

UPPER BULKLEY RIVER RECONNAISSANCE WITH REFERENCE TO
JUVENILE STEELHEAD CARRYING CAPACITY

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Abstract.--Bioreconnaissance of the Upper Bulkley River system was conducted in late summer of 1981 by the Fish Habitat Improvement Section. Objectives were to outline present standing crop and an estimate of carrying capacity for juvenile steelhead. No reliable information on adult steelhead spawning distribution or escapements was available. Very rough estimates of steelhead distribution and juvenile standing crop were made. Populations in the order of 92,000 fry and 48,000 parr were estimated, translating to adult escapement in the range of 155 to 1,260. The major problem in determining steelhead distribution and standing crop was the uncertainty in separating steelhead from resident rainbow trout populations. A recommendation for further assessment to determine steelhead distribution and the ratio of resident trout-steelhead was made.

INTRODUCTION

The Upper Bulkley River is that portion of the Bulkley River above the Morice River confluence (Fig. 1). The watershed covers 2,400 km² of the eastern

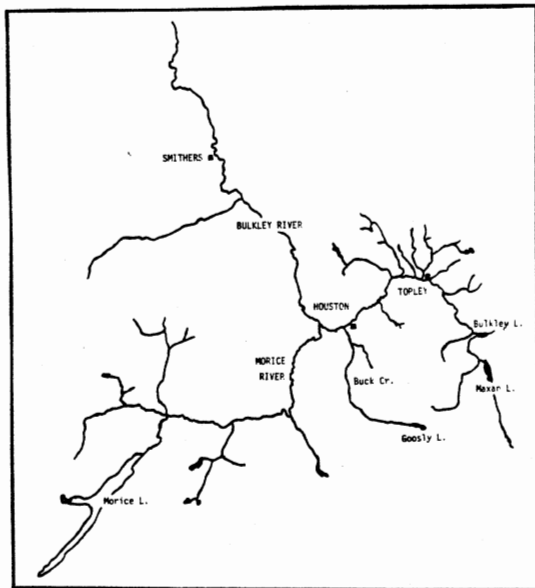


Figure 1.--The Bulkley River watershed upstream of Smithers, B. C. Scale 1:600,000.

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portion of the Bulkley Valley, originating at Bulkley and Maxan Lakes. Anadromous salmonid species using the Upper Bulkley include chinook, coho, pink and sockeye salmon, and summer run steelhead trout. As part of an overview of steelhead enhancement opportunities in the Bulkley-Morice River system, a bioreconnaissance of the Upper Bulkley River was conducted. Objectives were to outline present standing crop and an estimate of carrying capacity for juvenile steelhead. The program was conducted by the Fish Habitat Improvement Section (F.H.I.S.) of the B. C. Fish and Wildlife Branch and Region 6 Fisheries Management staff.

METHODS

Bioreconnaissance of the Upper Bulkley River was conducted by air-photo analysis and late summer fish population and fish habitat assessment. Prior to the field program stream reach breaks were located by air photo analysis and a general field program was planned. Field sampling included detailed habitat description by reach and intensive fish population estimates at 24 sites throughout the Upper Bulkley system. A description of methodologies employed by the F.H.I.S. is given in de Leeuw (1981). The field program was conducted August 30 to September 3, 1981.

RESULTS

General Description of Watershed

General topography of the Upper Bulkley watershed is that of low mountains and hills. The Upper Bulkley River is generally a low gradient, frequently meandering stream with some moderate gradient sections. Tributaries are generally moderate to high gradient; many

are lake-headed. The system is quite productive, as indicated by relatively high T.D.S. (mean at Houston, = 80 mg/l)² and high estimated mean annual temperature (7.0°C)³.

Discharge Regime

Flow records for the Upper Bulkley watershed are included in Appendix I (including Bulkley River near Houston, Richfield Creek and Buck Creek). Discharge in the Upper Bulkley below Buck Creek historically ranges from a mean high of 72.9 m³/s (2,600 cfs) in May to winter low flows of near 1.0 m³/s (35 cfs). Mean late summer discharge (September) is 2.3 m³/s (82 cfs), with a recorded minimum of 0.5 m³/s (18 cfs). Discharge during the August 1981 sampling period was extremely low, recorded at 0.54 m³/s (19 cfs; Aug. 31, 1981, W.S.C. pers. comm.). The major component of this flow originated from Buck Creek, recorded at 0.42 m³/s (15 cfs). The mainstem Bulkley above Buck Creek was therefore 0.12 m³/s (4.3 cfs). F.H.I.S. estimates in the Bulkley above Buck Creek were roughly twice this figure (0.25 m³/s; 8.9 cfs). Discharge estimates from sample sites throughout the watershed are summarized in Table 1.

Reach Habitat Description

Stream habitat was divided into reaches on the basis of air photo analysis and field sampling (Fig. 2). A summary of reach lengths and habitat parameters is given in Table 2. A brief description of habitat follows. Some representative photographs are included in Appendix 2. Habitat sampling data is included in Appendix 3.

The mainstem Bulkley is generally a low gradient meandering stream. A total of five reaches were identified. Due to the extremely low discharge most reaches had very long glide and pool habitat, with only short riffle areas. In terms of juvenile salmonid rearing most glide and pool area was unproductive (nearly standing water). Only deeper riffle areas and the very head ends of glides and pools were conducive to salmonid production.

The best area for salmonid rearing was Reach 3. This reach had slightly higher gradient and therefore more and better quality riffle habitat. Substrates were generally larger, in the gravel and cobble categories. The stream above Topley appeared significantly smaller, as indicated by the reduced wetted width in Reaches 4 and 5. A more meandering channel was evident, as was dirt and clay banks (as opposed to gravel and bars) and instream debris.

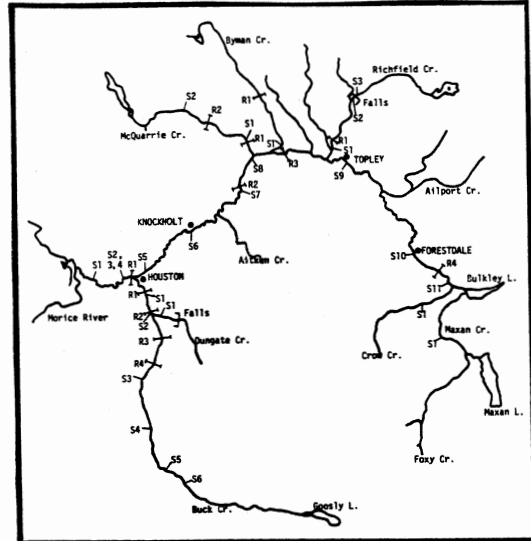


Figure 2.--The Upper Bulkley River system, indicating reach breaks (R1) and sample sites (S1).

Tributaries to the Upper Bulkley are generally moderate to high gradient, with an abundance of good quality rearing habitat. Buck Creek is the most significant tributary in terms of rearing area and habitat quality. Buck Creek is accessible to approximately mid-way in Reach 5 where a falls is located (M. Lough, pers. comm.)⁴. McQuarrie Creek is another significant tributary, headed by McQuarrie Lake. A poorly installed culvert may cause fish migration problems roughly mid-way in Reach 3 (near site 2), negating access to McQuarrie Lake. Other significant tributaries include Richfield and Maxan Creeks. Smaller important tributaries were also present, including Byman, Foxy and possibly Ailport Creeks. All other tributaries were dry or otherwise considered insignificant at the time of survey. Higher flows may give a different impression.

Fish Population Assessment

Juvenile fish population estimates were conducted at 26 sites in the Upper Bulkley watershed (24 electrofishing, 2 seining). A series of representative habitat types were sampled throughout most reaches. In later estimates effort was concentrated on favourable habitat. A summary of results is given in Table 3 with complete data included in Appendix 4. Discussion of population assessment by species follows, and will include distribution (adult and juvenile), density, habitat selection and standing crop estimates. All data and calculations are included in Appendices 5 through 8.

²Environment Canada, 1974. Water Quality Data, British Columbia 1961-1971. Inland Waters Directorate, Water Quality Branch, Ottawa.

³from Skeena River Steelhead Carrying Capacity Analysis (Tredger, MS., 1982); estimated from Water Survey of Canada temperature data.

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TABLE 1.--Summary of discharge estimates in streams in the Upper Bulkley River system, August 30 to September 3, 1981.

STREAM	LOCATION	ESTIMATED DISCHARGE (M ³ /S)	
		W.S.C.	F.H.I.S.
Bulkley	below Buck Cr.	0.54	1.60 (57 cfs)
Bulkley	above Buck Cr. - Knockholt	0.12	0.25 (8.8 cfs)
Bulkley	Topley	N/A	0.19 (6.8 cfs)
Bulkley	Forestdale	N/A	0.075 (2.7 cfs)
Bulkley	below Bulkley Lake (2 km)	N/A	0.32 (11.4 cfs)
Buck	lower (S1, 2)	0.42	0.46 (16.4 cfs)
Buck	upper (S6)	N/A	0.075 (2.7 cfs)
McQuarrie	lower (S1)	N/A	0.075 (2.7 cfs)
Byman	lower (S1)	N/A	0.034 (1.2 cfs)
Richfield	lower (S1)	N/A	0.20 (7.1 cfs)
	middle (S3)	N/A	0.05 (1.8 cfs)
Crow	middle (S1)	N/A	0.04 (1.4 cfs)
Maxan	below Maxan Lk. (4 km)	N/A	0.20 (7.1 cfs)

TABLE 2.--Summary of reach habitat characteristics of the Upper Bulkley River system.

STREAM	REACH	LENGTH (m)	GRADIENT (%)	AREA (m ²)	MEAN WIDTH (m)	GENERAL	P/R/G RATIO	COVER TYPE (%)	MAJOR SUBSTRATES
Bulkley R.	1	8,900	0.5	143,900	16	irregular meander, moderate gradient	35/ 9/56	B, L, OV	(0.7) F, SG, LG (C, B)
	2	23,000	0.1	347,700	15	meandering, with oxbows, very low gradient	64/ 6/30	L, OV, C, B, IV	(1.0) F, SG, LG
	3	8,000	0.4	75,700	9.5	irregular, moderate gradient	15/32/53	L, C, OV	(1.0) F, SG, LG (C)
	4	25,200	0.25	174,106	7	meandering, with oxbows, very low gradient	37/ 1/62	OV, L, C	(3.5) F, SG, LG
	5	5,200	0.1	34,200	6.5	meandering, very low gradient, originates from Bulkley Lk.	22/ 8/70	L, C, OV	(7.1) F, SG, LG
Buck Cr.	1	2,500	0.6	23,600	9.5	unconfined with wide gravel channel	not sampled, similar to Buck Creek Reach 3		
	2	2,200	0.7	23,800	10.8	confined canyon	21/ 0/79	B, OV, C	(1.7) C, LG, B
	3	3,800	1.6	35,900	9.5	unconfined with wide gravel channel	0/45/55	B (L, OV)	(2.0) F, C, LG
	4	2,000	1.5	21,600	10.8	confined canyon	not sampled, similar to Buck Creek Reach 2		
Dungate Cr.	5	38,500	0.2	362,700	9.4	unconfined, irregular meander	15/18/67	B, OV, L	(3.2) LG, SG, F
	1	2,100	5.1	7,600	3.6	high gradient, entrenched, probable falls	0/83/17	B, OV	(30.7) SG, LG, C, B
McQuarrie Cr.	1	1,600	4.7	3,600	2.2	moderate gradient, channelized	not sampled		
	2	6,600	2.5	15,000	2.3	entrenched in steep valley, some canyon areas	18/34/48	OV, L, C	(15.2) LG, SG, C
Byman Cr.	3	6,000	3.0	13,600	2.3	headed by McQuarrie Lake	not sampled		
	1	5,600	2.7	16,800	3	channelized at lower end	0/49/51	OV, B	(7.8) C, B, LG
Richfield Cr.	2	10,300	2.8	30,900	3	small stream, lake headed	not sampled		
	1	2,300	2.0	14,900	6.5	meandering through valley bottom	8/12/80	OV, B, C	(8.6) C, LG, F
Crow Cr.	2	6,300	2.7	27,600	4.4	entrenched in deep canyon, high falls at top of reach	9/60/31	B, OV, L	(6.2) LG, C, SG
	1	14,500	2.0	41,400	2.9	small stream through forest	45/25/30	L, OV	(21.3) SG, F, C
Maxan Cr.	1	12,500	0.5	146,700	11.7	lake headed (Maxan Lake)	9/18/74	L, OV	(6) LG, SG, F, C

TABLE 3.--Summary of fish population estimate results conducted in the Upper Bulkley River system, August 30 to September 3, 1981.

