

**BULL TROUT POPULATIONS  
OF THE NORTH THOMPSON RIVER BASIN, BRITISH COLUMBIA:  
INITIAL ASSESSMENT OF A BIOLOGICAL WILDERNESS**

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## INTRODUCTION

The "Dolly Varden" of the North Thompson River watershed are technically not that species at all, but rather are bull trout (*Salvelinus confluentus*). Bull trout have been established as a species distinct from the Dolly Varden (*Salvelinus malma*), with which they had formerly been lumped together (Cavender, 1978). The American Fisheries Society accepted this distinction in 1980 (Pratt, 1992). Bull trout are primarily an inland, non-anadromous char of the Pacific Northwest and Intermountain West of the United States and Canada (Pratt, 1992).

The biology and status of bull trout populations have not been studied extensively. Interest has increased with the growing awareness of the fact that bull trout populations are experiencing declines or are threatened over much of their range, especially south of the Canadian border. Bull trout are currently listed as a candidate species under the United States Federal Endangered Species Act (Ratliff and Howell, 1992), and have been classified as a 'species of special concern' in British Columbia by the American Fisheries Society (Williams et. al., 1989). Gordon Haas of the University of British Columbia (pers. comm.) agrees that some populations in British Columbia are threatened, but feels that certainly not all are. Bull trout are vulnerable by nature. Primary reasons for this are their high susceptibility to angling and their requirements for relatively pristine habitat (Ratliff and Howell, 1992).

Little knowledge of bull trout biology and population status exists for the North Thompson basin. Many anglers and residents have expressed the opinion that bull trout numbers in the North Thompson watershed are declining. The province's Fisheries Branch and the Habitat Conservation Fund responded by commissioning an initial assessment of North Thompson River bull trout. This investigation was designed to gather information about:

- i) present populations of bull trout in the Barriere, Clearwater, Mud, Albreda, and Upper North Thompson Rivers.

- ii) baseline biological information: age, growth, life history, and genetic variability.
- iii) quantity and quality of available spawning and rearing habitat.

Good biological information is required to design an effective fisheries management plan for this complex system, and also to ensure that bull trout habitat is protected from human activities. Any potential enhancement schemes will also require watershed-specific knowledge of bull trout biology and habitat utilization.

### STUDY AREA DESCRIPTION

See Map 1, page 5, of the study location.

The North Thompson River arises in the Cariboo Mountains of British Columbia. The river flows south for 300 km, and meets the South Thompson River at Kamloops to form the Thompson River. The drainage area is approximately 13,200 km<sup>2</sup>, and major tributaries include the Albreda, Mud, Blue, Raft, Clearwater, and Barriere Rivers.

The Barriere, Clearwater, Mud, Albreda, and upper reaches of the North Thompson Rivers are tributaries that were thought to spawn and/or rear bull trout. Recruitment of bull trout to the North Thompson sport fishery is likely dependent on production by these tributaries.

Forest cover is Interior Wet-Belt over much of the watershed. In the lower reaches near Kamloops however, the climate is drier and forest cover is of the ponderosa pine/douglas fir zone.

The upper North Thompson and the northern tributaries of Albreda, Mud and Clearwater Rivers drain higher elevations in the Monashee and Cariboo Mountains and receive glacial runoff inputs. Of these the Clearwater is lake-fed and therefore clear. The Barriere River is a lake-fed stream originating at lower elevations on the Shuswap Highland.

Mean annual flow of the North Thompson River is approximately 431 m<sup>3</sup>/s (Water Survey of Canada, 1980). Peak flow in the mainstem occurs in late spring - early summer, and low flows in late fall and winter.

The Clearwater River is within Wells Gray Park and the habitat is relatively pristine. Forest harvesting has occurred on most other major tributaries to the North Thompson, extensively on some. The upper Adams River basin, tributary to the South Thompson River, was also sampled. It receives glacial run-off, and extensive clearcutting has impacted the watershed.

## **MATERIALS AND METHODS**

The goals of the study were to identify populations, locate spawning and rearing areas, and to sample fish to obtain biological information. Background information was primarily from two sources; angler reports and Fisheries Branch staff. No systematic investigation of bull trout distribution, life history patterns, or spawning and rearing areas has taken place in the North Thompson watershed. Because of this the study design was very loose as the field season began. It was an attempt to enact broad coverage in areas bull trout had been reported from, so that rearing/spawning streams could be identified and focused on for the remainder of the season. Several streams were dropped from the investigation because they showed no evidence of being used by bull trout for rearing.

