ASSESSMENT OF FISHERIES ENHANCEMENT FOR POWELL LAKE, AT POWELL RIVER, B.C.

By

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For

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VICTORIA, B.C.

MAY, 1986

1.0 INTRODUCTION

In 1985, representatives of MacMillan Bloedel Ltd. approached the Powell River Salmon Society with an offer to provide initial funding if the Society would undertake to culture rainbow trout (Salmo gairdneri) for stocking Powell Lake. Accordingly, the Society approached the Lower Mainland Fisheries Section for permission to proceed, and a pilot program of broodstock capture and culture was approved for 1985.

At the same time, regional staff requested input from the Fisheries Improvement Unit (FIU) towards more clearly identifying and quantifying enhancement options and potential for rainbow trout in the Powell Lake system, specifically in the Powell and Daniels rivers, major tributaries to the lake. However, a subsequent review of existing data revealed that very little was known about the Powell Lake fishery or its associated biology. An overview of the entire system was jointly undertaken during summer and early fall 1985 by the regional Fisheries Section[1] and FIU[2], with the assistance of the Conservation Officer Service[3] and the Powell River Salmon Society[4].

2.0 LAKE DESCRIPTION

Powell Lake is a fjord lake with its outlet located at Powell River, B.C. (Fig. 1). In its morphometry and steep surrounding topography, the lake is very similar to the many marine inlets along the B.C. Coast. It is approximately 50 km in length, 12,000 ha in area, and consists of six interconnected basins (Matthews, 1962). The lake is separated from the adjacent Strait of Georgia by a rocky sill 46 m above sea-level. An impassable hydro-electric dam built at the outlet in 1911 raised the lake to its present height of 56 m above sea-level (Williams, et al, 1961).

Maximum depth is near 360 m (Mathews, 1962), and mean depth undoubtedly approaches or exceeds 150 m. The lake is meromictic, in that an upper freshwater layer approximately 100 m deep overlies stagnant "old sea water" that was trapped in the lake some 10,000 years ago (Williams, et al, 1961).

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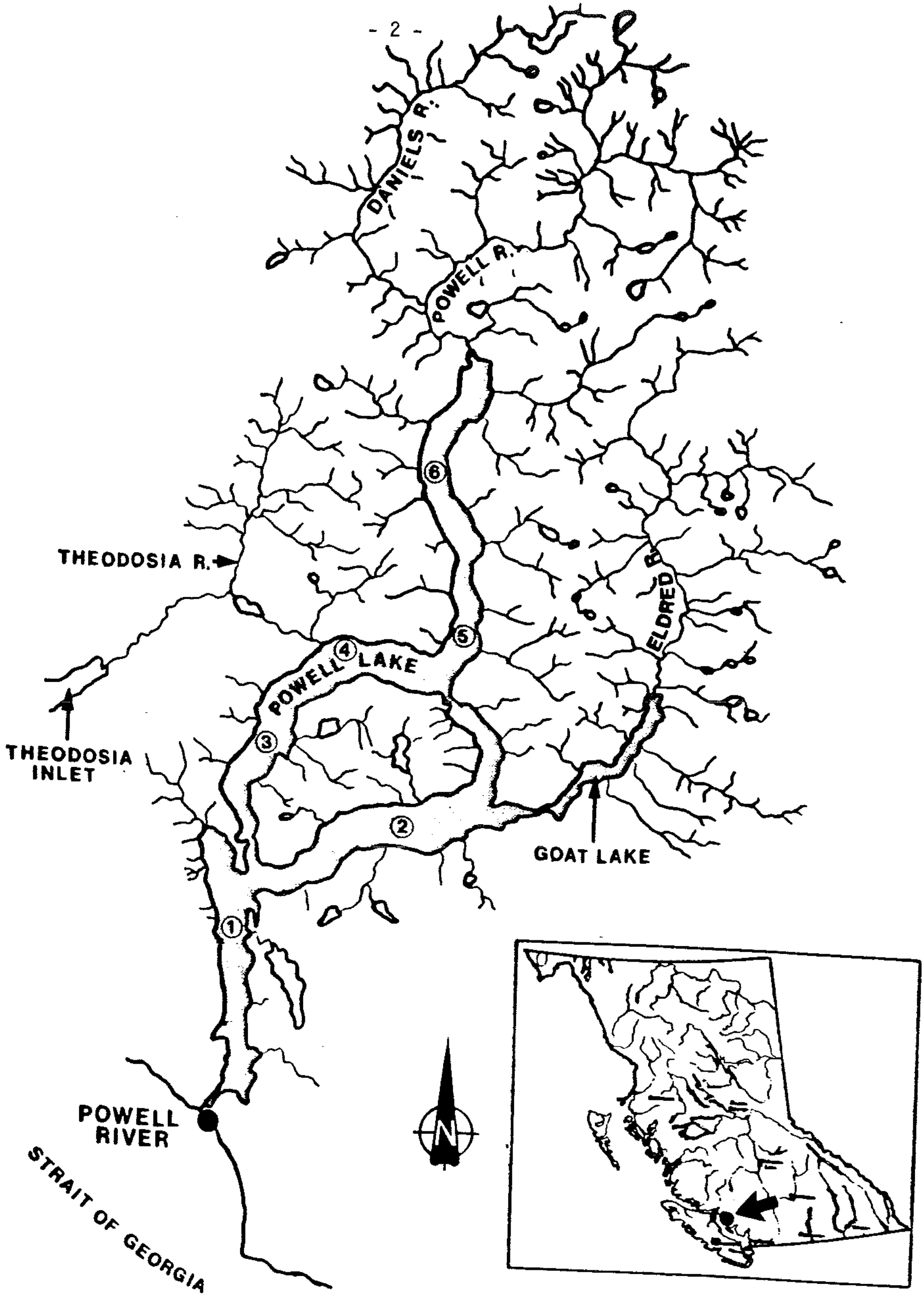