STREAM	REACH	SITE	F I S H D E N S I T Y (N O . / M ²)					Chinook	Other Species ¹
			Rainbow			≥2+			
			0+	1+	1+				
Bulkley R.	1	1	0.02	0.11	0	0.13	0	LnD 1.97, Su 0.14	
		2	0	0.16	0.01	0	0.07	LnD 2.78, Sc 0.14, MW 0.01, L present	
		3	0	0.004	0	0.01	0.05	LnD present, Su 0.03. MW 0.31	
		4	0	0	0	0	0	Su present	
	2	5	0	0.10	0.02	0.27	0.04	LnD 0.34, Su 0.02	
		6	0	0.05	0	0.07	0.14	LnD 0.04, Su 0.02, Sc 0.29	
		7	0.01	0	0	0.03	0	LnD 1.26, Su 0.13	
	3	8	1.03	0.03	0.01	0.09	0.06	LnD 1.54, Su 0.01	
		9	0	0	0	0.03	0	LnD 0.30	
	5	10	0.04	0.02	0	0	0	LnD, L, Sq, Su present, Sc 0.02	
		11	0.15	0	0	0	0	LnD 0.15, MW 0.01	
Buck Cr.	2	1	0.13	0.06	0.01	0.01	0	LnD 0.07	
		2	0.47	0.19	0.02	0	0.13	LnD 0.23, L present	
		3	0.63	0.03	0.01	0	0	LnD 0.09	
	5	4	0.18	0.41	0.14	0	0	LnD 0.53, MW 0.03	
		5	0.09	0.36	0	0	0	LnD 0.21, Su 0.46	
		6	0.18	0.13	0.02	0	0	LnD 0.05	
Dungate Cr.	1	1	1.13	0.22	0.05	0	0.15	DV 0.05	
McQuarrie Cr.	1	1.89	0.54	0.06	0.10	0	LnD 0.71		
	2	0.63	0.40	0.11	0	0	0		
Byman Cr.	1	1	0.18	0.18	0.09	0.05	0	LnD 0.05	
Richfield Cr.	1	1	0.96	0.19	0.05	0.20	0	0	
	2	2	0	0.14	0.19	0	0	0	
	3	3	0.21	0.11	0.05	0	0	0	
(above falls)									
Crow Cr.	1	1	0.08	0.18	0.29	0	0	Sc 0.03, L present	
Maxan Cr.	1	1	0.31	0.19	0.005	0	0	LnD 0.11	

¹Other species legend: LnD - longnose dace; Su - sucker species; Sc - sculpin species; MW - Mountain Whitefish; L - lamprey; Sq - squawfish, DV - Dolly Varden.

Chinook salmon

Adult chinook salmon are known to use the mainstem Bulkley River and maximum recorded escapement has been 1,200 chinook, with 1980 and 1981 escapements of 500 and 250 respectively (M. Whately⁵, pers. comm.). In late summer population estimates juvenile chinook were found in lower Buck Creek, Dungate Creek and in the mainstem Bulkley up to Reach 3. Maximum sampled density occurred in Dungate Creek ($0.15/m^2$), a mainstem glide (head end) in Reach 2 ($0.14/m^2$) and in Site 2 of Buck Creek ($0.13/m^2$). All chinook captured were fry, with the exception of 1 yearling (a precocious male). Mean size was 69.4 mm (3.67 g). Habitat utilized by juvenile chinook in the mainstem Bulkley included riffles (where deep enough) and the head ends of glides and pools. The middle portion of long glides and pools (termed flats) were virtually barren.

Standing crop of juvenile chinook was estimated at 10,671 fish, or a total biomass of 39 kg. By applying standing survival rates, estimates of roughly 3,700 to 3,900 smolts, and adult escapement of 140 to 150 (at 3:1 catch to escapement) can be derived. These smolt yield and escapement figures apply only to the juvenile population which had remained in the Upper Bulkley system. The number which have migrated from the system as smolts (Sub 1) or for rearing in downstream areas are not accounted for.

Coho salmon

Adult coho salmon are known to use the mainstem Upper Bulkley River and many of the tributaries, including Maxan Creek, Richfield Creek, and Buck Creek. The latest escapement data on file indicates a total run size of 1,650 in 1978. Juvenile coho were found in the mainstem Bulkley to Topley (Reach 4) and in the lower ends of Buck, McQuarrie, Byman and Richfield Creeks. Maximum densities were found in Richfield Creek (0.20 fry/ m^2) and in Reach 2 of the mainstem in riffle habitat (0.27 fry/ m^2). All coho sampled were fry, with a mean size of 63.9 mm (3.13 g). Estimated standing crop in the Bulkley system was 11,853 fry, or roughly 37 kg. This standing crop translates to a smolt yield of roughly 3,700 to 4,150, and an adult escapement of 140 to 160 (at 3:1 catch to escapement). As with chinook these estimates may not represent the total population.

Rainbow (steelhead) trout

Juvenile rainbow trout were found throughout the Upper Bulkley watershed. A total of 813 were captured ranging in age from 0+ to 3+ (Table 4). Mean size of Upper Bulkley rainbow was similar to rainbow in some other local Skeena River streams (Appendix 5).

Table 4.--Summary of juvenile rainbow trout captures in the Upper Bulkley River system, August 30 to September 3, 1981.

	A G E G R O U P			
	0+	1+	2+	3+
n sampled	505.0	242.0	59.0	7.0
%	62.1	29.8	7.3	0.8
mean fork length (mm)	46.4	85.3	121.4	148.0
mean weight (g)	1.06	6.61	19.05	34.52

Resident/steelhead division.-- Bulkley-Morice summer-run steelhead are known to spawn in the Upper Bulkley watershed. Resident trout are also known to be very abundant, especially in the upper watershed in and near headwater lakes (eg. Goosly, McQuarrie, Bulkley, Maxan, etc.). The numbers and areas used by steelhead for spawning are unclear at this time, but a probable upper limit for escapement is in the order of 200 to 500 (M. Lough, pers. comm.). Residents have reported steelhead spawning in Buck Creek (mid-Reach 5) and in McQuarrie Creek. Other areas used are unknown. As there are no major barriers in the mainstem Bulkley (excepting beaverdams above Topley), it is conceivable that steelhead could easily utilize areas in the upper watershed (including Maxan, Crow and Foxy Creeks). High spring flows make this a distinct possibility (M. Whately, pers. comm.).

As the above discussion might suggest, the major problem in attempting to outline juvenile steelhead distribution and standing crop lies in the resident-steelhead division. By making some very rough assumptions of resident-steelhead mix in areas of the watershed, very rough estimates of steelhead standing crop can be made. This will be attempted only to give a rough idea of how large the steelhead population might be.

Standing crop estimate.-- Rainbow trout standing crop estimates in the Bulkley system (including tributaries above Bulkley Lake) are included in Appendix 7. This discussion will attempt to outline steelhead standing crop.

As a starting point steelhead distribution will be assumed to cover the mainstem to Bulkley Lake, Buck Creek to the falls in Reach 5, Dungate Creek, McQuarrie Creek to the culvert midway in Reach 3, lower Byman Creek and Richfield Creek to the falls. Within these areas a resident-steelhead mix will be assumed, ranging from 80% steelhead in the lower mainstem to 10% steelhead in upper reaches of some tributaries. Areas not considered are assumed 100% resident. All ratios were roughly estimated by considering the likelihood of steelhead spawning, the proximity to large resident rainbow population centers, and the juvenile age distribution. As an example of the latter, an area with high 2+ and 3+ abundance compared to 0+ and 1+ would be considered mostly resident. This was done in consideration of work conducted in some Morice River tributaries (Owen and Lamprey Creeks), where juvenile steelhead were thought to migrate to the larger stream

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Table 5.--Rough estimates of steelhead-resident ratio and steelhead standing crop by stream in the Upper Bulkley watershed.

STREAM	REACH	STEELHEAD/ RESIDENT RATIO	STEELHEAD STANDING CROP	
			0+	≥1+
Bulkley R.	1-3	80/20	26,100	4,650
	4,5	50/50	250	60
Buck Cr.	1-4	80/20	29,380	18,460
	5 to 2nd bridge	40/60	12,530	7,880
	5 to falls	10/90	1,320	2,450
Dungate Creek	1	80/20	6,900	1,650
McQuarrie Creek	1	80/20	3,080	1,610
	2,3	30/70	5,760	3,010
Byman Creek	1	50/50	750	1,140
Richfield Creek	1, 2	60/40	12,240	7,140
Total Steelhead			92,100	48,050

at 1 or 2 years of age (Tredger, 1981). A summary of resident-steelhead ratios and estimated standing crop by stream and reach is given in Table 5.

Steelhead standing crop was estimated at roughly 92,000 fry and 48,000 parr. Total biomass was roughly 560 kg (Appendix 8). In terms of age distribution of parr, the 1+ population was 78.5% (37,700 fish or 249 kg), 2+ population was 19.2% (9,230 fish or 176 kg) and 3+ population was 2.3% (1,100 fish or 38 kg).

Smolt yield estimates ranged from 4,100 to 11,800 depending on the smolt yield "model" used (Appendix 8). Subsequent adult escapement estimates ranged from 155 to 1,260.

The lowest smolt yield was 4,145 calculated by using the estimated fry population and average survival rates to smolt stage. Smolt translation from late summer standing crop to smolt yield estimated 5,600 at 10 smolts/kg. The 1+ parr population translates to 11,320 smolts based on 30% 1+ parr to smolt survival, and the total parr population translates to 16,820 smolts. The large discrepancy in smolt estimates based on fry with those based on parr (1+ and total) suggests (i) large differences in year class strength, and (ii) an error was made in steelhead standing crop estimates. The fact that adult population size (escapement) is considered near the lower figures suggest that parr-based smolt estimates are high. This could easily be accounted for in the steelhead-resident division estimates (ie. we have overestimated the steelhead component).

DISCUSSION

As steelhead standing crop estimates have shown, it is very difficult to get any confident estimates of present steelhead populations in the Upper Bulkley system through juvenile population assessment. The primary reason is the difficulty in differentiating steelhead from resident rainbow juveniles. Without some clarification all estimates must be considered very rough.

In terms of habitat, the Upper Bulkley could (and may) be a very good steelhead producer. The system is highly productive (temperature, T.D.S.) and has a number of high quality lake-headed tributaries (particularly Buck and McQuarrie Creeks). These lake-headed tributaries are extremely important in steelhead production throughout the Skeena system⁶. The major constraint to steelhead production in terms of habitat quality is the generally low gradient mainstem. Habitat was not generally good quality rearing habitat, and was particularly poor in August of 1981 due to extremely low discharge.

The actual steelhead carrying capacity is difficult to assess because of the large resident population. What the habitat is capable of supporting is not necessarily related to potential smolt yield in a direct fashion. Consider the entire watershed as potential steelhead rearing habitat, and assume (i) all rainbow present are steelhead and (ii) present standing crop equals carrying capacity of the habitat, then potential smolt yield would be very high (in the order of 20,000 to 40,000, resulting in adult populations (escapement) of 1,500 to 3,000). This is unrealistic because of the resident populations, particularly near the headwater lakes.

Further Assessment Requirements

Before any refinement of steelhead production estimates can be contemplated, and before any less than obvious enhancement recommendations can be made, the status of the present steelhead population must be clarified. To accomplish this the following assessment is recommended:

1. collect information on adult escapement and distribution of spawners. This might involve more intensive reconnaissance in the spring, or even

⁶Skeena River Steelhead Carrying Capacity Analysis, Tredger, MS. 1982.

some limited radio tagging near the Bulkley-Morice confluence (or where Upper Bulkley adults overwinter).

2. begin to resolve the steelhead-resident question. Step 1 will provide most information in this regard. Other possible techniques include analysis of otolith characteristics (Neilson, 1982), age structure and sex ratio.

Once more is known about the rainbow-steelhead population carrying capacity and smolt production, questions can be resolved.

Present Enhancement Options

As stated previously only obvious enhancement possibilities can be recommended at this time. Any further techniques, specifically manipulating the steelhead-resident balance in favor of steelhead, must await further knowledge. Present enhancement options include the following:

1. McQuarrie Creek - replace the culvert mid-way in Reach 3. This culvert has the potential to block adult and juvenile migrations. Whether steelhead presently ascend to this point is unknown.
2. Bulkley River - if flows observed in 1981 are at all representative of late summer conditions there may be some merit in considering flow control. Reaches 1 to 3 may not benefit from limited flow control simply because of the size of the channel. Too much water would be required. Portions of Reaches 4 and 5 may benefit as channel width is much reduced. Bulkley Lake would be the likely candidate for such action.

If the above were to be considered, then some method to ensure adequate recruitment to the affected area must be included. This would involve fry seeding or spawning habitat enhancement.

Any of these options should be assessed in detail before any action is considered.
3. All tributaries - the lower ends of most tributaries are channelized (eg. Buck Creek through Houston, McQuarrie Creek, Byman Creek). As these streams are very important further development should be regulated. No instream enhancement is recommended at this time (but not ruled out).