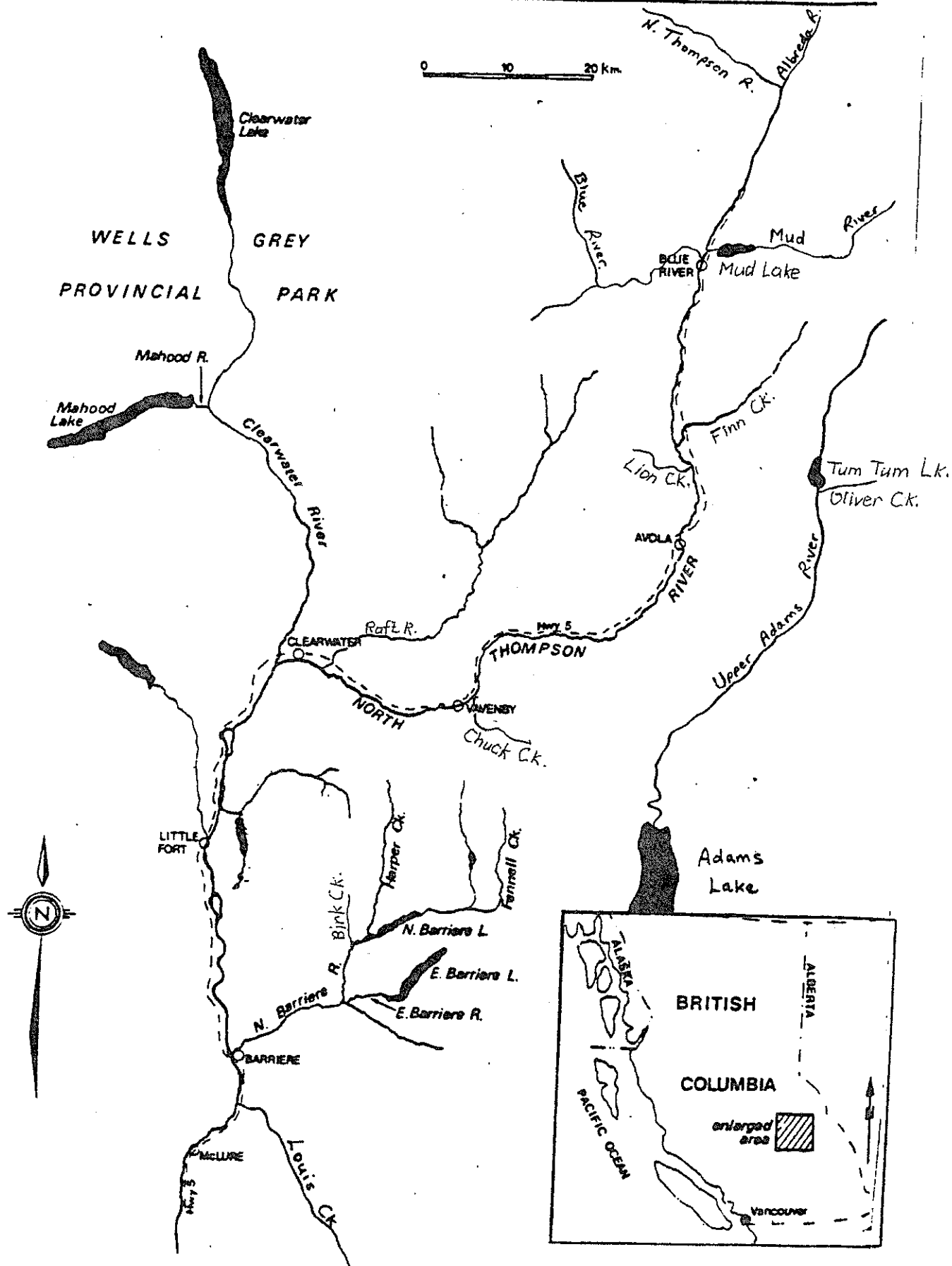
We were unable to begin the field season until the second week of August, 1992, due to funding timing and other commitments.

### **Juvenile rearing**

All streams that were initially included in the investigation were sampled for presence/absence of juvenile and young-of-the-year (0+, fry) bull trout. Young-of-the-year and juveniles were captured using a Smith-Root model 15A gas-powered electroshocker. The high power of this unit was important in the low-conductivity, glacial water of the upper watershed. In each stream being assessed, several sites were chosen from different locations unless bull trout fry were found at the first site. Sites were chosen that included usable bull trout fry habitat; unembedded cobble substrate with low water velocities, primarily, and secondarily low-gradient side-channels with instream cover (Oliver, 1979; Pratt, 1985). The reason for the emphasis on fry habitat was our assumption that presence of young-of-the-year implied spawning in the stream.

MAP 1

# LOCATION MAP OF STUDY STREAMS IN THE NORTH THOMPSON REGION OF B.C.



Streams that were assessed for the presence of juvenile bull trout were: Barriere River tributaries Harper Creek, Birk Creek, Vermilion Creek, and Fennel Creek; Raft River near Clearwater; Chuck Creek near Vavenby; Finn and Lion Creeks near Avola; Blue River; Mud River; Albreda River and tributaries Dominion Creek, Allan Creek, and Clemina Creek; the upper North Thompson River mainstem; and upper Adams river tributary Oliver Creek.