Figure 1. Powell Lake and Associated Drainage (scale 1:250,000)

Although there is some level of mixing at the halocline, Powell Lake may be viewed as a deep, freshwater lake circulating freely above stagnant saline waters trapped below (T. F. Pedersen[5], pers. comm.).

As a result of flooding associated with dam construction, Goat Lake is now essentially part of Powell Lake, connected to it by a navigable channel (Fig. 1). Although considerably smaller (approx. 540 ha), it may nonetheless be considered a "large lake" in itself, and is similar to Powell in its fjord-like characteristics. Unfortunately, no morphometric or scientific data are available for Goat Lake. Consequently, it is unknown how deep the lake is, or if it contains a bottom layer of salt water.

3.0 TRIBUTARY STREAMS AND ACCESSIBILITY/SUITABILITY TO TROUT

There are a great number of major and minor streams tributary to Powell and Goat lakes (Fig. 1). Many (including all major ones) were investigated by boat and, where possible, by road in 1985. Due to the mountainous surroundings (Figs. 2 and 3), the majority of streams that enter the lakes are short and extremely steep (see Appendix I for photographic documentation). Although short, lowermost portions and/or alluvial fans of some may be recruitment and rearing areas for trout, the greatest portion of their streamlengths can be ruled out from a trout production point of view. The same applies to most of the smaller streams tributary to larger ones.

It is acknowledged that with the large number of streams involved, some may have been overlooked during the 1985 overview. However, the most significant streams were investigated, and those with greatest potential for trout production (based on gradient and availability of habitat) are as follows:

1. the Powell River
2. the Daniels River (tributary to Powell River)
3. Jim Brown Creek
4. the Eldred River, and
5. Olsen Creek (Fig. 4)

It should be noted that the first three are inaccessible to lake fish due to major fish barriers at the outlet of the Powell River and approximately 100 m above the outlet of Jim Brown Creek (Fig. 4; Appendix I).

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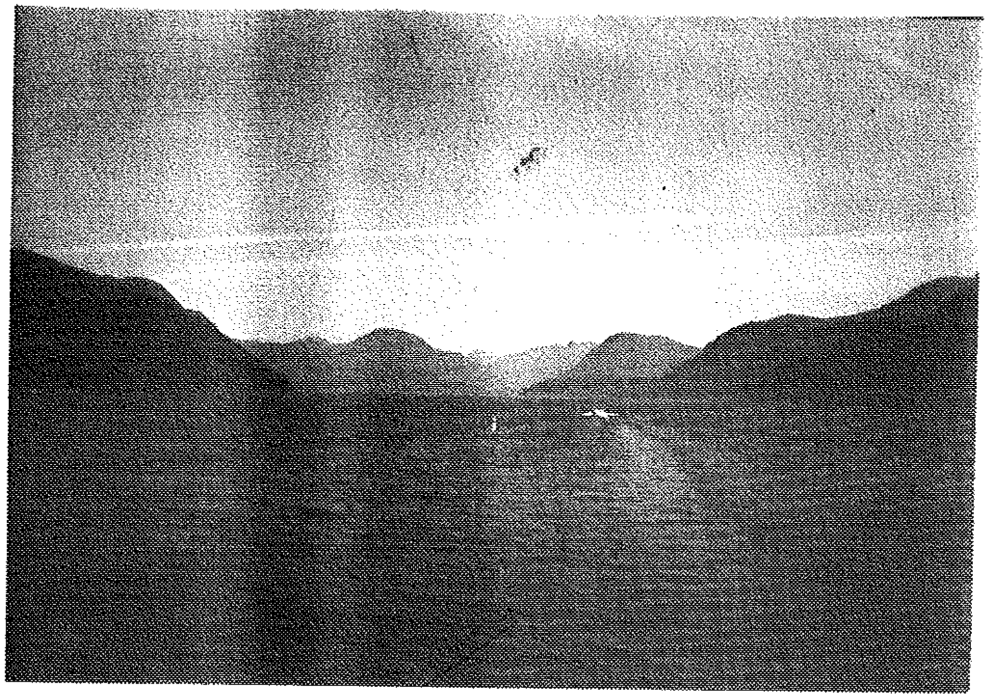