SUMMARY

1. Bioreconnaissance of the Upper Bulkley River system (above the Morice River confluence) was conducted August 30 to September 3, 1981. Methods included habitat description and detailed late summer fish population estimates.
2. Discharge in the mainstem Upper Bulkley River was extremely low when sampled; near the lowest

on record. Major tributary streams had no obvious low flow problems, while many small streams were dry.

3. The mainstem Bulkley was divided into five reaches based on air-photo analysis. The majority of the stream was low gradient, often meandering. The best area in terms of salmonid rearing habitat was Reach 3. Tributary streams generally offered good, moderate to high gradient rearing habitat.
4. Due to low flows in the mainstem, salmonids were generally restricted to preferred habitat (some riffles, and heads of glides and pools). Much of the stream was unproductive (glide and pool "flats").
5. Juvenile chinook salmon were found in the mainstem Bulkley to Reach 3, and in Buck and Dungate Creeks. Standing crop was estimated at 10,671 fry (39 kg), translating to roughly 3,700 to 3,900 smolts and an adult escapement of 140 to 150.
6. Juvenile coho were found in the mainstem to Topley (Reach 4) and in lower Buck, McQuarrie, Byman and Richfield Creeks. Standing crop was estimated at 11,853 fry (37 kg) with an estimated smolt yield of 3,700 to 4,150 and estimated escapement of 140 to 160.
7. Juvenile rainbow trout were found throughout the watershed, concentrated in tributary streams and preferred mainstem habitat. The population was assumed to consist of juvenile steelhead and resident stocks, making steelhead standing crop estimates very difficult. Rough estimates of resident-steelhead division were made, and steelhead standing crop estimates of 92,100 fry and 48,000 parr (37,700 - 1+, 9,230 - 2+ and 1,100 - 3+) were made. Smolt yield estimates ranged from 4,100 to 16,800, with an estimated escapement of 155 to 1,260. The lower figures represent the generally accepted population level.
8. Actual steelhead carrying capacity in terms of smolt yield was not addressed in detail because of the resident population. If all area was under steelhead production (ie. no resident rainbow), then roughly 20,000 to 40,000 smolts and 1,500 to 3,000 adults (escapement) might be produced annually.
9. It was recommended that further assessment be centered on determining the present status of the steelhead population. This would involve determining population size (adult) and areas used for spawning and rearing. This will form the basis for further work on the Upper Bulkley.
10. Some limited enhancement measures were suggested. Further recommendations must await clarification of present steelhead production.

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APPENDIX I

Historic flow records for the Upper Bulkley River and tributaries,
including the Bulkley River near Houston, Buck and Richfield Creeks.

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BUCK CREEK AT THE MOUTH - STATION NO. 08EE013

MONTHLY AND ANNUAL MEAN DISCHARGES IN CUBIC METRES PER SECOND FOR THE PERIOD OF RECORD

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	MEAN	YEAR
1973	0.467	0.322	0.594	3.61	28.6	15.2	2.38	0.589	0.764	1.60	0.576	0.276	4.61	1973
1974	0.292	0.473	0.358	3.78	23.0	18.6	5.15	0.571	0.397	1.40	0.759	0.349	4.62	1974
1975	0.259	0.193	0.206	0.558	18.2	9.39	1.69	1.42	1.41	1.72	3.14	1.02	3.29	1975
1976	1.07	0.868	0.577	1.95	41.6	29.9	5.95	3.16	3.01	2.79	2.24	1.26	7.89	1976
1977	0.879	0.800	0.637	14.3	21.5	5.02	3.04	0.753	1.27	2.46	0.970	0.622	4.38	1977
1978	0.411	0.335	0.437	3.12	16.2	15.4	2.58	0.656	0.577	1.99	2.61	0.633	3.76	1978
1979	0.316	0.229	0.245	4.11	30.5	11.9	2.65	0.624	0.379	0.715	0.358	0.283	4.39	1979
MEAN	0.528	0.460	0.436	4.49	25.7	15.1	3.35	1.11	1.12	1.81	1.52	0.635	4.71	MEAN

LOCATION - LAT 54 23 52 N DRAINAGE AREA, 580 km²
LONG 126 39 04 W NATURAL FLOW

BUCK CREEK AT THE MOUTH - STATION NO. 08EE013

ANNUAL EXTREMES OF DISCHARGE AND ANNUAL TOTAL DISCHARGE FOR THE PERIOD OF RECORD

YEAR	MAXIMUM INSTANTANEOUS DISCHARGE (m ³ /s)	MAXIMUM DAILY DISCHARGE (m ³ /s)	MINIMUM DAILY DISCHARGE (m ³ /s)	TOTAL DISCHARGE (dam ³)	YEAR
1973	75.3 AT 20:25 PST ON MAY 17 *	72.5 ON MAY 17 *	0.227B ON DEC 31	146 000	1973
1974	32.6 AT 19:56 PST ON MAY 26	32.0 ON MAY 26	0.096B ON JAN 20 *	146 000	1974
1975	34.8 AT 19:50 PST ON MAY 11	33.7 ON MAY 12	0.159B ON FEB 19	104 000	1975
1976	61.7 AT 19:09 PST ON MAY 11	61.2 ON MAY 11	0.524B ON MAR 27	249 000	1976
1977	62.0 AT 01:17 PST ON APR 27	59.2 ON APR 27	0.345 ON AUG 23	138 000	1977
1978	41.6 AT 21:40 PST ON JUN 14	38.5 ON JUN 15	0.317B ON FEB 10	119 000	1978
1979	68.8 AT 23:06 PST ON MAY 3	66.0 ON MAY 4	0.164B ON MAR 3	139 000	1979
	B - ICE CONDITIONS	* - EXTREME RECORDED FOR THE PERIOD OF RECORD		149 000	MEAN

Aug. 31, 1981: Q = 0.544 m³/s

MONTHLY AND ANNUAL MEAN DISCHARGES IN CUBIC METRES PER SECOND FOR THE PERIOD OF RECORD

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	MEAN	YEAR
1964	---	---	---	---	---	---	---	---	0.933	0.751	0.669	---	---	1964
1965	---	---	---	---	4.19	2.21	1.35	0.308	0.258	1.61	1.43	0.383	---	1965
1966	0.045	0.042	0.127	1.84	2.25	2.07	0.554	0.612	0.405	0.684	0.442	0.248	0.777	1966
1967	0.065	0.042	0.055	0.266	8.77	2.81	0.098	0.024	0.035	0.492	0.289	0.145	1.10	1967
1968	0.129	0.148	0.293	0.714	11.2	3.60	1.25	0.356	0.839	1.31	0.885	0.203	1.76	1968
1969	0.134	0.080	0.066	0.922	7.40	1.03	0.166	0.107	1.47	1.23	1.74	0.939	1.28	1969
1970	0.325	0.211	0.209	0.710	5.58	1.83	0.358	0.368	0.178	0.360	0.217	0.123	0.879	1970
1971	0.116	0.113	0.098	0.466	8.39	3.37	2.78	1.10	0.929	0.977	0.645	0.496	1.64	1971
1972	0.164	0.086	0.310	0.802	11.5	4.86	0.870	0.183	0.120	0.864	0.747	0.364	1.75	1972
1973	0.281	0.139	0.111	0.812	9.18	3.89	0.367	0.075	0.112	0.350	0.179	0.034	1.30	1973
1974	0.037	0.065	0.057	1.33	8.00	5.20	1.16	0.103	0.138	0.276	0.131	0.067	1.39	1974
MEAN	0.144	0.103	0.147	0.874	7.65	3.09	0.895	0.328	0.492	0.809	0.670	0.300	1.32	MEAN

LOCATION - LAT 54 30 59 N DRAINAGE AREA, 173 km²
 LONG 126 20 04 W NATURAL FLOW

Station discontinued 1974.

BULKLEY RIVER NEAR HOUSTON - STATION NO. 08EE003

MONTHLY AND ANNUAL MEAN DISCHARGES IN CUBIC METRES PER SECOND FOR THE PERIOD OF RECORD

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	MEAN	YEAR
1930	---	---	---	---	---	---	---	---	---	3.01	---	---	---	1930
1931	---	---	---	---	32.5	18.9	12.3	1.64	0.767	2.58	---	---	---	1931
1933	---	---	---	---	---	35.7	11.0	1.66	0.916	---	---	---	---	1933
1934	---	---	---	---	---	11.3	---	---	---	---	---	---	---	1934
1935	---	---	---	13.3	72.3	---	---	---	---	---	---	---	---	1935
1937	---	---	---	15.4	63.8	47.7	---	---	---	17.9	---	---	---	1937
1938	---	---	---	---	69.5	20.7	---	---	---	---	---	---	---	1938
1939	---	---	---	---	---	37.7	---	---	---	1.53	5.37	---	---	1939
1940	---	---	---	41.5	73.8	16.7	---	---	---	---	---	---	---	1940
1941	---	---	---	51.0	45.1	14.1	---	---	---	---	---	---	---	1941
1942	---	---	---	---	67.8	28.8	---	---	---	---	---	---	---	1942
1944	---	---	---	12.4	34.5	11.8	5.35	1.21	3.18	10.5	4.87	---	---	1944
1945	---	---	---	---	97.2	21.6	4.13	1.39	0.508	1.14	---	---	---	1945
1946	---	---	---	9.99	102	43.7	33.8	6.43	1.19	1.50	---	---	---	1946
1947	---	---	---	32.7	61.8	34.2	15.7	7.63	4.19	7.82	---	---	---	1947
1948	---	---	---	---	127	26.3	7.93	10.1	3.97	3.31	---	---	---	1948
1949	---	---	---	---	82.5	17.7	8.36	6.48	3.59	3.67	10.7	---	---	1949
1950	---	---	---	---	59.2	36.1	7.84	3.36	1.62	1.49	---	---	---	1950
1951	---	---	---	---	91.6	15.0	4.08	5.34	1.28	---	---	---	---	1951
1971	1.03	1.53	1.32	2.49	85.7	59.8	35.3	5.46	4.28	8.08	6.06	4.93	18.1	1971
MEAN	1.03	1.53	1.32	22.3	72.9	27.7	13.3	4.61	2.32	5.21	6.75	4.93	18.1	MEAN

LOCATION - LAT 54 23 45 N DRAINAGE AREA, 2 380 km²
 LONG 126 42 30 W NATURAL FLOW

BULKLEY RIVER NEAR HOUSTON - STATION NO. 08EE003

ANNUAL EXTREMES OF DISCHARGE AND ANNUAL TOTAL DISCHARGE FOR THE PERIOD OF RECORD

YEAR	MAXIMUM INSTANTANEOUS DISCHARGE (m ³ /s)	MAXIMUM DAILY DISCHARGE (m ³ /s)	MINIMUM DAILY DISCHARGE (m ³ /s)	TOTAL DISCHARGE (dam ³)	YEAR
1930	---	---	---	---	1930
1931	---	53.8 ON MAY 4	---	---	1931
1933	---	---	---	---	1933
1934	---	---	---	---	1934
1935	---	94.0 ON MAY 15	---	---	1935
1937	---	85.0 ON MAY 26	---	---	1937
1938	---	122 ON MAY 25	---	---	1938
1939	---	152 ON MAY 17	---	---	1939
1940	---	110 ON MAY 12	---	---	1940
1941	---	90.9 ON MAY 3	---	---	1941
1942	---	102 ON MAY 13	---	---	1942
1944	---	49.3 ON MAY 17	---	---	1944
1945	---	156 ON MAY 19	---	---	1945
1946	---	171 ON MAY 10	---	---	1946
1947	---	96.8 ON APR 28	---	---	1947
1948	---	193 ON MAY 25	---	---	1948
1949	---	148 ON MAY 13	---	---	1949
1950	---	119 ON MAY 13	---	---	1950
1951	---	204 ON MAY 14 *	---	---	1951
1971	---	130 ON MAY 14	0.9348 ON JAN 9 *	571 000	1971
	B - ICE CONDITIONS	* - EXTREME RECORDED FOR THE PERIOD OF RECORD		571 000	MEAN

Aug. 31, 1981 : Q = 0.544 m³/s

APPENDIX 2 Some representative photographs of streams
 in the Upper Bulkley watershed, August 30
 to September 3, 1981.



1. Upper Bulkley River in Reach 1, at Nadina Rd. in Houston. This Reach is typified by short riffles with long glide-pool habitat.



2. Upper Bulkley River in Reach 2 at Houston Townsite. Extremely low discharge ($0.25 \text{ m}^3/\text{s}$; 9 cfs) made much of this Reach basically standing water.