### **Adult and sub-adult populations**

Methods chosen for the investigation of older size classes were site specific due to the different characteristics of each stream, and included:

i) **Netting**

1 1/2" (3.75 cm) monofilament gillnets were used as tangle nets wherever suitable. 'Once-only' sites were the North Thompson mainstem near Chuck Creek and at the mouth of the Blue River. 'Index' sites were the inlet and outlet of Mud Lake from August 22 to October 15, the upper North Thompson River below the Albreda confluence (October 1 - 15), and the Albreda River at the first highway bridge upstream of the North Thompson (October 1 - 15). As well, tangle nets were set at the inlet and outlet of Tum Tum Lake, on the upper Adams River, on October 20/21.

In lakes tangle nets were set along the eight-foot contour (the depth of the net), near or in the inlet and outlet streams. Net sites chosen in rivers were in less than eight feet of water, generally on an eddy-line beside the main flow of current.

Most bull trout captured in the tangle nets were alive when the net was checked. If not killed for age analysis, fish were tagged with orange Floy spaghetti tags (see Appendix 2), measured, scale sampled, and released. Smaller bull trout (especially 20 - 25 cm fish) were more likely to be gilled and killed, as were Rocky Mountain whitefish (*Prosopium williamsoni*).

ii) Stream walks

Streams that were low and clear were surveyed on foot for adult and sub-adult fish. Suitable streams were: Barriere River tributaries Birk Creek (Aug. 27 - Sept. 9) and Harper Creek (Aug. 21 - 31, lower 5 km; Sept. 9 - Sept. 21, upper river from km 12 - km 16 of the Forest Service Road); Raft River (once only); Chuck Creek (Aug. 11 - Sept. 1); Finn Creek (Aug. 10 - Oct. 6); Lion Creek (Aug. 10 - Oct. 19); Albreda River and tributaries Dominion Creek and Clemina Creek (Sept. 10 - Oct. 16). All sightings were recorded.

iii) Snorkel surveys

Initially we planned to use this technique extensively throughout the watershed, and it was to be the primary means of locating and enumerating spawners. Glacial flows discolouring the upper North Thompson, Albreda, Mud, and upper Adams Rivers however, made snorkelling impossible. The Albreda was snorkelled once in the midst of a cold spell in September, but visibility was still not adequate. The North Barriere River was snorkelled on August 31, for much of its length below North Barriere Lake, as was the lower Barriere mainstem during peak Chinook salmon spawning on September 11.

iv) Angling

Bull trout are known to be highly susceptible to angling, even on spawning migrations (Fraleay, 1985). Typically we used salmon roe bait and heavy pyramid weights, which held the bait stationary on the bottom. Efficiency of the technique seemed relatively high for sub-adult fish. One 35 cm bull trout was caught twice within fifteen minutes!

Angling was a supplemental technique on stream walks, used to probe deep pools which could not be seen into. Also, the North Thompson mainstem was sampled on an infrequent basis, but only immature fish were ever captured. Prior to October 1 angling was the technique used to assess the Albreda and upper North Thompson Rivers for adults.

Hooks were barbless, and fish were released after being floy-tagged, photographed, and scale sampled.

### **Age and growth**

Otoliths were collected from 36 bull trout during the study. Twenty-five were from the upper North Thompson basin, and represented a wide size distribution. Juveniles and young-of-the-year were collected from Dominion Creek and the Albreda River. Sub-adults were collected from Mud Lake. Adults were caught in Mud Lake and the North Thompson River at the Albreda confluence. Otoliths were collected from one large, spawned-out fish caught in Harper Creek in the Barriere watershed. Otoliths were also collected from nine adult and sub-adult bull trout from Tum Tum Lake in the upper Adams River basin.

Otoliths were stored in small vials of glycerin. J.S. DeGisi at the Fisheries Center, University of British Columbia, prepared and aged all 36 otoliths. The methodology DeGisi used for preparing most otoliths is described by Hall (1991). The largest otoliths required considerably more preparation.

Although scale samples were taken from virtually all fish captured, the only scales analyzed to date were those of juvenile fish from which otoliths were taken. The accuracy of scale reading results is high for younger age classes, and this effort was made to confirm otolith aging results. A look at scales from older fish suggested that ages of fish older than age five would be consistently underestimated.

### **Genetic Variation**

To obtain inferences about relatedness of North Thompson bull trout, blood and liver samples were collected from bull trout from the Barriere, Mud, Albreda, upper North Thompson, and upper Adams River basins. They were delivered to Dr. J.D. McPhail of the University of British Columbia, who intends to conduct electrophoretic analysis on the tissue samples at some future time.

## RESULTS

Sub-adult and adult specimens from various sampling locations were shown to Gordon Haas of the University of British Columbia, who positively identified them as bull trout (see Haas and McPhaill, 1991).

### Juvenile rearing

Streams sampled for presence/absence of juveniles were: Barriere River tributaries Harper Creek, Birk Creek, Vermillion Creek, and Fennel Creek; Raft River near Clearwater; Chuck Creek near Vavenby; Finn and Lion Creeks near Avola; Blue River; Mud River; Albreda River and tributaries Dominion Creek; Allan Creek; and Clemina Creek; the upper North Thompson River mainstem; and upper Adams River tributary Oliver Creek.