Figure 2. Powell Lake: south basin, looking north.

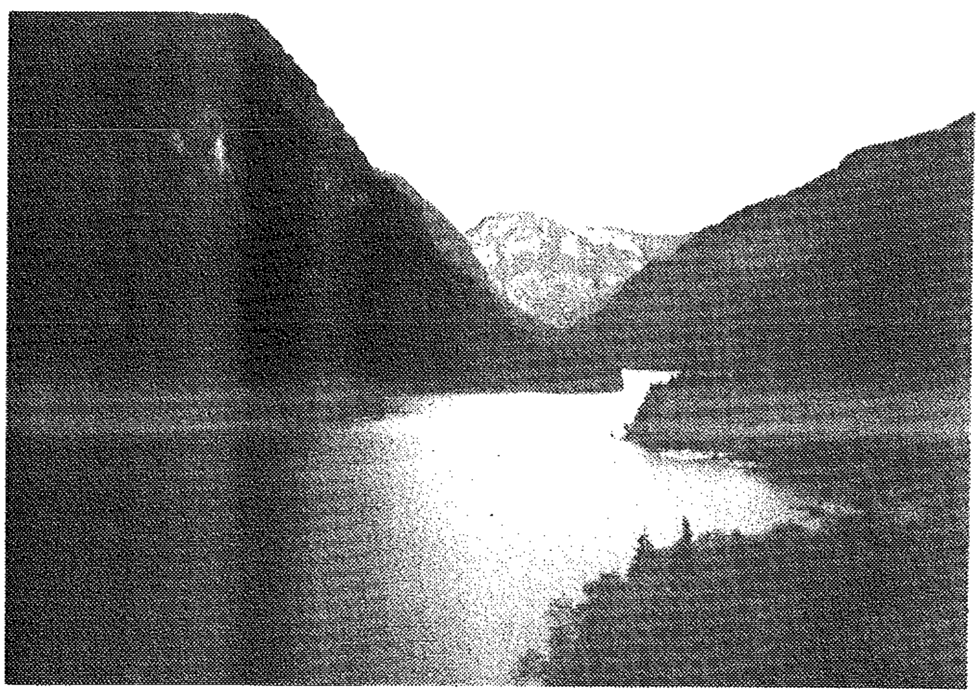

Figure 3. Goat Lake: near centre, looking northeast.