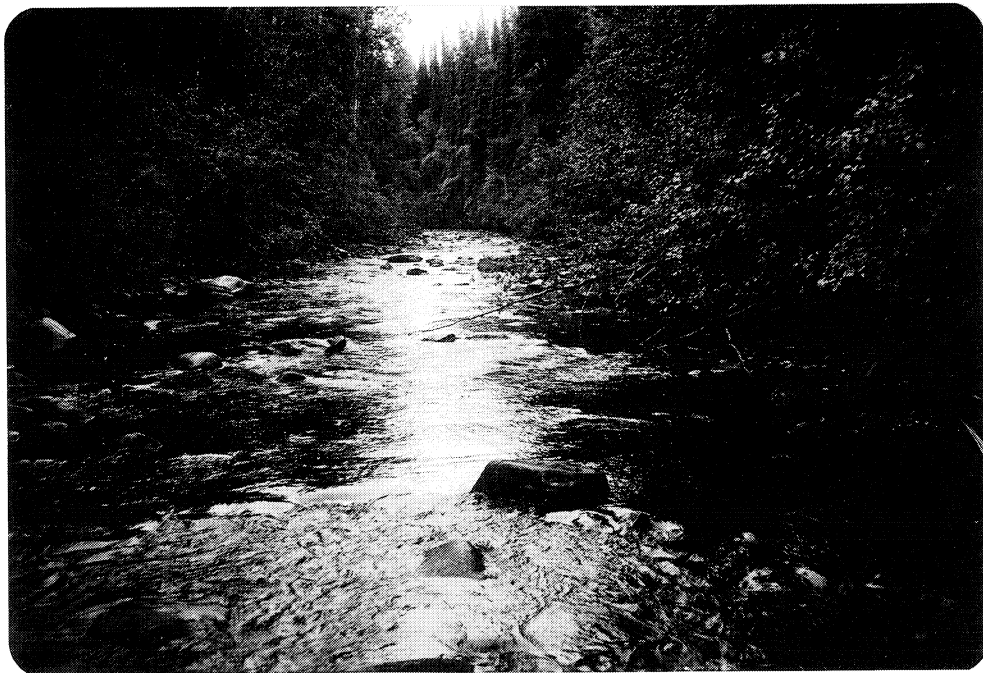
3. Upper Bulkley River in Reach 2 at Knockholt. Again long very slow glides and pools were present with short riffle sections. Riffles were generally shallow and in very small substrates.



4. Upper Bulkley River in Reach 3 below McQuarrie Creek. Long glides and pools remained the dominant habitats, however riffle-glide habitat in larger substrate (eg. cobble) was quite abundant. Note the wide active channel width, indicative of high spring flows.



5. Upper Bulkley River in Reach 4 at Forestdale. Again low discharge has made much of this habitat slow moving pools and glides. Short, shallow riffles were present. Instream debris and overstream cover was quite abundant.



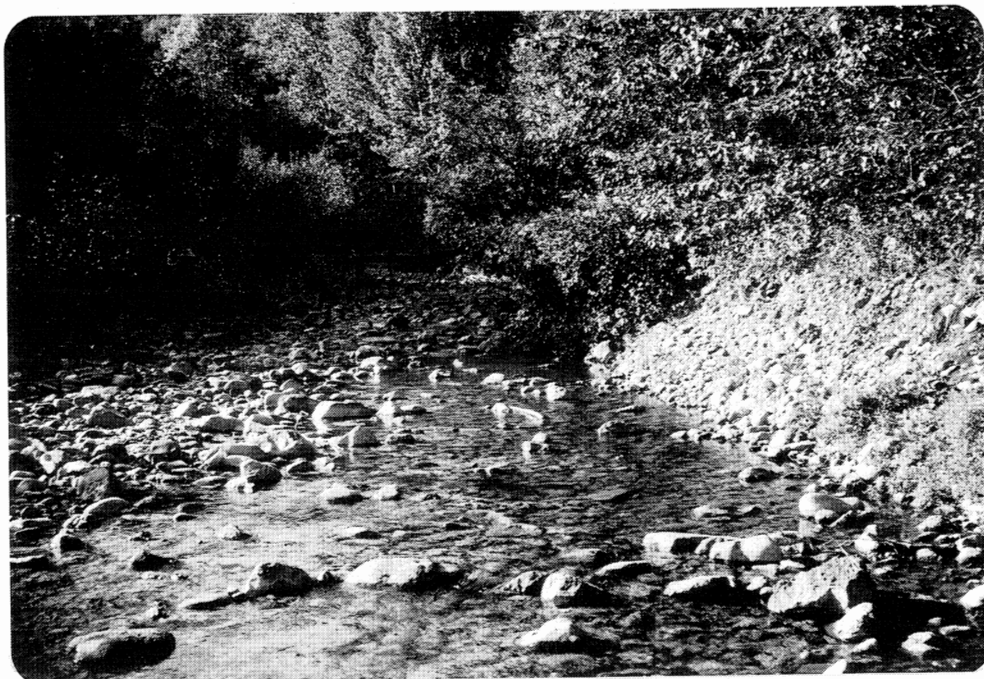
6. Buck Creek in Reach 2, showing excellent steelhead rearing habitat.



7. Buck Creek in Reach 5, at 2nd bridge on Buck Flats Road.



8. Buck Creek in the middle portion of Reach 5. Gradient was somewhat less than the previous site; however, excellent cover was still available.



9. McQuarrie Creek at lower end of Reach 2. Excellent rearing habitat for especially 0+ rainbow trout was present. Substrates were covered with degrading green algae.



10. Richfield Creek in Reach 2, roughly 200 m below falls.

APPENDIX 3 Summary of stream habitat sampling in the Upper
Bulkley watershed, August 30 to September 3, 1981.

• Habitat characteristics of

Bulley

R.

R1

HABITAT TYPE

REACH LENGTH (m)

8.9 Km

A = 143,867

Habitat unit	POOL Value %	RIFFLE Value %	GLIDE Value %
No. of units sampled	1	6	7
Average length (m)	250	14.2	74.4
Average wetted width (m)	20	14.7	14.9
Average channel width (m)	30	38.3	31.1
Average depth (cm)	1.2	0.19	0.33
Average area (m ²)	5000	209.0	1108
Total no. of units in reach	10	62	73
Total area of units in reach (m ²)	50,000 35%	12,942 9%	80,925 56%
Average area log debris cover (m ²)	3	0.4	0.5
Average area boulder cover (m ²)	5	1.8	2.4
Average area instream vegetation (m ²)	0	0	0
Average area overstream vegetation (m ²)	0	0	0.7
Average area cutbanks (m ²)	0	0	0
Average area total cover (m ²)	8 0.2%	2.2 1%	3.6 0.3%
Average % substrate fines	95	12	26
Average % substrate small gravel	3	21	26
Average % substrate large gravel	2	36	25
Average % substrate cobble	0	22	15
Average % substrate boulder	1	9	8
Average % substrate bedrock	0	0	0

Habitat characteristics of

Bullseye R

Reach 2

HABITAT TYPE
REACH LENGTH (m)

23 km

Area = 347,719

Habitat unit	POOL Value %	RIFFLE Value %	GLIDE Value %
No. of units sampled	6	5	7
Average length (m)	13.5	26.8	77.2
Average wetted width (m)	17.8	9.3	12.6
Average channel width (m)	27.0	39.2	32.9
Average depth (cm)	1.12	0.12	0.37
Average area (m ²)	2403.0	249.2	972.7
Total no. of units in reach	93	77	108
Total area of units in reach (m ²)	223,479 64%	19,138 5.5%	105,052 30%
Average area log debris cover (m ²)	4.8	1.8	2.8
Average area boulder cover (m ²)	1.3	0.9	0.1
Average area instream vegetation (m ²)	1	0	5.4
Average area overstream vegetation (m ²)	4.3	0.4	6.4
Average area cutbanks (m ²)	3	0.1	6.4
Average area total cover (m ²)	14.4 0.6%	3.2 1.3%	21.1 2.2%
Average % substrate fines	67	24	38
Average % substrate small gravel	9	31	20
Average % substrate large gravel	11	23	21
Average % substrate cobble	8	18	17
Average % substrate boulder	5	4	4
Average % substrate bedrock	0	0	0

Habitat characteristics of

Rubio River

Reach # 3

HABITAT TYPE
REACH LENGTH (m)

8.0 Km

Area = 75,676

Habitat unit	POOL Value %	RIFFLE Value %	GLIDE Value %
No. of units sampled	1	4	4
Average length (m)	60	23	44.2
Average wetted width (m)	8	10.8	9.5
Average channel width (m)	45	50	61.2
Average depth (cm)	0.60	0.13	0.29
Average area (m ²)	480	248.4	419.9
Total no. of units in reach	24/11.1%	96/44.4%	96/44.4%
Total area of units in reach (m ²)	11,520/15.2%	23846.4/31.5%	40,310.4/53.3%
Average area log debris cover (m ²)	4	0	1.1
Average area boulder cover (m ²)	0	0	0
Average area instream vegetation (m ²)	1	0	0
Average area overstream vegetation (m ²)	1	0	0.5
Average area cutbanks (m ²)	4	0	0.2
Average area total cover (m ²)	10/2.1%	0/0%	1.8/0.4%
Average % substrate fines	70	10	20
Average % substrate small gravel	5	44	24
Average % substrate large gravel	20	35	45
Average % substrate cobbles	5	11	11
Average % substrate boulder	0	0	0
Average % substrate bedrock	0	0	0

• Habitat characteristics of

Bulley R

R4

HABITAT TYPE
REACH LENGTH (m)

25.2 Km

Area = 174,106

Habitat unit	POOL Value %	RIFFLE Value %	GLIDE Value %
No. of units sampled	4	2	6
Average length (m)	53.8	10.5	116.5
Average watted width (m)	11	3.2	6
Average channel width (m)	17	22.5	17.2
Average depth (cm)	1.08	0.07	0.26
Average area (m ²)	591.8	33.6	669.0
Total no. of units in reach	108	54	162
Total area of units in reach (m ²)	63,914 37%	1,814 1%	108,378 62%
Average area log debris cover (m ²)	6.5	0.3	8
Average area boulder cover (m ²)	1.5	0	0
Average area instream vegetation (m ²)	1	0	0.3
Average area overstream vegetation (m ²)	11.5	0.5	8.7
Average area cutbanks (m ²)	3	0	0.3
Average area total cover (m ²)	23.5 4.0%	0.8 2.4%	17.3 2.6%
Average % substrate fines	83	20	62
Average % substrate small gravel	12	60	53
Average % substrate large gravel	1	20	3
Average % substrate cobble	3	0	2
Average % substrate boulder	1	0	0
Average % substrate bedrock	0	0	0

Habitat characteristics of

Bullocky R. Reach #5

HABITAT TYPE
REACH LENGTH (m)

5.2 Km

Area = 34,200

Habitat unit	POOL Value %	RIFFLE Value %	GLIDE Value %
No. of units sampled	2	1	3
Average length (m)	11.5	8.5	35
Average wetted width (m)	8.8	8	6
Average channel width (m)	16.5	18	21
Average depth (cm)	0.65	0.10	0.27
Average area (m ²)	101.2	68	210
Total no. of units in reach	76/333%	38/16.7%	114/50%
Total area of units in reach (m ²)	7,691.2/4%	2,584.0/7%	23,940.0/70%
Average area log debris cover (m ²)	8.3	0	8.8
Average area boulder cover (m ²)	0	0	0
Average area instream vegetation (m ²)	0	1	0.7
Average area overstream vegetation (m ²)	0.9	0	2.7
Average area cutbanks (m ²)	0	0	4.7
Average area total cover (m ²)	9.2/9.1%	1/1.5%	16.9/8.0%
Average % substrate fines	50	10	37
Average % substrate small gravel	40	70	33
Average % substrate large gravel	10	20	30
Average % substrate cobbles	0	0	0
Average % substrate boulder	0	0	0
Average % substrate bedrock	0	0	0

• Habitat characteristics of

Back Creek Reach 2

HABITAT TYPE
REACH LENGTH (m)

2.7 Km

Area = 23,829

Habitat unit	POOL Value %	RIFFLE Value %	GLIDE Value %
No. of units sampled	1		3
Average length (m)	40		91.3
Average wetted width (m)	18		9.8
Average channel width (m)	21		15
Average depth (cm)	0.5		0.22
Average area (m ²)	720		894.7
Total no. of units in reach	7		21
Total area of units in reach (m ²)	5040/21.7%		18,789/78.8%
Average area log debris cover (m ²)	2		0.2
Average area boulder cover (m ²)	10		5
Average area instream vegetation (m ²)	0		0
Average area overstream vegetation (m ²)	3		2
Average area cutbanks (m ²)	5		0.5
Average area total cover (m ²)	20/28%		77/0.9%
Average % substrate fines	10		12
Average % substrate small gravel	15		15
Average % substrate large gravel	20		27
Average % substrate cobble	15		28
Average % substrate boulder	15		18
Average % substrate bedrock	40		0