Bull trout young-of-the year were found in Harper Creek, Chuck Creek, Finn Creek, Dominion Creek, and Oliver Creek. Relatively concentrated fry rearing areas were:

- i) Harper Creek above km 12 of the Forest Service road. Bull trout were the only salmonid fry or juveniles captured.
- ii) The bottom 1 km of Chuck Creek. Relatively high densities of both bull trout and rainbow trout fry were present.
- iii) Dominion Creek below the highway 5 crossing. Bull trout were the only salmonid fry captured (see Figures 1, 2, & 3, Appendix 1).
- iv) The upper reaches of Oliver Creek. Bull trout were the only salmonid fry captured. These creeks are assumed to be spawning streams.

Small juvenile bull trout were captured in Birk Creek, Allan Creek, and Clemina Creek, although young-of-the-year were not found. Only lower reaches of these streams were sampled.

Larger juvenile bull trout 20 - 30 cm were captured in the Albreda River and Mud River. Smaller juveniles were not found in these higher-order streams.

### **Sub-adult rearing**

Sub-adult bull trout, sexually immature fish of approximately 30 - 50 cm, were caught throughout the period of the study and appear to be widely distributed. Sub-adults were captured in the mainstem North Thompson River near the Finn Creek confluence, at the mouth of the Blue River (Figure 4, Appendix 1), and below the mouth of the Albreda River. They were also observed in Finn Creek at the peak of chinook salmon spawning, and were captured in Mud Lake (Figure 5, Appendix 1), Mud River, the Albreda River below the Dominion Creek confluence, and Tum Tum Lake on the upper Adams River drainage. Mud Lake was sampled bi-weekly from August 22 to October 15, and catches were exclusively sexually immature fish 26 - 56 cm through late September. Large, kelt bull trout were part of the catch in October. Tum Tum Lake was sampled only once, on October 20/21, and both adult and sub-adult bull trout were abundant.

### **Spawning**

Locating spawning adults was a goal of this investigation, though few were found. Mainstem North Thompson angling effort from August 10 to September 17, and netting from October 1 to October 16 did not capture any bull trout maturing to spawn. The only adult fish captured in these efforts were kelts after October 1.

Two solitary bull trout in spawning condition were observed in Harper Creek at approximately km 12 of the road, one on September 9, the other on September 21. The latter was spawned out and drying (Figure 8, Appendix 1). These upper reaches were not investigated before September 9, when information about the spawning area of the creek was first heard.

One large adult bull trout was observed in Finn Creek on August 30, just below the highway 5 crossing. The fish was located well upstream of any chinook salmon spawning that was still occurring, and was approximately 65 - 70 cm long, so was assumed to be a migrating, mature adult. The fish did not appear to be in spawning coloration, though Oliver (1979) and McPhaill and Murray (1979) observed that maturing fish may still be green when first entering spawning streams. No other large adult fish were seen in Finn Creek between August 10 and October 8.

Two paired bull trout adults were observed in the Albreda River near the Dominion Creek confluence on October 8. Poor visibility in the Albreda throughout the field season hampered efforts at visual observation. The lower reaches of Dominion and Clemina Creeks were walked bi-weekly from August 24 to October 16, and no bull trout adults or redds were seen.

Bull trout kelts were captured in the upper North Thompson River at the Albreda confluence on October 2 (Figure 7, Appendix 1) and October 8, in Mud Lake on October 15 (Figure 6, Appendix 1), and in Tum Tum Lake on October 20/21.

### **Age and Growth**

Twenty-six bull trout from the North Thompson basin and ten from the upper Adams River basin were aged from their otoliths. Aging results are presented in Table 1.

Table 1. Estimated age of Bull trout (*Salvelinus confluentus*) from otolith analysis.

Location	Fish length (mm)	Age	Remarks
Mud Lk.	450	10+	
	280	4+	
	250	7+	
	520	10+	
	320	6+	
	300	6+	
	450	8+	
	500	14+	
	780	20+	Female Kelt
North Thompson R. (Albreda confluence)	750	24+	Male Kelt
	530	10+	Female Kelt
Albreda R.	200	5+	
Dominion Ck. (Albreda R. tributary)	56	0+	
	59	0+	
	61	0+	
	51	0+	
	57	0+	
	87	1+	
	109	1+	
	100	1+	
	87	1+	
	99	1+	
	185	3+	
	155	2+	
	148	2+	
Harper Ck.	730	15+	Spawned male
Tum Tum Lk. (Adams R. watershed)	540	11+	Male Kelt
	540	8+	Female Kelt
	360	7+	
	460	8+	Male Kelt
	480	10+	Female Kelt
	600	8+	
	400	8+	
	310	5+	
	320	5+	
	320	6+	

### Stomach Contents

Fish killed for their otoliths were sampled for stomach contents.

Dominion Creek juvenile bull trout age 0+ through 3+ had only insects in their stomach. A 200 mm Albreda juvenile also had insects in its stomach. Sub-adults 250 mm to 320 mm in Mud Lake had been eating fish primarily and in one case insects also. All bull trout sampled larger than this had been eating fish exclusively. Prey fish species identified were Rocky Mountain whitefish (*Prosopium williamsoni*) and sculpins (*Cottus sp.*). All kelt bull trout from the upper North Thompson drainage had empty stomachs.