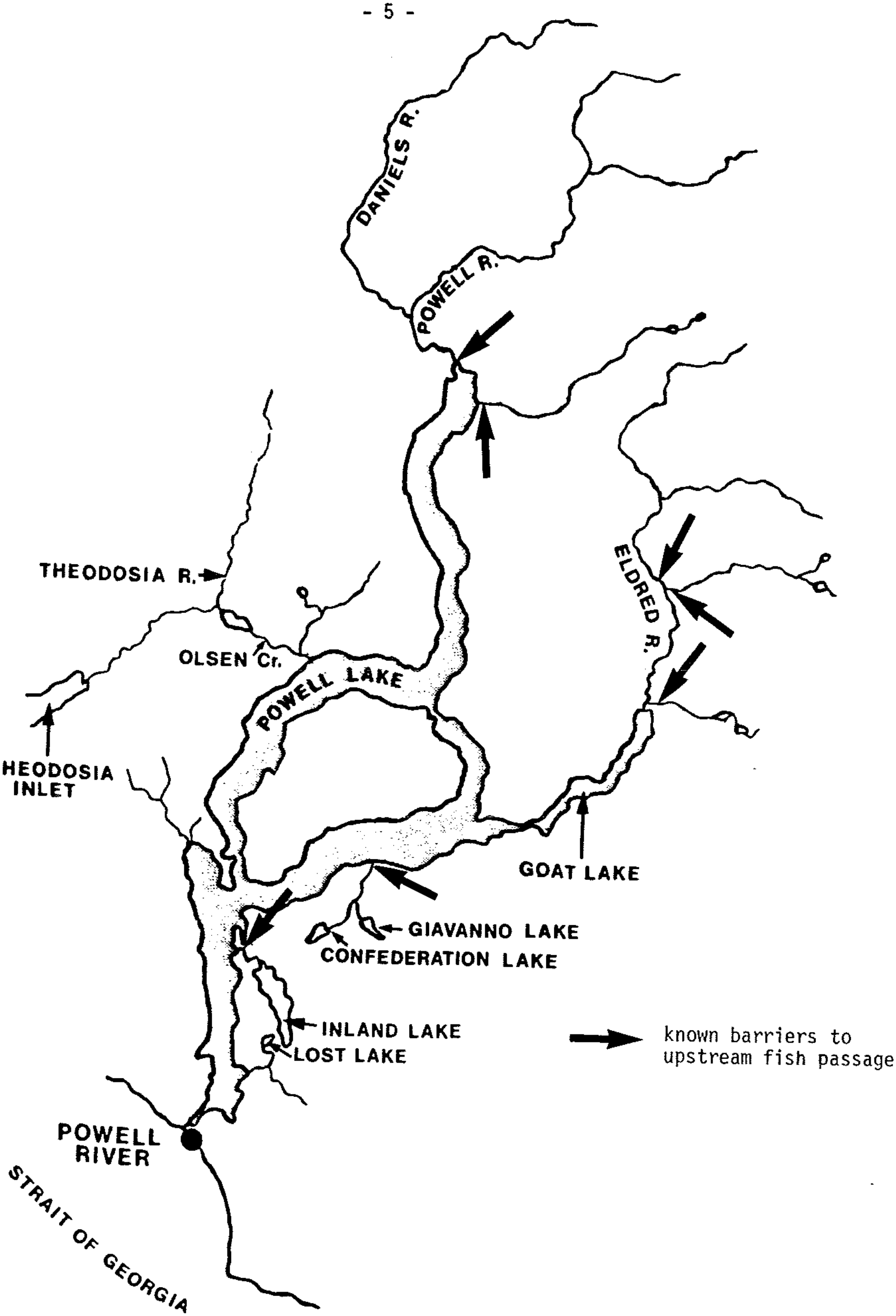

Figure 4. Streams with gradient and habitat suitable to trout production, based on 1985 overview (scale 1:250,000).

Similarly, a chute on the Eldred River may also restrict lake fish to the lowermost 8 km under most (if not all) flow conditions. In addition, barriers also exist on a number of other smaller but potentially productive streams (Fig. 4; Appendix I).

No barriers were encountered in the lowermost 1 km (approx.) of Olsen Creek, which was investigated in 1985. However, due to a diversion structure, additional discharge from the upper Theodosia River is diverted down Olsen Creek, particularly during high flows. This has resulted in massive erosion and streambed instability (Appendix I), greatly limiting trout spawning and rearing potential.

Lastly, a number of other streams, though accessible, appear to have water shortage problems, as observed in 1985. These include the outlet of Lost Lake and two tributaries entering the head of Chippewa Bay (extreme north end of the south basin); the former had a flow of less than 0.01 m^3/s (0.35 cfs) in July 1985, and the latter contained some isolated pools, but had no active flow in September.

4.0 FISH POPULATIONS IN ACCESSIBLE STREAM LENGTH

Following standard procedures (DeLeeuw, 1981), electrofishing was conducted in stream areas accessible to lake fish (i.e., downstream from barriers, or in streams without known barriers) on July 11-12, 1985 (Appendix II). Cutthroat trout (S. clarki clarki) fry and yearlings were the only salmonids caught at sites in lowermost portions of outlet streams from Lost and Inland lakes (sites 1 and 2, respectively; Fig. 5). Densities of these fish were very low in both cases (Table 1). Both sites were dominated by sculpins (Cottus asper) which were present at considerable densities (5-10 g/m^2, Table 1). These were the only two sites where water conductivity was sufficient to allow electrofisher operation. A third site was attempted in the Eldred River near site 4, in Figure 5, but was aborted due to extremely low conductivity. The electrofisher registered no output, and fish were observed darting about, unaffected. Similar results (or lack of them) were obtained from another trial in one of the small lake-headed tributaries to the Eldred River.