Habitat characteristics of

Buck Creek Reach #3

HABITAT TYPE

REACH LENGTH (m) *3.8 Km*

Area = 35,896

Habitat unit	POOL Value %	RIFFLE Value %	GLIDE Value %
No. of units sampled		6	4
Average length (m)		25.2	41.2
Average wetted width (m)		8.9	10
Average channel width (m)		37.8	33
Average depth (cm)		0.20	0.36
Average area (m ²)		223.9	412
Total no. of units in reach		72	48
Total area of units in reach (m ²)		16,120/45	19,776/55
Average area log debris cover (m ²)		0	0.8
Average area boulder cover (m ²)		9.7	1.8
Average area instream vegetation (m ²)		0	0
Average area overstream vegetation (m ²)		0	0.5
Average area cutbanks (m ²)		0	0
Average area total cover (m ²)		9.7/4.3%	3.1/0.8%
Average % substrate fines		11	44
Average % substrate small gravel		12	10
Average % substrate large gravel		32	18
Average % substrate cobble		35	24
Average % substrate boulder		10	4
Average % substrate bedrock		0	0

• Habitat characteristics of

Rock Creek Reach #5

HABITAT TYPE
REACH LENGTH (m)

38.5 Km

Habitat unit	POOL Value %	RIFFLE Value %	GLIDE Value %
No. of units sampled	3	15	18
Average length (m)	29	11.5	26.6
Average wetted width (m)	12.3	7.2	9.7
Average channel width (m)	14.3	18.7	18.4
Average depth (cm)	1.0	0.08	0.3
Average area (m ²)	356.7	82.8	258.0
Total no. of units in reach	156	782	939
Total area of units in reach (m ²)	55,645/15	64,750/18	242,280/67
Average area log debris cover (m ²)	5	0.8	1.2
Average area boulder cover (m ²)	1.7	0.6	2.1
Average area instream vegetation (m ²)	0.3	0.1	0.7
Average area overstream vegetation (m ²)	4	1.4	1.7
Average area cutbanks (m ²)	1.3	0.5	0.8
Average area total cover (m ²)	12.3/3.5%	3.4/4.1%	6.5/2.5%
Average % substrate fines	33	9	26
Average % substrate small gravel	18	20	21
Average % substrate large gravel	17	45	33
Average % substrate cobble	15	22	15
Average % substrate boulder	7	4	5
Average % substrate bedrock	10	0	0

• Habitat characteristics of

Jungate Creek

HABITAT TYPE

REACH LENGTH (m)

2.1 Km

Area = 7640 m²

Habitat unit	POOL Value %	RIFFLE Value %	GLIDE Value %
No. of units sampled		<i>4</i>	<i>2</i>
Average length (m)		<i>10.1 m</i>	<i>4.5 m</i>
Average wetted width (m)		<i>3.6 m</i>	<i>3.5 m</i>
Average channel width (m)		<i>5.6 m</i>	<i>5.5 m</i>
Average depth (cm)		<i>0.1 m</i>	<i>0.2 m</i>
Average area (m ²)		<i>37.6 m²</i>	<i>15.8 m²</i>
Total no. of units in reach		<i>168 / 66.7%</i>	<i>84 / 33.3%</i>
Total area of units in reach (m ²)		<i>6316.8 / 82.6%</i>	<i>1327.2 / 17.4%</i>
Average area log debris cover (m ²)		<i>0.1 m²</i>	<i>0.5 m²</i>
Average area boulder cover (m ²)		<i>5.3 m²</i>	<i>8.3 m²</i>
Average area instream vegetation (m ²)		<i>0 m²</i>	<i>0</i>
Average area overstream vegetation (m ²)		<i>0.9 m²</i>	<i>0.5</i>
Average area cutbanks (m ²)		<i>0.4 m²</i>	<i>0.5</i>
Average area total cover (m ²)		<i>6.6 / 17.6%</i>	<i>9.8 / 62.0%</i>
Average % substrate fines		<i>9.0%</i>	<i>12.6%</i>
Average % substrate small gravel		<i>22.5%</i>	<i>30.4%</i>
Average % substrate large gravel		<i>23.8%</i>	<i>20.0%</i>
Average % substrate cobble		<i>27.6%</i>	<i>15.0%</i>
Average % substrate boulder		<i>15.0%</i>	<i>15.0%</i>
Average % substrate bedrock		<i>0</i>	<i>0</i>

• Habitat characteristics of

M^cQuinn Creek (upper side) Reach #2

HABITAT TYPE

REACH LENGTH (m)

6.6 Km

Habitat unit	POOL Value %	RIFFLE Value %	GLIDE Value %
No. of units sampled	2	3	3
Average length (m)	6.0	6.2	17.7
Average wetted width (m)	2.9	3.5	1.7
Average channel width (m)	12.5	10	7.3
Average depth (cm)	0.25	0.05	0.12
Average area (m ²)	17.4	21.7	30.1
Total no. of units in reach	158/25%	237/37.5%	237/37.5%
Total area of units in reach (m ²)	2749.2/18.3%	5142.9/34.2%	7133.7/47.5%
Average area log debris cover (m ²)	1.3	0.1	1.0
Average area boulder cover (m ²)	0	0.2	0.7
Average area instream vegetation (m ²)	0	0	0.3
Average area overstream vegetation (m ²)	1.8	0.6	1.7
Average area cutbanks (m ²)	2.3	0.1	0.3
Average area total cover (m ²)	5.4/31.0%	1.0/4.6%	4.1/13.6%
Average % substrate fines	15	8	13
Average % substrate small gravel	23	25	27
Average % substrate large gravel	40	45	36
Average % substrate cobble	15	20	17
Average % substrate boulder	7	2	7
Average % substrate bedrock	0	0	

• Habitat characteristics of

Byman Creek

HABITAT TYPE

REACH LENGTH (m)

Reach 1 5.6 km

Habitat unit	POOL Value %	RIFFLE Value %	GLIDE Value %
No. of units sampled		3	3
Average length (m)		8.3	5.8
Average wetted width (m)		2.5	3.7
Average channel width (m)		25.3	30
Average depth (cm)		0.06	0.12
Average area (m ²)		20.8	21.5
Total no. of units in reach		397/50%	397/50%
Total area of units in reach (m ²)		8257.6/49.2%	8535.5/50.8%
Average area log debris cover (m ²)		0	0
Average area boulder cover (m ²)		0.1	0
Average area instream vegetation (m ²)		0	0.1
Average area overstream vegetation (m ²)		2	1
Average area cutbanks (m ²)		0	0.1
Average area total cover (m ²)		2.1/10.0%	1.2/5.6%
Average % substrate fines		2	9
Average % substrate small gravel		6	14
Average % substrate large gravel		12	23
Average % substrate cobble		45	44
Average % substrate boulder		35	10
Average % substrate bedrock		0	0

• Habitat characteristics of

Richfield Creek

HABITAT TYPE
REACH LENGTH (m)

2.3 Km

Area = 14929

Habitat unit	POOL Value %	RIFFLE Value %	GLIDE Value %
No. of units sampled	1	2	3
Average length (m)	7	5	15.7
Average wetted width (m)	5	5	7
Average channel width (m)	12	8.5	9.0
Average depth (cm)	0.7	0.15	0.5
Average area (m ²)	35.0	25.0	109.9
Total no. of units in reach	36/16.7%	72/33.3%	108/50%
Total area of units in reach (m ²)	1260/8.4%	1800/12.1%	11,869/79.5%
Average area log debris cover (m ²)	4	0.15	0.1
Average area boulder cover (m ²)	0.5	0.18	0.7
Average area instream vegetation (m ²)	0	0	0
Average area overstream vegetation (m ²)	0	1.8	2.7
Average area cutbanks (m ²)	4	0.15	0.7
Average area total cover (m ²)	8.5/24.3%	2.3/9.2%	4.2/3.8%
Average % substrate fines	10	0	20
Average % substrate small gravel	20	10	13
Average % substrate large gravel	30	30	30
Average % substrate cobbles	30	40	27
Average % substrate boulder	10	20	10
Average % substrate bedrock	0	0	0

Habitat characteristics of

Ridgely Creek

St. 1225

Reach 2

HABITAT TYPE

REACH LENGTH (m)

6.3 Km

Area = 27,623

Habitat unit	POOL Value %	RIFFLE Value %	GLIDE Value %
No. of units sampled	1	3	2
Average length (m)	8	15	12
Average wetted width (m)	4	4.5	4.3
Average channel width (m)	7	6.2	6
Average depth (cm)	0.35	0.10	0.13
Average area (m ²)	32	67.5	51.6
Total no. of units in reach	82	245	164
Total area of units in reach (m ²)	2624/9.4	16527/60	8462/30.6
Average area log debris cover (m ²)	1.0	0.3	0
Average area boulder cover (m ²)	1.0	2.6	1.5
Average area instream vegetation (m ²)	0.0	0	0
Average area overstream vegetation (m ²)	0.5	1.0	0.5
Average area cutbanks (m ²)	0.5	0	0.5
Average area total cover (m ²)	3.0/9.4%	3.9/5.8%	2.5/4.8%
Average % substrate fines	0	7	10
Average % substrate small gravel	10	20	20
Average % substrate large gravel	30	37	35
Average % substrate cobbles	30	31	25
Average % substrate boulder	10	10	10
Average % substrate bedrock	20	0	0

• Habitat characteristics of

Crow Creek

HABITAT TYPE
REACH LENGTH (m)

14.5 Km

Area = 41385

Habitat unit	POOL Value %	RIFFLE Value %	GLIDE Value %
No. of units sampled	3	5	4
Average length (m)	6.2	3.4	4.5
Average wetted width (m)	3.7	2.2	2.6
Average channel width (m)	9.3	9.6	9.2
Average depth (cm)	0.04	0.05	0.2
Average area (m ²)	22.9	7.5	11.7
Total no. of units in reach	811.5/25%	1352.5/41.7%	1082.0/33.3%
Total area of units in reach (m ²)	18,583.4/44.9%	10,143.8/24.5%	12,659.4/30.6%
Average area log debris cover (m ²)	6.2	0.3	0.6
Average area boulder cover (m ²)	0	0	0
Average area instream vegetation (m ²)	0	0.1	0
Average area overstream vegetation (m ²)	0.3	0.8	0.0
Average area cutbanks (m ²)	0.2	0	0.1
Average area total cover (m ²)	6.7/29.3%	1.2/16%	1.1/9.4%
Average % substrate fines	47	28	4
Average % substrate small gravel	30	54	71
Average % substrate large gravel	23	18	25
Average % substrate cobbles	0	0	0
Average % substrate boulder	0	0	0
Average % substrate bedrock	0	0	0

• Habitat characteristics of

Moxon Creek

Reach 1

HABITAT TYPE
REACH LENGTH (m)

12.5 Km

Area = 146,720

Habitat unit	POOL Value %	RIFFLE Value %	GLIDE Value %
No. of units sampled	1	3	4
Average length (m)	20	12	25
Average wetted width (m)	8	9	12
Average channel width (m)	15	14	14
Average depth (cm)	0.4	0.08	0.3
Average area (m ²)	160	108	300
Total no. of units in reach	80	240	360
Total area of units in reach (m ²)	12,800/9	25,920/18	108,000/74
Average area log debris cover (m ²)	15	1	6.3
Average area boulder cover (m ²)	0	0	0
Average area instream vegetation (m ²)	0	0.2	0.6
Average area overstream vegetation (m ²)	8	2	5.0
Average area cutbanks (m ²)	0	0	2.5
Average area total cover (m ²)	23.0/14.4%	3.2/3.0%	14.4/4.8%
Average % substrate fines	35	9	24
Average % substrate small gravel	30	25	21
Average % substrate large gravel	20	38	35
Average % substrate cobble	15	28	19
Average % substrate boulder	0	0	1
Average % substrate bedrock	0	0	0

APPENDIX 4 Fish population estimates in the Upper Bulkley
Watershed, August 30 to September 3, 1981.

Condition factors used in Upper Bulkley River
population estimates.

rainbow trout	1.065	$\times 10^{-5}$	$(l)^3$
coho	1.2	$\times 10^{-5}$	$(l)^3$
chinook	1.1	$\times 10^{-5}$	$(l)^3$
sculpin spp.	1.0	$\times 10^{-5}$	$(l)^3$
longnose dace	1.15	$\times 10^{-5}$	$(l)^3$
mountain whitefish	1.35	$\times 10^{-5}$	$(l)^3$
sucker spp.	2.50	$\times 10^{-5}$	$(l)^{2.88}$

SITE # 1

[illegible]

HABITAT DESCRIPTION: riffle-glide side channel to main stem Bulkley

² F fines, SG small gravel, LG large gravel, C cobbles, B boulders, Br bedrock

Bullocky River #2

Between Levee & Houston just above falls

under (Nadine R.)