Sexually immature bull trout 310 - 600 mm captured in Tum Tum Lake had been feeding on fish only. Some, but not all, of the kelts captured in Tum Tum Lake had begun to feed on fish. Rocky Mountain whitefish was the prey species identified.

## DISCUSSION

### Life History

The three life history patterns identified for interior populations of bull trout are resident, fluvial (migration between spawning tributary and a larger river), and adfluvial (migration between spawning tributary and a lake) (Pratt, 1992). Both fluvial and adfluvial life history patterns have been identified for North Thompson basin bull trout. The majority of bull trout biological literature describes adfluvial populations (Pratt, 1992).

### Rearing habitat

Bull trout are a cold water species. McPhaill and Murray (1979) found that temperatures of 2 - 4°C resulted in highest egg survival. Cold water temperatures are also important for juvenile rearing. Disease problems were reported from the Kootenay trout hatchery when bull trout juveniles were reared at temperatures greater than 12°C (Brown, 1985), and fry and juvenile growth rates may be higher at low temperatures as well (McPhaill and Murray, 1979).

Unlike other salmonids, after hatching bull trout remain in substrate interstices for up to three weeks before filling their swim bladders with air. This is possibly due to the importance of maintaining position in the high gradient streams bull trout often rear in (McPhaill and Murray, 1979). Emergence success has been negatively correlated with the proportion of fine substrate at the redd location (Weaver and White, 1985, as cited in Pratt, 1992).

After emerging, juvenile bull trout remain closely associated with the stream bottom. They are found within the streambed interstices or immediately above (Oliver, 1979; Pratt, 1985; R.P. Griffiths, pers. comm.). The literature reports that habitat includes i) unembedded cobble substrate associated with lower water velocities, ii) pockets of slower

water near high velocity, food bearing water, iii) low-velocity side channel areas, and iv) unconsolidated submerged woody debris (Oliver, 1979; Pratt, 1985). North Thompson bull trout fry and juveniles were electroshocked from all of the above habitat types. Young-of-the-year North Thompson bull trout selected slower, shallower water than did older juveniles.

Areas of groundwater infiltration are preferentially utilized for spawning and rearing, due to their moderating effect on temperatures (Allan, 1980; Pratt, 1985; Shepard, 1985; Oliver, pers. comm.). No such areas were identified during our study, however.

Juveniles of migratory bull trout populations typically remain in spawning streams for 1 - 3 years before migrating to lake or larger stream (Oliver, 1979; Pratt, 1985). The ages of juvenile bull trout captured in Dominion Creek were from 0+ to 3+, so this pattern is probably valid for the North Thompson as well.

Older age classes rear in higher-order streams or lakes. Tangle net catches suggest that Mud Lake and Tum Tum Lake may be the most important sub-adult/adult rearing areas for the upper North Thompson and upper Adams basins, respectively. Sub-adult bull trout appear to be distributed throughout the upper North Thompson River, and were captured in the Albreda also. Bull trout from the southern portion of the watershed utilize the mainstem of the North Thompson River, lakes of the Barriere River system, and probably Kamloops Lake also.

Although adfluvial and fluvial life histories have been identified for the North Thompson area, the life histories of individual fish may be a combination of both strategies, with varying proportions of either. Migrations of the closely related Dolly Varden and Arctic char are complex and variable, even within a single basin, and are affected by such factors as food availability, overwintering requirements, and approaching maturity (Armstrong, 1984; Gyselman, 1984).

### Food Habits

Bull trout of less than approximately 110 mm have been found to feed exclusively on insects. Above this size fish may be included in the diet, with piscivory increasing with increasing bull trout size (Shepard et. al., 1984, as cited in Pratt, 1992). In the upper North Thompson drainage, bull trout of 200 mm or less sampled for stomach contents contained only insects. Bull trout of 250 mm or more had been feeding predominantly on fish. Whitefish appear to be the primary prey species, as indicated by stomach content analysis of adult and sub-adult bull trout from Mud Lake and Tum Tum Lake. A long time Valemount resident informed us that at one time bull trout to 36 inches (925 mm) followed whitefish schools up the upper North Thompson River in spring, and could be caught approximately 15 miles (24 km) above the Albreda confluence (and incidentally, that neither the large bull trout nor the large whitefish schools were to be found there any longer). Sub-adult and adult bull trout in Alberta and Montana have also been associated with whitefish concentrations (Allan, 1980; Shepard et. al., 1984, as cited in Pratt, 1992). Salmon fry and smolt out-migrations in the spring are likely targeted by North Thompson bull trout as well.

### Age and Growth

Age and growth information from the Wigwam River, British Columbia, and Flathead Lake, Montana, are presented below (Table 2).