During further electrofishing conducted September 16-19, 1985, however, sampling was effectively achieved at site 4 in the Eldred River, by means of table salt additions to increase conductivity. Following installation of downstream and upstream stopnets, the salt was added gradually (sprinkled),

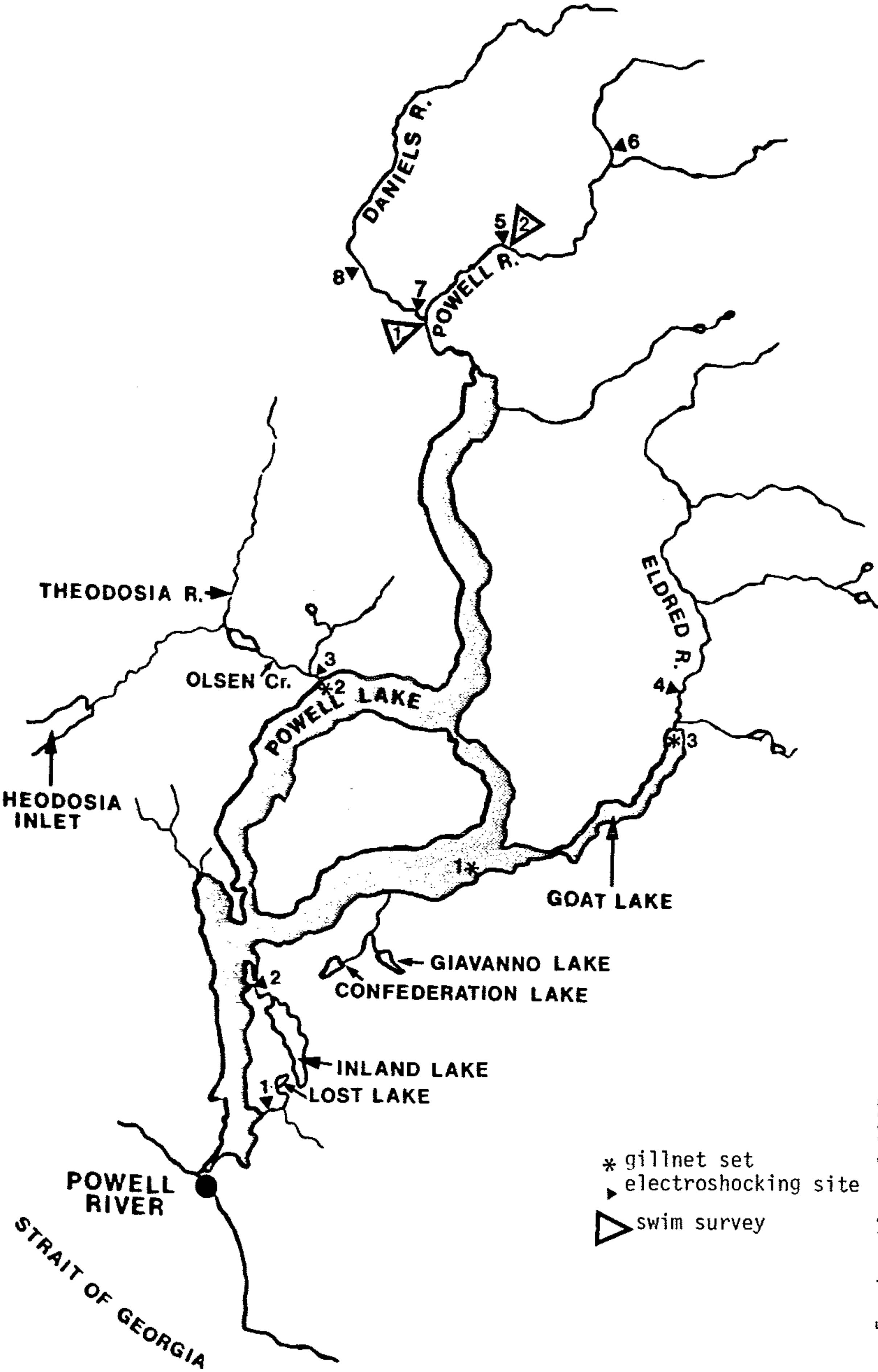

Figure 5. Location of 1985 sampling in the Powell Lake drainage (scale 1:250,000).

