70	0.92
Moberly	2	pool	MW		148		
Moberly	2	pool	MW		200		
Moberly	2	pool	MW		215		
Moberly	2	pool	MW		235		
Moberly	2	pool	MW		235		
Moberly	2	pool	MW		245		
Moberly	2	pool	MW		260		
Moberly	2	pool	MW		265		
Moberly	2	pool	MW		280		
Moberly	2	pool	MW		290		
Moberly	2	pool	MW		315		
Moberly	2	pool	MW		315		
Moberly	2	pool	MW		325		
Moberly	2	pool	MW		325	400.00	1.17
Moberly	2	pool	MW		72	3.65	0.98
Moberly	2	pool	MW		73		
Moberly	2	pool	MW		215		

APPENDIX I: Sportfish samples

System	Reach	Habitat type	Species	Age	Length (mm)	Weight (g)	Fulton Condition (K)
Moberly	2	pool	MW		60		
Moberly	2	pool	MW		64		
Moberly	2	pool	MW		68	2.60	0.83
Moberly	2	pool	MW		69		
Moberly	2	pool	MW		73	3.50	0.90
Moberly	2	pool	MW		74	3.55	0.88
Moberly	2	pool	MW		75	3.80	0.90
Moberly	2	pool	MW		260		
Moberly	3	glide	MW	0+	59	1.65	0.80
Moberly	3	glide	MW	0+	69	3.15	0.96
Moberly	3	glide	MW	0+	66	2.20	0.77
Moberly	3	glide	MW	0+	49	1.05	0.89
Moberly	3	glide	MW	0+	58	4.35	2.23
Moberly	3	glide	MW	0+	76	3.90	0.89
Moberly	3	glide	MW	1+	139	24.90	0.93
Moberly	3	glide	MW		245		
Moberly	3	glide	MW		145		
Moberly	3	glide	MW		152		
Moberly	3	glide	MW		155		
Moberly	3	glide	MW		156		
Moberly	3	glide	MW		163		
Moberly	3	glide	MW		141		
Moberly	3	glide	MW		145		
Moberly	3	glide	MW		134		
Moberly	3	glide	MW		74		
Moberly	3	glide	MW		35		
Moberly	1	pool	NP		216		
Moberly	2	glide	NP		207		
Moberly	3	slough	NP	0+	152	24.00	0.68
Moberly	3	slough	NP	7+	530	1,300.00	0.87
Moberly	3	slough	NP	7+	560	1,300.00	0.74
Moberly	3	slough	NP	8+	645	2,200.00	0.82
Moberly	3	slough	NP	9+	660	2,100.00	0.73
Moberly	3	slough	NP		175		
Moberly	3	slough	NP		115		
Moberly	5	glide	NP	0+	185	38.30	0.60
Moberly	5	glide	NP	0+	118	10.20	0.62
Moberly	5	glide	NP	0+	205	57.30	0.67
Moberly	5	glide	NP	0+	139	16.90	0.63
Moberly	5	glide	NP	0+	146	19.40	0.62
Moberly	5	glide	NP	0+	161		
Moberly	5	glide	NP	0+	162	24.10	0.57
Moberly	5	glide	NP	0+	129	9.15	0.43
Moberly	5	glide	NP	0+	132	19.90	0.87

APPENDIX I: Sportfish samples

System	Reach	Habitat type	Species	Age	Length (mm)	Weight (g)	Fulton Condition (K)
Moberly	5	glide	NP	0+	137	15.30	0.60
Moberly	5	glide	NP	1+	190	38.00	0.55
Moberly	5	glide	NP	2+	283	150.00	0.66
Moberly	5	glide	NP	2+	320	210.00	0.64
Moberly	5	glide	NP	3+	448	575.00	0.64
Moberly	5	glide	NP	4+	440	580.00	0.68
Moberly	5	glide	NP	5+	468	560.00	0.55

Appendix II
Length-age relationship and condition factors for sport fish collected in the Peace River tributaries, September, 1989

System	Age	n	Min	Max	Mean	S.D.	Condition
				Arctic grayling			
Moberly River	0+	2	65	79	72	9.9	1.235
	1+	4	175	195	181	9.5	1.135
				Lake whitefish			
Moberly River	5+	4	290	335	309	19.5	1.200
	6+	1	-	-	360	-	1.290
				Mountain whitefish			
Farrell Creek	0+	1	-	-	75	-	-
Maurice Creek	0+	3	88	103	97	7.8	0.873
Moberly River	0+	9	49	90	69	13.1	1.020
	1+	6	137	172	153	13.4	0.917
	2+	3	185	271	222	44.2	1.197
	3+	5	230	254	243	12.3	1.242
	4+	4	245	290	270	21.2	1.125
	5+	6	255	340	307	30.1	1.207
	6+	1	-	-	355	-	1.560

Appendix II (continued)
Length-age relationship and condition factors for sport fish collected in the Peace River tributaries, September, 1989

System	Age	n	Min	Max	Mean	S.D.	Condition
				Northern pike			
Moberly River	0+	11	118	205	151	25.6	0.629
	1+	1	-	-	190	-	0.550
	2+	2	283	320	301	26.2	0.650
	3+	1	-	-	448	-	0.640
	4+	1	-	-	440	-	0.680
	5+	1	-	-	468	-	0.550
	7+	2	530	560	545	21.2	0.805
	8+	1	-	-	645	-	0.820
	9+	1	-	-	660	-	0.730
				Rainbow trout			
Lynx Creek	0+	3	59	85	69	14.2	1.187
	1+	5	113	140	124	10.0	1.158
	2+	3	136	198	175	33.7	1.190
Maurice Creek	0+	18	48	93	70	12.3	1.150
	1+	10	98	140	119	14.0	1.147