Table 2. Bull trout lengths-at-age: Flathead Lake and Wigwam River

Drainage (source)	Total length (mm) at annulus								
	I	II	III	IV	V	VI	VII	VIII	IX
Flathead Lake (Fraley and Shepard, 1988)*	68	129	204	291	384	472	566	658	731
Wigwam River (Oliver, 1979)	64	114	176	385	476	557	668	-	-

\* as cited in Goetz, (1989)

Contrast this information with results of the North Thompson study (Table 3):

Table 3. Bull trout length at age: upper North Thompson and upper Adams drainages

Basin	Fork length at age (n)							
	0+	1+	2+	3+	4+	5+	6+	7+
Upper N. Thompson	57(5)	96(5)	152(2)	185(1)	280(1)	200(1)	310(2)	250(1)
Tum Tum Lake	-	-	-	-	-	315(2)	340(2)	500(2)

Table 3 continued:

Basin	Fork length at age (n)						
	8+	9+	10+	11+	14+	20+	24+
Upper N. Thompson	450(1)	-	485(2)	-	500(1)	780(1)	750(1)
Tum Tum Lake	500(2)	480(1)	-	540(1)	-	-	-

Because of the small data set from our study many age classes are represented by only one fish, and lengths-at-age may seem anomalous.

Growth of upper North Thompson bull trout during their first three years is roughly comparable to that of Wigwam and Flathead basin fish. In the North Thompson area growth is highly variable for individual fish of older age classes, but is obviously much slower than that reported elsewhere. Highly variable growth rates may reflect the high degree of potential variation in individual life histories.

Bull trout from the North Thompson watershed may attain a size which nears the maximum reported for the species. Pratt (1992) states bull trout have been captured to 38 pounds (17 kg). Bull trout of 32 pounds (15 kg) and 27 pounds (12 kg) have been reported from the North Thompson River.

The ages of North Thompson River bull trout may exceed maximums reported elsewhere. Goetz (1989) reports bull trout ages to 12 years in Eastern Washington, and 20 years in Alberta. A 75 cm male kelt captured in the upper North Thompson River was estimated to be 24 years old. The largest fish caught during the study, a 78 cm female kelt, was estimated to be 20 years old.

The upper North Thompson basin is a glacially-fed, relatively sterile drainage, with cold water temperatures, turbid water, and a short growing season the norm. The slow growth of upper watershed bull trout is probably a result of harsh rearing conditions. McCart (1985) notes parallels between bull trout life histories and those of far northern fish species such as lake trout, Arctic char, grayling, whitefish, and ciscoes. These include:

- i) advanced age at maturity
- ii) large size at maturity
- iii) potential for alternate-year spawning
- iv) extensive migrations
- v) separation of juvenile and adult segments of populations

He suggests these characteristics are adaptive in relatively unstable periglacial and northern environments, which the habitat of the upper North Thompson drainage may be comparable to. Only one large fish from the southern portion of the drainage was aged, a 73 cm male spawner from Harper Creek. It was estimated to be 16 years old.

Aging results seem extreme. Nonetheless we have confidence in the data. Joe DeGisi of the University of British Columbia read the otoliths. He has prepared and read thousands of otoliths from brook trout of the Sierra Nevada, which may reach ages of almost 20 years. He found the form of the bull trout and brook trout otoliths to be similar, and did not find evidence of false checking. He felt that the age estimates of the oldest fish are, if anything, conservative.

### Spawning

Bull trout may make spawning migrations of up to 225 km (Goetz, 1989). Migration may begin as early as spring, and the majority of the run typically enters spawning tributaries in August (McPhaill and Murray, 1979; Martin, 1985). Our investigation did not begin until the second week of August. The mainstem of the North Thompson River was assessed

for migrating adults from August 10 to October 15. Assessment in many reaches did not begin until the end of August. No mature bull trout were captured from the mainstem. In light of timing information cited above, this is perhaps not surprising, and inferences about population abundance probably cannot be made from our lack of success.

The earliest arrivals at spawning tributaries may be 'green' fish, not yet displaying spawning colours (McPhaill and Murray, 1979; Oliver, 1979). Gordon Haas of U.B.C. (pers. comm.) has mentioned that bull trout will commonly ascend high into spawning tributaries well before the spawning event. This tendency of bull trout to penetrate high into a spawning tributary was suggested in our study. Bull trout fry were not evenly distributed in Harper and Oliver Creeks. In both systems fry concentrations were in low gradient sections of the upper watersheds, and fry were absent from lower reaches, even in apparently suitable habitat. Allan and Clemina Creeks, on the Albreda drainage, have lower gradient areas above their lower reaches, but which were not sampled because of inaccessibility. Even though no 0+ were found, juvenile bull trout were captured in the lower reaches of Allan and Clemina Creeks. If bull trout are preferentially utilizing upper reaches of tributaries, and fry are localized in spawning areas, as appears to be the case in Harper and Oliver Creeks, Allan and Clemina Creeks must be considered as potential spawning streams. Dominion Creek was established as a bull trout spawning stream during juvenile electrofishing, but adults or redds were not observed during surveys of its lower reaches, even though suitable habitat exists there. A lower gradient, upper reach also exists on Dominion Creek, but it was not assessed.