Table 1: Summary of biomass densities (g/m^2) for all fish species captured at 1985 electrofishing sites in Powell Lake tributaries.

Site/Stream	Date of Sample	Rainbow Trout	Cutthroat Trout	Dolly Varden	Sculpins	Total Salmonid	Total
1. Lost Lake outlet	July 11/85	-	0.81	-	5.13	0.81	5.94
2. Washout Creek (Inland Lake outlet)	July 11/85	-	0.70	-	10.06	0.70	10.76
3. Olsen Creek	Sept. 18/85	0.06	0.16	-	2.60	0.22	2.82
3b. Olsen Creek	Sept. 18/85	0.35	-	-	-	0.35	0.35
4. Eldred River	Sept. 19/85	0.04	1.06	-	0.64	1.10	1.74
5. Powell River	Sept. 17/85	1.27	-	0.86	-	2.13	2.13
6. Powell River	Sept. 16/85	0.11	-	0.82	-	0.93	0.93
7. Daniels River	Sept. 17/85	0.22	-	0.05	-	0.27	0.27
8. Daniels River	Sept. 17/85	1.45	-	0.41	-	1.86	1.86

as required, to maintain optimum equipment output and capture efficiency. Cutthroat trout fry and yearlings dominated the capture at this site (Table 1). Sculpins were again present, but at low densities. Two fry were identified as rainbow trout. In terms of total salmonid biomass, the results at the Eldred River site were slightly higher than those in the lake outlet streams sampled in July (sites 1 and 2), but not significantly so. On the other hand, total biomass, including sculpins, was considerably lower at the Eldred site (Table 1).

September sampling also included Olsen Creek (site 3; Fig. 5). Again, salt additions were required. The total salmonid capture consisted of one cutthroat fry and one rainbow fry (Appendix II), resulting in the lowest salmonid density found anywhere in the drainage (Table 1). These low captures at site 3 prompted additional sampling at a debris site immediately downstream (site 3b). The results were slightly better than at site 3, but not significantly so. It is interesting to note, however, that all fish captured at the site were identified as rainbow fry (Table 1; Appendix II).

5.0 FISH POPULATIONS IN THE POWELL AND DANIELS RIVERS

Following the particular interest of regional staff in the Powell-Daniels system, more intensive sampling was conducted in these streams, all of it during September 16-18, 1985. Four electrofishing sites to sample juvenile populations (sites 5-8; Fig. 5) and two swim surveys (wetsuit, mask, and snorkel) to enumerate larger (adult) fish were completed.

Electrofishing in both rivers again required salt additions. Rainbow trout and Dolly Varden char (Salvelinus malma) were the only species captured, except for several lamprey larvae (Lampetra richardsoni?) captured at site 5 in the Powell River. Total biomass density ranged from 0.27 to 2.13 g/m^2 at the four sites (Table 1), with slightly higher densities in the Powell River (ave. 1.53 g/m^2) compared to the Daniels (ave. 1.07 g/m^2). Sites 5 (Powell) and 8 (Daniels) contained the highest salmonid densities sampled in the drainage in 1985, and the overall mean of 1.30 g/m^2 for sites 5-8 is higher than the results in any of the accessible stream locations sampled (Table 1). However, compared to salmonid densities in the order of 5 g/m^2, which are often found in coastal streams, these results are very poor. Consistent with this, swim surveys indicated less than 5 adult rainbow (>20 cm) per kilometer below the Powell-Daniels confluence, and only 15-20 per kilometer in the Powell mainstem just above site 5 (Fig 5; Appendix III).

6.0 WATER QUALITY AND PRODUCTION POTENTIAL IN THE POWELL LAKE DRAINAGE

Low conductivity and fish densities encountered in Powell Lake tributaries reflect an extremely low abundance of nutrients. Water samples collected from the Powell, Daniels, and Eldred rivers in September 1985 all contained filterable residue (= total dissolved solids, or TDS) and total phosphorus levels of only 4 mg/ℓ and 0.005 mg/ℓ, respectively (Appendix IV).

File data for Powell Lake (Water Quality Unit, B.C. Ministry of Environment) indicate similarly low TDS and phosphorous levels in the upper 100 m of the water column; i.e., 10-14 mg/ℓ TDS, and 0.003-0.004 mg/ℓ total phosphorous (Appendix V). Powell Lake not only receives low nutrient input from tributary streams, but also has a "nutrient sink" caused by the stagnant, saline depths of the lake. Nutrients released through the decomposition of dead plant and animal matter that falls to the lake bottom are essentially trapped within the lower saline layer. This appears to be particularly true of phosphorus, and it is undoubtedly this nutrient that most limits biological production (to low levels).