DATE Sept 2/81

AREA 109.4 M²

SITE # 2

LENGTH 10.7 M

SPECIES	AGE	fi-RANGE	fi	MEAN WEIGHT	C _i	$\bar{p}$	$\bar{n}$	TOTAL BIOMASS	No./M ² DENSITY	BIOMASS DENSITY	No./linear meter
1+ RbT	1+	79-97	87.5	7.24	12	0.7	17.1	124.2	0.16	1.13	1.60
2+ RbT	2+	117	117	17.06	1	.7	1.43	24.4	0.01	0.22	0.13
MW		120	120	23.3	1	0.7	1.43	33.3	0.01	0.30	0.13
ChK		62-103	76.8	5.5	5	0.7	7.14	39.3	0.07	0.36	0.67
C Asper		73-105	94.3	9.0	3	0.2	15.0	135.2	0.14	1.23	1.40
LN Dace		31-86	58.2	2.9	461	0.2	305	876.8	2.78	7.99	28.5
Lamprey	1 adult	2.5'			3						
	2 sm to	10-20cm									

HABITAT DESCRIPTION:

Discharge

Gradient

Temperature (°C)

Turbidity

Hydraulic Type

Pool

Glide

Riffle

% area

mean width

mean depth

% cover

cover type¹substrate²

COMMENTS:

¹ L log, B boulder, IV instream vegetation, OV overstream vegetation, C cutbanks² F fines, SG small gravel, LG large gravel, C cobbles, B boulders, Br bedrock

Seine in glide

DATE Sept 2/81

AREA 300 M²

SITE # 3

LENGTH 50 M

[illegible]

÷ HABITAT DESCRIPTION:

Discharge

Gradient

Temperature (°C)

Turbidity

Hydraulic Type

Pool

Glide

Rifle

% area

mean width

mean depth

% cover

cover type¹
$$\text{substrate}^2$$

COMMENTS:

¹ L log, B boulder, IV instream vegetation, OV overstream vegetation, C cutbanks

² F fines, SG small gravel, LG large gravel, C cobbles, B boulders, Br bedrock

Sept 2/81

See Field Notes

SITE # 4

LENGTH _____ M

[illegible]

4 HABITAT DESCRIPTION:

Discharge

Gradient

Temperature (°C)

Turbidity

Hydraulic Type

Pool

Glide ✓

Rifle

% area

mean width

mean depth

% cover

cover type¹substrate²

COMMENTS:

¹ L log, B boulder, IV instream vegetation, OV overstream vegetation, C cutbanks

² F fines, SG small gravel, LG large gravel, C cobbles, B boulders, Br bedrock

Houston townsite Bulkeley R

DATE Sept 2/81

AREA 175 M²
LENGTH 15.7 M

SITE # 5

SPECIES	AGE	FI-RANGE	fi	MEAN WEIGHT	C _i	P	n	TOTAL BIOMASS	No./M ² DENSITY	BIOMASS DENSITY	No./linear meter
RBT	1+	75-97	86.5	7.0	14	0.8	17.5	122.3	0.10	0.70	1.11
	2+	132-142	137.3	27.7	3	0.8	3.8	103.4	0.02	0.59	0.24
COHO	0+	50-81	66.1	3.6	38	0.8	47.5	171.1	0.27	0.98	3.03
CH/NOOK	0+	67-73	70.3	4.0	6	0.8	7.5	30.1	0.04	0.17	0.48
PAGE		29-90	61.3	3.1	47	0.8	58.8	183.7	0.34	1.05	3.74
SUCKER		33-137	91.7	31.4	3	0.8	3.8	117.6	0.02	0.67	0.24

HABITAT DESCRIPTION:

Discharge _____ Gradient _____
 Temperature (°C) _____ Turbidity _____
 Hydraulic Type _____ Pool _____ Glide _____ Riffle _____
 % area _____
 mean width _____
 mean depth _____
 % cover _____
 cover type¹ _____
 substrate² _____

COMMENTS:

¹ L log, B boulder, IV instream vegetation, OV overstream vegetation, C cutbanks

² F fines, SG small gravel, LG large gravel, C cobbles, B boulders, Br bedrock

Bullock River at Knockholt Bridge

DATE Aug 30/81

AREA 105.6 M²
LENGTH 12 M

SITE # 6

SPECIES	AGE	fi-RANGE	fi	MEAN WEIGHT	C _i	P	n	TOTAL BIOMASS	No./M ² DENSITY	BIOMASS DENSITY	No. / linear meter
RBT	1+	72-79	75.2	4.6	4	0.7	5.7	26.0	0.05	0.25	0.48
CH/NOOK		59-68	63.6	2.8	10	0.7	14.3	40.7	0.14	0.39	1.19
SCALPIN		129	129	21.5	1	0.7	1.43	30.7	0.01	0.29	0.12
DACE		36-72	56.3	2.5	3	0.7	4.29	10.6	0.04	0.10	0.36
COHO		58-67	63	3.0	5	0.7	7.14	21.6	0.07	0.20	0.60
SUCKER		36	36	1.17	1	0.7	1.43	1.67	0.01	0.02	0.12

HABITAT DESCRIPTION:

Discharge

Gradient

Temperature (°C)

Turbidity

Hydraulic Type

Pool

Glide

Riffle

% area

mean width

mean depth

% cover

cover type¹

substrate²

COMMENTS:

¹ L log, B boulder, IV instream vegetation, OV overstream vegetation, C cutbanks

² F fines, SG small gravel, LG large gravel, C cobbles, B boulders, Br bedrock

Bullay River Bridge site between Knobloch + McQuary creek

DATE Sept 2/81 AREA 96.3 M² SITE # 7

DATE Sept 2/81

AREA 96.3 M²

SITE # 7

LENGTH 10.3 M

[illegible]

÷ HABITAT DESCRIPTION:

Discharge

Gradient

Temperature (°C)

Turbidity

Hydraulic Type

Pool

Glide

Rifle

% area

mean width

mean depth

% cover

cover type¹
$$\text{substrate}^2$$

COMMENTS:

¹ L log, B boulder, IV instream vegetation, OV overstream vegetation, C cutbanks

² F fines, SG small gravel, LG large gravel, C cobbles, B boulders, Br bedrock

John McQuarrie

DATE Sept 2/81

AREA 95.6 m²

SITE # 8

LENGTH 7.8 M

: HABITAT DESCRIPTION:

Gradient

Turbidity

Riffle

% area

mean width

mean depth

% cover

cover type¹
$$\text{substrate}^2$$

COMMENTS:

¹ L log, B boulder, IV instream vegetation, OV overstream vegetation, C cutbanks

² F fines, SG small gravel, LG large gravel, C cobbles, B boulders, Br bedrock

Sept 1/81

AREA 88.6 M²

SITE # 9

LENGTH 12.2 M

[illegible]

÷ HABITAT DESCRIPTION:

Discharge

Gradient

Temperature ($^{\circ}\text{C}$)

Turbidity

Hydraulic Type

Pool

Glide

Rifle

% area

mean width

mean depth

% cover

cover type¹substrate²

COMMENTS:

¹ L log, B boulder, IV instream vegetation, OV overstream vegetation, C cutbanks

² F fines, SG small gravel, LG large gravel, C cobbles, B boulders, Br bedrock

Bullseye R. at Forecreek

DATE Sept 1/81

AREA 67.8 M²

SITE # 10

LENGTH 11 M

SPECIES	AGE	fi-RANGE	fi	MEAN WEIGHT	C _i	P	n	TOTAL BIOMASS	No./M ² DENSITY	BIOMASS DENSITY	No. / linear meter
RBT	0+	49-52	50.5	1.4	2	0.7	2.9	3.9	0.04	0.06	0.26
	1+	113	113	15.4	1	0.7	1.4	22	0.02	0.32	0.13
SCULPIN		103	103	10.9	1	0.7	1.4	15.6	0.02	0.23	0.13
DACE		42-45			2	N/A					
LAMPREY					present	N/A					
SQUAWFISH		27-47 + Fry (1/2)				N/A					
SUCKER		Fry - lots				N/A					

HABITAT DESCRIPTION:

Discharge	Gradient		
Temperature (°C)	Turbidity		
Hydraulic Type	Pool	Glide	Riffle
% area			
mean width			
mean depth			
% cover			
cover type ¹			
substrate ²			

COMMENTS:

¹ L log, B boulder, IV instream vegetation, OV overstream vegetation, C cutbanks

² F fines, SG small gravel, LG large gravel, C cobbles, B boulders, Br bedrock

² F fines, SG small gravel, LG large gravel, C cobbles, B boulders, Br bedrock

Bulldog R

Buck Creek (below Dugate Creek)

DATE _____

AREA 122.4 m²

SITE # 2

LENGTH 12 m

SPECIES	AGE	II-RANGE	$\bar{II}$	MEAN WEIGHT	C _i	$\bar{P}$	$\bar{n}$	TOTAL BIOMASS	No./m ² DENSITY	BIOMASS DENSITY	No./linear meter
RbT	0+	29-60	49.6	1.34	46	0.8	57.5	77.31	0.47	0.63	4.79
	1+	76-101	88.3	7.43	19	0.8	23.75	176.51	0.19	1.44	1.98
	2+	115-139	127	22.40	2	0.8	2.50	56.0	0.02	0.46	0.21
CH/NOOK		61-78	69.8	3.8	13	0.8	16.2	61.9	0.13	0.51	1.35
NACE		65-113	85.2	7.5	23	0.8	28.8	216.8	0.23	1.77	2.40
LAMPREY					present						

HABITAT DESCRIPTION:

Discharge

Gradient

Temperature (°C)

Turbidity

Hydraulic Type

Pool

Glide

Riffle

% area

mean width

mean depth

% cover

cover type¹substrate²

COMMENTS:

¹ L log, B boulder, IV instream vegetation, OV overstream vegetation, C cutbanks² F fines, SG small gravel, LG large gravel, C cobbles, B boulders, Br bedrock

SITE # _____

LENGTH _____ M

[illegible]

HABITAT DESCRIPTION:

Discharge

Gradient

Temperature (°C)

Turbidity

Hydraulic Type

Pool

Glide

Rifle

% area

mean width

mean depth

% cover

cover type¹

substrate²

COMMENTS:

¹ L log, B boulder, IV instream vegetation, OV overstream vegetation, C cutbanks

² F fines, SG small gravel, LG large gravel, C cobbles, B boulders, Br bedrock

AREA 125.2 M²
LENGTH 22.8 M

SITE # 4

· HABITAT DESCRIPTION:

Gradient

Turbidity

Glide

Rifle

% area

mean width

mean depth

% cover

cover type¹
$$\text{substrate}^2$$

COMMENTS:

¹ L log, B boulder, IV instream vegetation, OV overstream vegetation, C cutbanks

² F fines, SG small gravel, LG large gravel, C cobbles, B boulders, Br bedrock

DATE Aug 31/81

AREA 80 m²
LENGTH 14 m

SITE # 6

[illegible]

HABITAT DESCRIPTION:

Discharge

Gradient

Temperature (°C)

Turbidity

Hydraulic Type

Pool

Glide

Rifle

% area

mean width

mean depth

% cover

cover type¹

substrate²

COMMENTS:

¹ L log, B boulder, IV instream vegetation, OV overstream vegetation, C cutbanks

² F fines, SC small gravel, LG large gravel, C cobbles, B boulders, Br bedrock

LENGTH 14.5 M

[illegible]

HABITAT DESCRIPTION:

Discharge

Gradient

Temperature (°C)

Turbidity

Hydraulic Type

Pool

Glide

Rifle

% area

mean width

mean depth

% cover

cover type¹

substrate²

COMMENTS:

¹ L log, B boulder, IV instream vegetation, OV overstream vegetation, C cutbanks

² F fines, SC small gravel, LG large gravel, C cobbles, B boulders, Br bedrock

LENGTH 7.5 M

² F fines, SC small gravel, LG large gravel, C cobbles, B boulders, Br bedrock

Sept 3/81

AREA 19.4 M²

SITE # 2

LENGTH 12.8 M

• HABITAT DESCRIPTION:

Gradient

Turbidity

Rifle

% area

mean width

mean depth

% cover

cover type¹substrate²

COMMENTS:

¹ L log, B boulder, IV instream vegetation, OV overstream vegetation, C cutbanks

² F fines, SG small gravel, LG large gravel, C cobbles, B boulders, Br bedrock

Sept 3/81

AREA 31.2 m²

SITE #

LENGTH 10.9 M

: HABITAT DESCRIPTION:

Gradient

Turbidity

Glide

Rifle

% area

mean width

mean depth

% cover

cover type¹substrate²

COMMENTS:

¹ L log, B boulder, IV instream vegetation, OV overstream vegetation, C cutbanks

² F fines, SG small gravel, LG large gravel, C cobbles, B boulders, Br bedrock

² F fines, SG small gravel, LG large gravel, C cobbles, B boulders, Br bedrock

Richfield, Ah. above falls ab. Topley Edg Rd
Sept. 11/81 1981 Sp. 5 1/2 SITE # 3

DATE _____

Sept 1/81

AREA

50.5

SITE 幸

3

LENGTH 10 M

[illegible]

• HABITAT DESCRIPTION:

Discharge

Gradient

Temperature (°C)

Turbidity

Hydraulic Type

Pool

Glide

Rifle

% area

mean width

mean depth

% cover

cover type¹
$$\text{substrate}^2$$

COMMENTS:

¹ L log, B boulder, IV instream vegetation, OV overstream vegetation, C cutbanks

² F fines, SG small gravel, LG large gravel, C cobbles, B boulders, Br bedrock

SITE # 1

LENGTH 22 M

[illegible]

· HABITAT DESCRIPTION:

Discharge

Gradient

Temperature (°C)

Turbidity

Hydraulic Type

Pool

Glide

Rifle

% area

mean width

mean depth

% cover

cover type¹
$$\text{substrate}^2$$

COMMENTS:

¹ L log, B boulder, IV instream vegetation, OV overstream vegetation, C cutbanks

² F fines, SG small gravel, LG large gravel, C cobbles, B boulders, Br bedrock

SITE # _____

LENGTH 56 M

· HABITAT DESCRIPTION:

Gradient

Turbidity

Riffle

cover type¹
$$\text{substrate}^2$$

COMMENTS:

¹ L log, B boulder, IV instream vegetation, OV overstream vegetation, C cutbanks

² F fines, SG small gravel, LG large gravel, C cobbles, B boulders, Br bedrock

APPENDIX 5 Cumulative length-frequency analysis of juvenile
 chinook and coho salmon and rainbow trout
 captured in the Upper Bulkley watershed, August
 30 to September 3, 1981.

RAINBOW ⁶³ TROUT CUMULATIVE LENGTH FREQUENCY

SYSTEM: UPPER BULKLEY

DATE: Aug. 31 to Sept. 3, 1981

TRIBS. SAMPLED: mainstem, Buck, Dungate, McQuarrie, Byman, Richfield, Crow and Maxan.

		Age	N		Age	N		Age	N	
30	I		1	90	III	8	150			0
1				1	II	7	1			1
2	II		5	2	III	8	2			2
3	III		2	3	II	3	3			3
4	IIII		8	4	I	1	4			4
5	IIII		10	5	II	8	5	I	3+	1
6	IIII		16	6	II	2	6			6
7	IIII		12	7	II	5	7	I	2+	1
8	IIII		21	8	II	3	8			8
9	IIII		11	9			9			9
40	IIII		28	100	II	2	160			0
1	IIII		22	1	I	1	1			1
2	IIII		24	2	II	3	2			2
3	IIII		38	3	I	1	3			3
4	IIII		37	4	II	1+1, 2+	4			4
5	IIII		44	5	II	2+	5	I	3+	1
6	IIII		29	6	I	1	6			6
7	IIII		30	7			7			7
8	IIII		25	8	II	2	8			8
9	IIII		25	9	II	2+	9			9
50	IIII		23	110	II	2+2+	170			0
1	IIII		15	1	II	2	1			1
2	IIII		12	2	II	2+1, 2+	2			2
3	IIII		12	3	II	2+, 2+	3			3
4	IIII		13	4	II	2+	4			4
5	IIII		12	5	II	2+	5			5
6	IIII		7	6			6			6
7	IIII		6	7	II	2+	7			7
8	IIII		4	8	I	2+	8			8
9	IIII		5	9	II	2+	9			9
60	IIII		4	120	II	2+	180			0
1				1	I	1	1			1
2				2	II	2	2			2
3		0+	1	3			3			3
4				4	II	2+	4			4
5		0+	1	5	I	1	5			5
6		0+, 1+	2	6	II	2+, 2+	6			6
7		1+	1	7	I	1	7			7
8		1+	1	8			8			8
9	III	0+, 1+, 1+, 1+	4	9	III	2+	9			9
70	III	1+	4	130			190			0
1	III	1+	4	1	I	1	1			1
2	IIII	1+	7	2	II	2+, 2+, 2+	2			2
3	IIII		7	3	I	1	3			3
4	IIII		5	4	II	3+	4			4
5	IIII		4	5	I	1	5			5
6	IIII		9	6			6			6
7	IIII		4	7			7			7
8	IIII		5	8	I	2+	8			8
9	IIII		16	9	II	1	9			9
80	IIII		21	140		3+	OTHER			0
1	III		4	1			28	I	0+	1
2	IIII		11	2	I	2+	29	II	0+	2
3	IIII		12	3						3
4	IIII		15	4						4
5	IIII		14	5						5
6	IIII		9	6	II	3+	2			6
7	IIII		12	7						7
8	IIII		5	8						8
9	IIII		13	9						9

CHINOOK SALMON CUMULATIVE LENGTH FREQUENCY

SYSTEM: _____

DATE: _____

TRIBS. SAMPLED: _____

	Age	N		Age	N		Age	N	
40				100			0		0
1				1			1		1
2				2			2		2
3				3	1+		3		3
4				4			4		4
5				5			5		5
6				6			6		6
7				7			7		7
8				8			8		8
9				9			9		9
50	0+			0			0		0
1				1			1		1
2				2			2		2
3				3			3		3
4				4			4		4
5				5			5		5
6				6			6		6
7		1		7			7		7
8				8			8		8
9		1		9			9		9
60		3		0			0		0
1		1		1			1		1
2		1		2			2		2
3		1		3			3		3
4		3		4			4		4
5		2		5			5		5
6		6		6			6		6
7		2		7			7		7
8		2		8			8		8
9		2		9			9		9
70		5		0			0		0
1		3		1			1		1
2		2		2			2		2
3		5		3			3		3
4		4		4			4		4
5		3		5			5		5
6		1		6			6		6
7				7			7		7
8		1		8			8		8
9		2		9			9		9
80				0			0		0
1				1			1		1
2		1		2			2		2
3				3			3		3
4		1		4			4		4
5				5			5		5
6				6			6		6
7				7			7		7
8				8			8		8
9				9			9		9
90	0+			0			0		0
1				1			1		1
2				2			2		2
3				3			3		3
4				4			4		4
5				5			5		5
6				6			6		6
7				7			7		7
8				8			8		8
9				9			9		9

COHO SALMON
CUMULATIVE LENGTH FREQUENCY

SYSTEM: _____ - 65 -

DATE: _____

TRIBS. SAMPLED: _____

[illegible]

SPECIES	AGE	N. SAMPLED	MEAN LENGTH (mm)	RANGE (mm)	MEAN WEIGHT (g)
Rainbow	0+	505	46.4	28- 69	1.06
	1+	242	85.3	66-112	6.61
	2+	59	121.4	104-157	19.05
	3+	7	148	134-165	34.52
Chinook	0+	53	69.4	57- 84	3.67
	1+	1	103	-	12.02
Coho	0+	85	63.9	48- 81	3.13

Comparison of mean size of age groups of juvenile rainbow trout in the Upper Bulkley system with those of selected Skeena systems.

STREAM	MEAN FORK LENGTH BY AGE GROUP			
	0+	1+	2+	3+
Upper Bulkley (1981)	46.4	85.3	121.4	148
Kispiox (1980)	42.8	87.2	132.2	-
(1981)	38.7	78.4	124.7	-
Owen Creek (1980)	50.5	92.0	128.0	-
(1981)	45.4	91.7	148.5	-
Lamprey Creek (1980)	47.8	87.5	122.7	-
(1981)	39.0	78.4	124.4	-

APPENDIX 6 Fish density - stream habitat relationships
in the Upper Bulkley watershed derived from
juvenile fish population estimates, August
30 to September 3, 1981.

STREAM	REACH/SITE		HABITAT	F I S H D E N S I T Y			
				Rainbow	Trout	Coho	Chinook
				0+	Total Parr		
<u>Bulkley</u>	1	1	riffle-glide	0.02	0.11	0.13	0
		2	riffle	0	0.17	0	0.07
		3	glide (head)	0	<0.01	0.01	0.05
		4	glide (flat)	0	0	0	0
	2	5	riffle	0	0.12	0.27	0.04
		6	glide (head)	0	0.05	0.07	0.14
		7	glide (head)	0.01	0	0.03	0
	3	8	riffle-glide	1.03	0.04	0.09	0.06
	4	9	riffle-glide (head)	0	0	0.03	0
		10	pool-glide	0.04	0.02	0	0
	5	11	pool-riffle	0.15	0	0	0
<u>Bulkley Summary</u>							
	Reach 1, 2		glide flats	0	0	0	0
			glide heads	0.003	0.018	0.037	0.063
			riffles	0.007	0.133	0.133	0.037
			pool heads	assume = glide heads			
			pool flats	assume = glide flats			
	Reach 3		glide flats	0	0	0	0
			riffle-glide	1.03	0.04	0.09	0.06
			glide heads	assume = riffle glide			
			pool heads	assume = riffle glide			
			pool flats	assume = glide flats			
	Reach 4, 5		glide flats	0	0	0	0
			glide heads	0.02	0.01	0.015	0
			riffle	0.075	0	0.015	0
			pool heads	assume = glide heads			
			pool flats	assume = glide flats			
<u>Buck</u>	2	1	glide	0.13	0.07	0.01	0
	3	2	riffle glide	0.47	0.21	0	0.13
	5	3	riffle glide	0.63	0.04	0	0
		4	riffle glide	0.18	0.55	0	0
		5	riffle glide	0.09	0.36	0	0
		6	riffle glide	0.18	0.15	0	0
Buck Summary			to 2nd bridge (Site 4)	0.35	0.22	0.005	0.065
			above 2nd bridge	0.14	0.26	-	-
<u>Dungate</u>	1	1	riffle-glide-riffle	1.13	0.27	0	0.15
<u>McQuarrie</u>	2	1	riffle	1.89	0.60	0.10	0
		2	pool-riffle	0.63	0.51	0	0
McQuarrie Summary			riffle	1.26	0.56	0.10	0
			glide	assume = riffle			
			pool	0.20	0.56	0.10	0
			- coho present to lower Reach 2 only				

(Cont'd.)

STREAM	REACH/SITE		HABITAT	F I S H D E N S I T Y			
				Rainbow Trout		Coho	Chinook
				0+	Total Parr		
<u>Byman</u>	1	1	riffle-glide-riffle	0.18	0.27	0.05	0
<u>Richfield</u> (above falls)	1	1	riffle-glide	0.96	0.23	0.20	0
	2	2	riffle-glide	0	0.33	0	0
	3	3	riffle	0.21	0.16		
Richfield Summary (below falls)			mean - coho in Reach 1 only	0.48	0.28	0.20	0
<u>Crow</u>	1	1	riffle-pool-glide	0.08	0.47	0	0
<u>Maxan</u>	1	1	riffle-glide	0.31	0.195	0	0

APPENDIX 7 Derivation of standing crop estimates for chinook
and coho salmon and rainbow trout in the Upper
Bulkley watershed based on habitat area and fish
population - habitat relationships.