Shepard (1985) has identified criteria for suitable spawning sites on the Flathead River:

- i) higher order tributaries
- ii) greater amounts of gravel and cobble substrate
- iii) low channel gradient
- iv) areas of overhanging bank cover
- v) maximum stream temperature less than 18°C
- vi) nearby groundwater seepage

McPhaill and Murray (1979) found that in a high gradient stream pockets of loosely compacted gravel and cobble would be utilized for spawning.

Oliver (1979) found migrating bull trout used debris accumulations along stream margins for cover. The two adult, paired bull trout seen in the Albreda River were found in exactly this type of cover, on October 7.

#### Spawning timing

Only inferences about the completion time of spawning activities can be made from our results. Spawning was clearly completed in Harper Creek, in the southern portion of the North Thompson drainage, by September 19. This inference is based on a thorough walk of the upper river on which only one dying, spawned-out fish was seen. An informant who had known the creek in the 1950's stated that bull trout were in the creek above road km 12 from the first of August until mid-September.

In the upper North Thompson drainage kelts were captured on October 2 and October 7, in the North Thompson mainstem at the Albreda confluence, and on October 15 in Mud Lake. A pair however, was sighted in the Albreda on October 7. Spawning activities in the upper North Thompson basin are probably completed by mid-October.

On October 21 bull trout kelts were captured in Tum Tum Lake that appeared to have completed spawning recently.

Spawning timing has been reported elsewhere as early September to mid-October in the Flathead River (Martin, 1985); mid-September to late October in McKenzie Creek (McPhaill and Murray, 1979), and mid-September to late October in the Wigwam River (Oliver, 1979).

Considering the above information, and our spawning completion estimate of mid-October, we suggest early September to mid-October as the likely spawning period for upper North Thompson bull trout.

#### Age and size of maturity

Only one spawner was aged from Harper Creek, a 73 cm male that was 15 years old.

Spawners identified from the upper North Thompson drainage were from 53 - 78 cm in length and 10 - 24 years of age.

Spawners identified from Tum Tum Lake were from 46 - 54 cm in length, and 8 - 11 years of age.

Comparative data is presented in Table 4:

Table 4. Spawner age and size of three bull trout populations

<b>System (source)</b>	<b>Age</b>	<b>Mean Length (range)</b>
Flathead River (Martin, 1985)	mostly 6, 7	610 mm (300-875)
Wigwam River (Oliver, 1979)	4 - 7	518 mm (360-730)
McKenzie Creek (McPhaill and Murray, 1979)	4+-5+	443 mm (290-587)

Both alternate year and annual spawning strategies are known for bull trout (Pratt, 1992). Large (over 50 cm), sexually immature fish of advanced age (to 14 years) were captured in Mud and Tum Tum Lakes, and may be evidence of alternate year spawning. However, no fish the size of mid-October, Mud Lake kelts (up to 78 cm) were captured during regular netting in the Lake from late August through the end of September.

### Population distribution and status

Bull trout are distributed throughout the entirety of the North Thompson River mainstem. The status of bull trout populations in the watershed must be inferred largely from angler reports and cannot be quantified.

#### Lower Watershed

Populations of the lower watershed appear to be depleted. This assessment is based on reports from experienced anglers, who say catches of bull trout are now rare in certain areas they are accustomed to catching them. The bull trout populations of the Clearwater River have declined significantly in the past five years and may now be threatened. The most likely cause of the decline is overfishing. High angling pressure exists on the Clearwater River for chinook salmon and rainbow trout. Bull trout respond aggressively to lures and bait and are highly susceptible. They are prized as trophies and for eating qualities and are often kept.

Habitat degradation has also occurred. Downstream of the town of Clearwater, North Thompson tributaries have been impacted by forest harvesting in their upper reaches, and agriculture and settlement in their lower reaches.

#### Upper Watershed

Bull trout and Rocky Mountain whitefish are the co-dominant salmonid species of the North Thompson basin upstream of Finn and Lion Creeks, major Pacific salmon-producing tributaries near Avola. Anglers and long-term residents of the upper North Thompson basin report population declines noticeable within the past decade, of both bull trout and their prey species, Rocky Mountain whitefish.

In the early 1980's Fisheries Branch staff carried out assessments of:

- i) Albreda River below Dominion Creek confluence on October 14. Numerous adult and immature bull trout were captured (Brian Chan, pers. comm.)

In October, 1992, angling at this location yielded only 2 immature bull trout and a sighting of 2 paired adults.

- ii) Finn Creek during the peak of chinook salmon spawning, in August. Again, numerous sub-adult and large adult bull trout were captured.

At peak chinook spawning in 1992 only four bull trout of 40 - 50 cm were observed in the lower reaches of the creek.

Comparisons of 1992 results with previous Fisheries Branch assessments also suggests decline, although methods employed were not identical.