7.0 FISH POPULATIONS IN POWELL AND GOAT LAKES

7.1 Abundance and Size

On July 7, 1985, 100 m experimental gillnets were installed in Powell Lake: (i) at the outlet of Olsen Creek and (ii) from a headland in the east basin and in Goat Lake near the outlet of the Eldred River (Fig 5). Each was removed approximately 24 hours later. Five species and a total of 164 fish were captured (Table 2).

Tables 2 to 5 and Figure 6 clearly indicate the dominance of cutthroat in the total catch, in terms of both numbers and size. This species represented 64% of the numbers and 73% of the biomass of the total catch from Powell Lake. Cutthroat were far more numerous and considerably larger than any other species in Powell Lake (Table 2). It is noteworthy that the larger size and numerical dominance of cutthroat (vs. rainbow) in the catch (4.5:1) is consistent with local reports of sport catch composition (est. 5:1 cutthroat to rainbow; P. Jantz, pers. comm.).

The catch results were similar in both Powell and Goat lakes except for the presence of many small Dolly Varden char and sculpins in the capture at the latter site. It is interesting to note that although

Table 2: Catch Composition (numbers of fish) in July 1985 gillnetting in Powell and Goat lakes.

Net No	Location	Species	Number	Size Range (mm)
1.	Powell Lake (east basin)	cutthroat trout	22	136 - 466
		rainbow trout	5	190 - 349
		kokanee salmon	4	111 - 216
		sculpins	1	145
2.	Powell Lake (nr. Olsen Creek)	cutthroat trout	17	124 - 427
		rainbow trout	4	278 - 339
		kokanee salmon	3	179 - 200
		sculpins	5	120 - 150
3.	Goat Lake (nr. Eldred R.)	cutthroat trout	20	174 - 539
		rainbow trout	4	254 - 355
		kokanee salmon	12	183 - 220
		Dolly Varden char	39	113 - 253
		sculpins	28	120 - 150

Table 3: Catch Composition (percentages) in July 1985 gillnetting in Powell and Goat lakes.

Net No.	Location	Cutthroat Trout	Rainbow Trout	Kokanee Salmon	Dolly Varden	Sculpins
1.	Powell Lake (east basin)	69	16	13	-	3
2.	Powell Lake (nr. Olsen Cr.)	59	14	10	-	17
	Powell Lake Total	64	15	11	-	10
3.	Goat Lake (nr. Eldred R.)	19	4	12	38	27
	Overall Total	36	8	12	24	20

Table 4: Biomass Composition* (kg) in July 1985 gillnetting in Powell and Goat lakes.

Net No.	Location	Cutthroat Trout	Rainbow Trout	Kokanee Salmon	Dolly Varden	Sculpins	Total
1.	Powell Lake (east basin)	5.0	1.2	0.2	-	0.0(3)	6.4
2.	Powell Lake (nr. Olsen Cr.)	3.0	1.2	0.2	-	0.1	4.5
3.	Goat Lake (nr. Eldred R.)	8.1	0.9	0.9	2.8	0.7	13.4
Totals		16.1	3.3	1.3	2.8	0.8	24.3

* Based on an estimated condition factor of approx. 1×10^{-5} for all species, as obtained for trout.

Table 5: Biomass Composition (percentages) in July 1985 gillnetting in Powell and Goat lakes.

Net No.	Location	Cutthroat Trout	Rainbow Trout	Kokanee Salmon	Dolly Varden	Sculpins
1.	Powell Lake (east basin)	78	19	3	-	0(.5)
2.	Powell Lake (nr. Olsen Cr.)	67	27	4	-	2
	Powell Lake Total	73	23	4	-	1
3.	Goat Lake (nr. Eldred R.)	60	7	7	21	5
	Overall Total	66	14	5	12	3