Mainstem Bulkley

STREAM	REACH	HABITAT	AREA (M ²)	CHINOOK DENSITY	NO. FISH	COHO DENSITY	NO. FISH		RAINBOW DENSITY		NO. FISH	
							0+	≥1+	0+	≥1+	0+	≥1+
Bulkley	1	pool	50,000 (35%)	-	-	-	-	-	-	-	-	-
		glide	80,925 (56%)	-	-	-	-	-	-	-	-	-
		riffle	12,900 (9%)	.037	477	.133	.007	.133	.007	.133	90	1,716
		head p/g	6,500 (5%)	.063	410	.037	.003	.018	.003	.018	20	117
		flat p/g	124,380 (86%)	0	0	0	0	0	0	0	0	0
					887						110	1,833
2		pool	223,479 (64%)	-	-	-	-	-	-	-	-	-
		glide	105,052 (30%)	-	-	-	-	-	-	-	-	-
		riffle	19,100 (6%)	.037	707	.133	.007	.133	.007	.133	134	2,540
		head p/g	10,431 (3%)	.063	657	.037	.003	.018	.003	.018	31	188
		flat p/g	316,424 (91%)	0	0	0	0	0	0	0	0	0
					1,347						165	2,728
3		pool	11,520 (15%)	-	-	-	-	-	-	-	-	-
		glide	40,310 (53%)	-	-	-	-	-	-	-	-	-
		riffle	23,846 (32%)	.06	1,431	.09	1.03	.04	1.03	.04	24,561	954
		head p/g	7,567 (10%)	.06	454	.09	1.03	.04	1.03	.04	7,794	302
		flat p/g	68,108 (58%)	0	0	0	0	0	0	0	0	0
					1,885						32,355	1,256
4		pool	31,957 (37%)	-	-	-	-	-	-	-	-	-
		glide	54,189 (62%)	-	-	-	-	-	-	-	-	-
		riffle	907 (1%)	0	0	.015	.075	0	.075	0	68	0
		head p/g	907 (1%)	0	0	.015	.02	.01	.02	.01	181	91
		flat p/g	85,312 (98%)	0	0	0	0	0	0	0	0	0
											249	91
5		pool	7,691 (22%)	-	-	-	-	-	-	-	-	-
		glide	23,940 (70%)	-	-	-	-	-	-	-	-	-
		riffle	2,584 (8%)	0	0	0	.075	0	.075	0	194	0
		head p/g	2,584 (8%)	0	0	0	.02	.01	.02	.01	52	26
		flat p/g	28,728 (84%)	0	0	0	0	0	0	0	0	0
											246	26
Total Bulkley mainstem					4,136	7,737					33,125	5,934

Tributaries

STREAM	REACH	HABITAT	AREA (M ²)	RAINBOW DENSITY		NO. FISH		COHO DENSITY	NO. FISH	CHINOOK DENSITY	NO. FISH
				0+	≥1+	0+	≥1+				
Buck	1	all	23,600	0.35	0.22	8,260	5,190	.005	118	.065	1,534
	2	all	23,800	0.35	0.22	8,330	5,240	.005	119	.065	1,549
	3	all	35,900	0.35	0.22	12,570	7,900	.005	179	.065	2,333
	4	all	21,600	0.35	0.22	7,560	4,750	0	-	0	-
	5	to 2nd bridge	89,500	0.35	0.22	31,330	19,690	0	-	0	-
	5	to falls	94,200	0.14	0.26	13,190	24,490	0	-	0	-
Buck Total							81,240 67,270		416		5,416
Dungate	1	all	7,640	1.13	0.27	8,630	2,060	0	-	.15	1,119
McQuarrie	1	all	3,600	1.07	0.56	3,850	2,010	.10	360		
	2	all	15,000	1.07	0.56	16,050	8,400	.10 (lower 1.5 km)	150		
	3	all	2,950	1.07	0.56	3,160	1,650	0	-		
	McQuarrie Total								510		
Byman	1	all	8,400	0.18	0.27	1,510	2,270	.05 (lower 4.2 km)	210		
Richfield	1	all	14,900	0.48	0.28	7,150	4,170	.20	2,980		
	2	all	27,600	0.48	0.28	13,250	7,730	0	0		
Richfield Total							20,400 11,900		2,980		
Total Tributaries											
Total Bulkley System (excluding tribs. above Topley)							134,840 95,550		4,116		6,535
							167,965 101,484		11,853		10,671

APPENDIX 8 Summary of standing crop estimates, population structure and projected smolt yield and adult escapement of chinook and coho salmon and steelhead trout in the Upper Bulkley watershed.

1. Steelhead

a) Standing Crop (calculated from Appendix 7 and estimates of distribution and resident/steelhead mix, see Table 4)

	0+	1+	2+	3+	Σ
n	92,100	37,720	9,230	1,100	-
mean length (mm)	46.4	85.3	121.4	148	-
mean weight (g)	1.06	6.61	19.05	34.52	-
total biomass (kg)	97.6	249.3	175.7	37.9	560.5

b) Smolt Yield and Adult Escapement Estimates

STANDING CROP	SMOLT YIELD MODEL USED	SMOLT YIELD	ADULT ESCAPEMENT	
560.5 kg	10 smolts/kg late summer biomass	5,600	420 ¹	210 ²
92,100 fry	15% fry to 1+ parr, 30+ 1+ parr to smolt	4,145	310	155
37,720 1+ parr	30% 1+ parr to smolt	11,320	850	425
48,050 total parr	35% parr to smolt	16,820	1,260	630

¹ Adult escapement at 15% smolt to adult survival and 1:1 catch to escapement ratio.

² Adult escapement at 15% smolt to adult survival and 3:1 catch to escapement ratio.

2. Coho and Chinook

a) Standing Crop

	COHO	CHINOOK
n	11,853	10,671
mean length (mm)	63.9	69.4
mean weight (g)	3.13	3.67
total biomass (kg)	37.1	39.2

b) Smolt Yield and Adult Escapement Estimates

STANDING CROP	SMOLT YIELD MODEL USED	SMOLT YIELD	ADULT ESCAPEMENT ¹
<u>Coho</u>			
37.1 kg	100 smolts/kg late summer biomass	3,710	140
11,853 fry	35% survival to smolt	4,150	156
<u>Chinook</u>			
39.2 kg	100 smolts/kg biomass	3,920	147
10,671 fry	35% survival to smolt	3,730	140

¹ Adult escapement at 15% smolt to adult survival and 3:1 catch to escapement ratio.

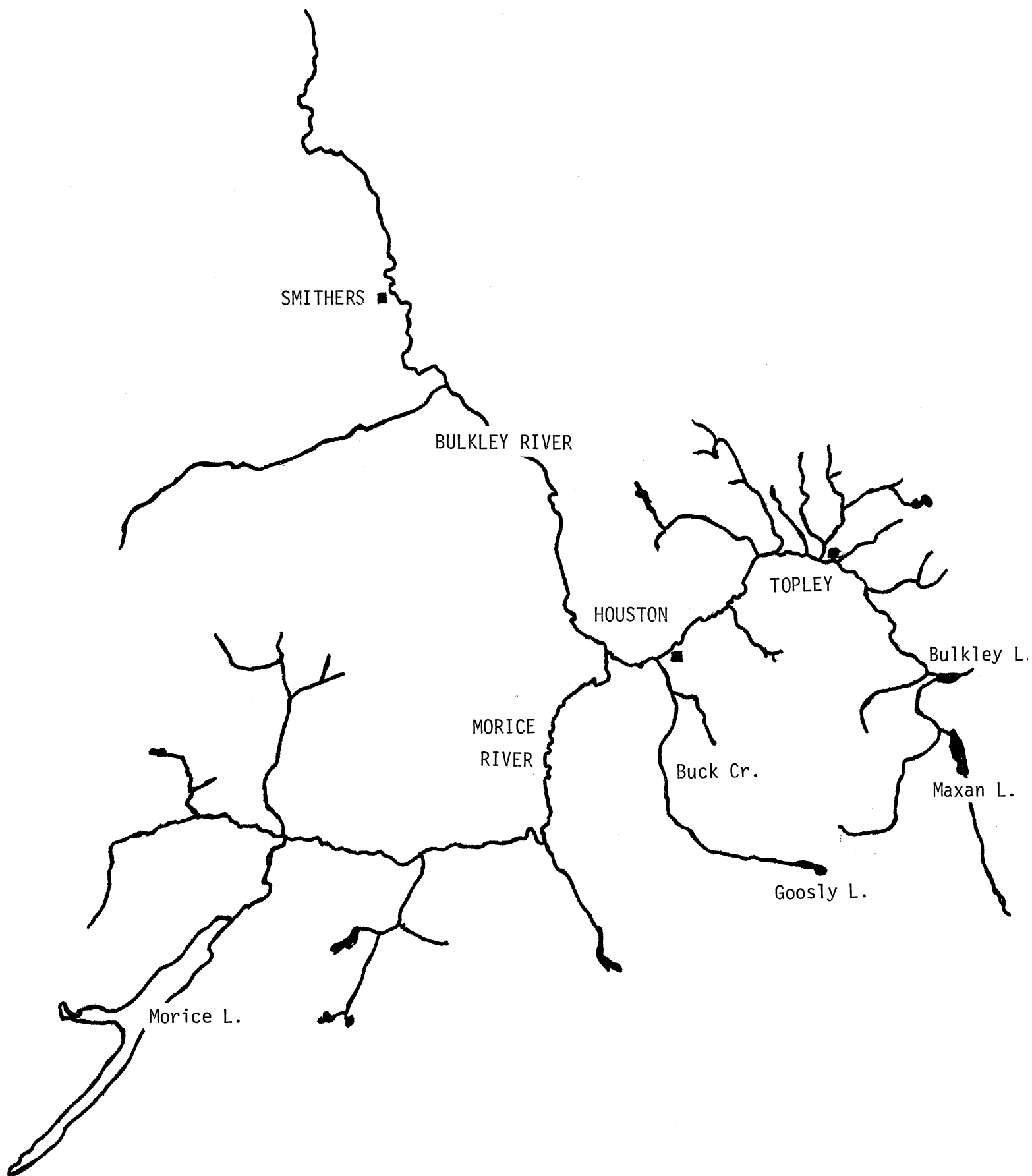


FIGURE 1. The Bulkley River watershed upstream of Smithers, B. C. Scale 1:600,000.

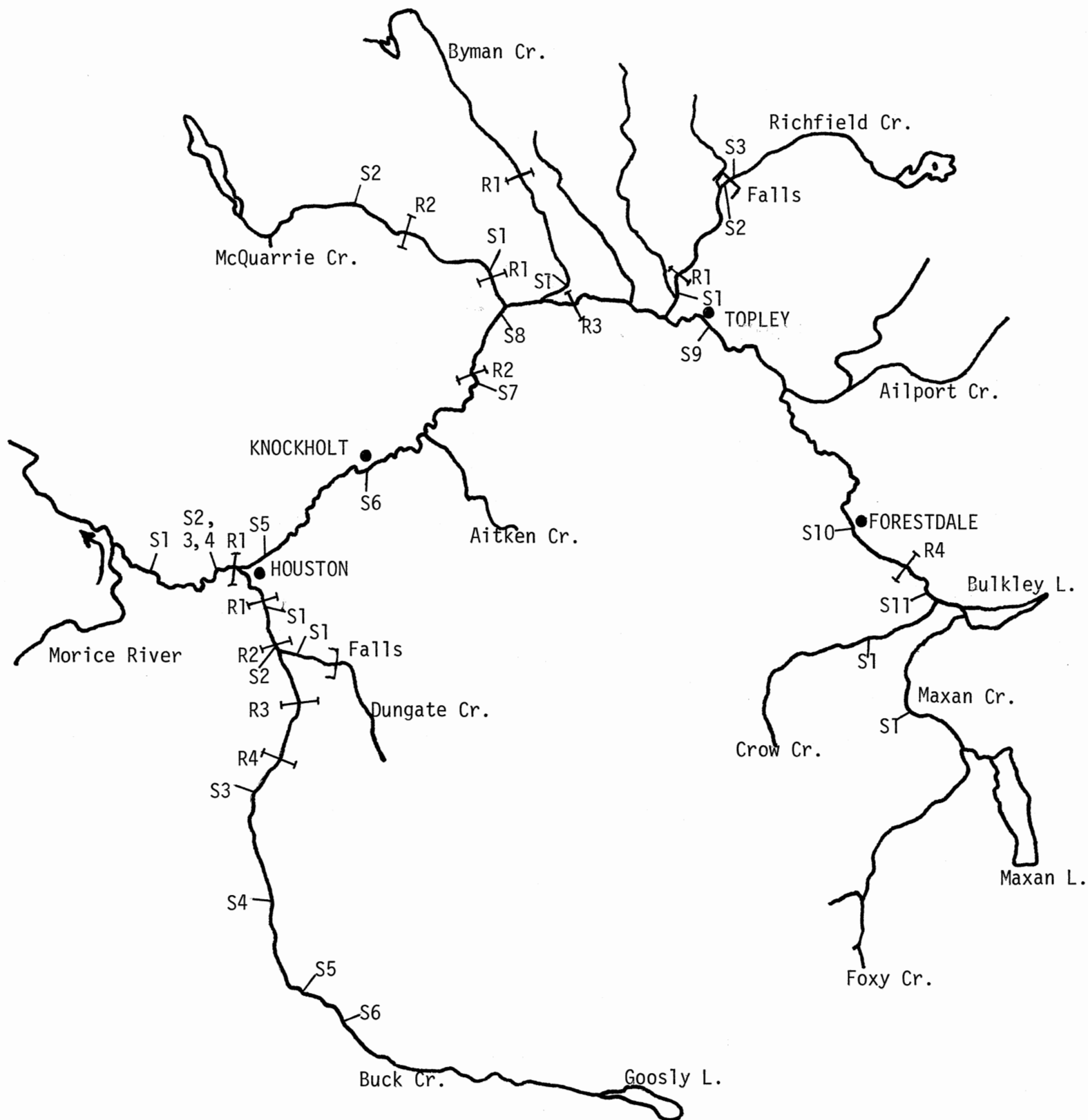


FIGURE 2. The Upper Bulkley River system, indicating reach breaks (R1) and sample sites (S1).