Overfishing is a probable cause of the decline. Fishing pressure in the upper North Thompson basin is relatively low, but bull trout are vulnerable when they concentrate in locations associated with:

- i) mainstem feeding in the spring
- ii) points of difficult passage on the mainstem North Thompson
- iii) salmon spawning in tributaries, for example Finn and Lion Creeks near Avola
- iv) their own spawning migrations

Aging results suggest slow-growth and late maturity for North Thompson area bull trout, and therefore low recruitment to the trophy size/age classes targeted by anglers. Effort and harvest therefore need not be high to still impact populations.

### Habitat status and distribution

The major human impact on identified bull trout spawning and rearing streams in the North Thompson drainage is forest harvesting. Potential deleterious effects include (from Ratliff and Howell, 1992):

- i) passage problems from slash
- ii) reduced recruitment of large woody debris
- iii) increased runoff, and associated scouring and loss of substrate
- iv) siltation reduces egg and fry survival, and has a secondary effect on food sources
- v) temperature changes

#### Harper Creek

The capability of Harper Creek above road km 12 is probably relatively high for bull trout rearing. The reach is characterized by unembedded cobble substrate, with suitable depths and velocities widely available (Figure 9). Low gradient side channel areas are also present.

Forest harvesting is extensive, though leave strips are in place along the stream. Streamflow was stable, water temperatures cool throughout the period of the study.

#### Chuck Creek

Chuck Creek is a small stream, but contains suitable spawning and rearing habitat over its lowest kilometer. Headwater logging has left the stream "flashy" (local report), and a culvert under Lost Creek Road is poorly designed and may hinder fish passage (Figure 11, Appendix 1).

### Finn Creek

Finn Creek offers near-ideal spawning and rearing substrate with abundant juvenile and adult cover in its lower reaches. Streamflow was stable, temperatures cool over the period of the study, despite the fact of extensive headwater logging. Rearing space however, is dominated by chinook salmon and rainbow trout. Reported barriers above the highway 5 crossing should be investigated, as suitable low gradient habitat exists in the upper watershed (not sampled), and bull trout are highly capable at ascending cascades and falls (J.D. McPhail, G. Haas, pers. comm.).

### Dominion Creek

Useable substrate exists in the lower reaches, and suitable velocities are in pockets along stream margins and in low gradient side channels. Water temperatures are very cold due to glacial inputs. Bank morphology, and the steep gradient of the stream, suggest Dominion Creek is a pretty violent place during peak runoff. Available habitat in Dominion, Clemina, and Allan Creeks appears underutilized. However, lower gradient upper reaches, which may be preferred by bull trout, do exist and were not assessed.

### Oliver Creek

Suitable spawning and rearing habitat was identified on Oliver Creek. Deleterious logging practices were also identified. Massive erosion in an unstable clearcut was observed (Figure 10, Appendix 1), as were thin or non-existent leave strips along the stream bank.

### Management Considerations

Based on age and growth results, we suggest that the sustainable harvest of North Thompson watershed bull trout is low. Recruitment is extremely low to trophy and spawner size classes, and rebuilding depleted stocks would be a long process. That bull

trout populations appear to be declining in the watershed suggests either habitat degradation or that the sustainable harvest of bull trout has been exceeded, or both.

Our intuition generally is that available bull trout rearing space throughout the watershed is underutilized. Habitat degradation may not be the problem. We do not presently recommend habitat 'enhancements' as a means for increasing bull trout populations.

Effective preservation of existing bull trout habitat will involve setting aside riparian leave strips during harvest, and careful consideration, for key bull trout streams, of the stability of flow regimes when determining the rate of harvest in a basin.

The life histories of North Thompson bull trout make them highly vulnerable to over-exploitation. A greater degree of protection than that of existing regulations may be required to salvage a quality fishery and healthy bull trout populations. Potential steps include:

- i) reduction of the bull trout catch quota from the current two per day, over the whole watershed or a portion
- ii) more restrictive size limits, for example a minimum size limit of 45 cm, which would increase recruitment into spawning and trophy size classes

Due to the lack of quantitative information provided by the investigation, we cannot know precisely the status of North Thompson basin bull trout populations. Therefore specific management recommendations are difficult to make.

### **Future study requirements**

More information is required in order to determine the need for regulation changes and to preserve existing bull trout habitat.

More precise knowledge of bull trout distribution within the North Thompson River watershed is required. A watershed-wide survey, by electroshocking, of all potentially suitable streams would identify presence/absence for future reference. The specifics of the sub-basin distribution of bull trout spawning and rearing habitat should also be established for key streams. This information is required for managers to protect habitat from human activities. Habitat distribution knowledge, along with forest harvesting plans obtained from the Ministry of Forests, could identify bull trout habitat at risk. Harvesting guidelines or plan modifications could then be established well in advance of any cutting.

Habitat criteria for bull trout spawning and rearing could be confirmed for this area during such an assessment. This is pre-requisite information for any future habitat enhancement activities.

Abundance and population status of North Thompson bull trout stocks must be investigated in a more quantitative manner. Adult enumeration fences on key streams such as the Albreda River and Harper Creek would supply numerical information, establish migration timing, and supply biological information such as the size and age distribution of spawners. The timing of such an investigation should probably be mid-July to the end of October.

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