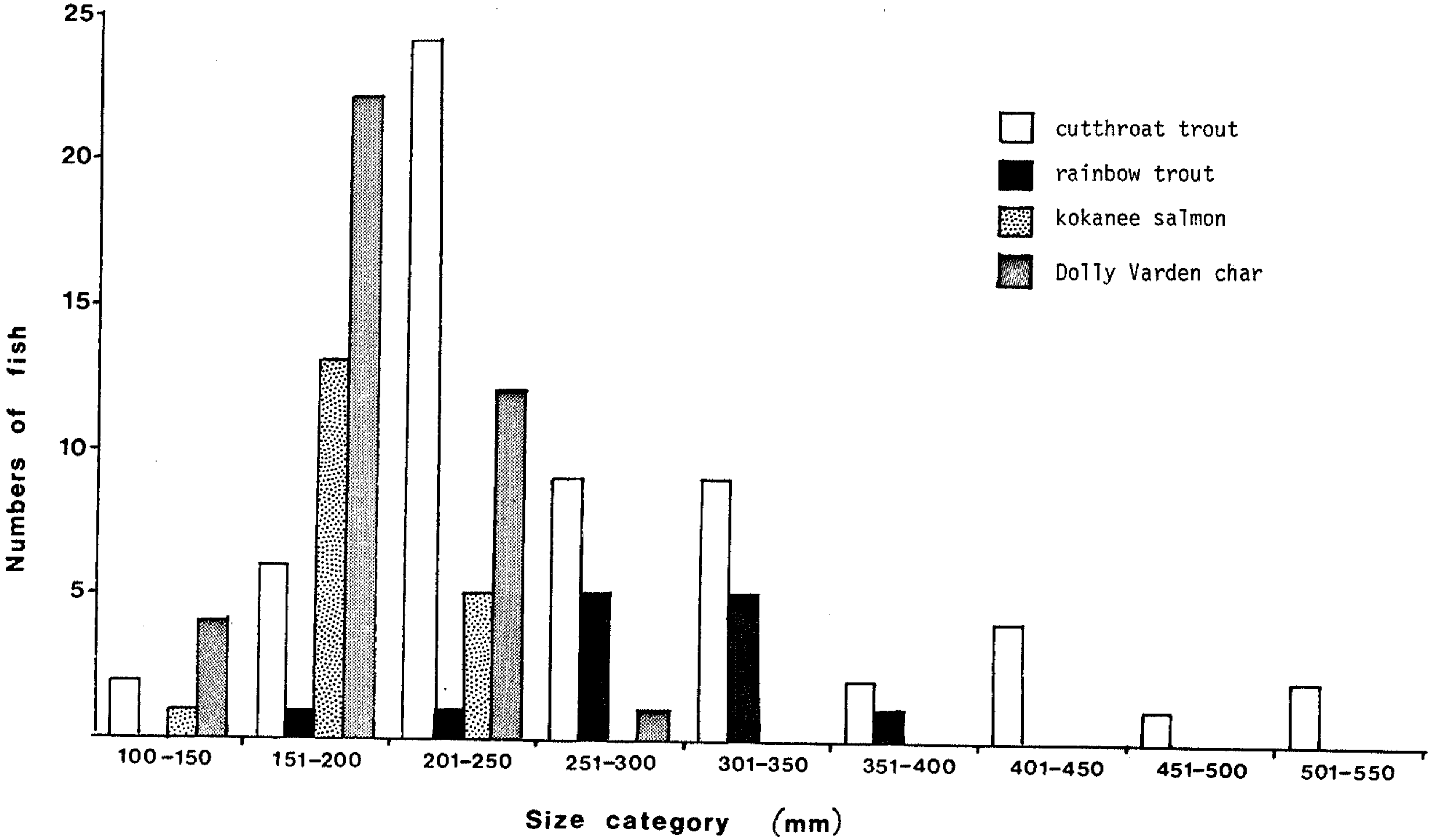

Figure 6. Numbers of fish, by species and size category, from July 1985 gillnetting in Powell and Goat lakes.

Dolly Varden were captured in stream sampling of the Powell-Daniels rivers, but not the Eldred (Section 4.0), this species was caught only in the Goat Lake net set (Table 2). Furthermore, all were small, the largest being 253 mm in length. Because of this, although cutthroat were outnumbered (Table 2), they nonetheless dominated the biomass (60%) at this site, similar to those in Powell Lake (Tables 4 and 5).

7.2 Age Composition

Scale samples were read from 47 fish (32 cutthroat, 9 rainbow, 6 kokanee) from the Powell Lake captures, and another 31 fish (17 cutthroat, 4 rainbow, 10 kokanee) from those in Goat Lake (Appendix IV).

Age composition for cutthroat is provided in Table 6. The high proportion of older fish in the sample (i.e., 25% age 5 or older) suggests that the population may be lightly exploited by angling. The fact that the total biomass of older age groups represents a high percentage of the total sample weight also supports this speculation (Ricker, 1975). The same pattern pertains to the rainbow trout in the sample (Table 7), and is even more skewed towards a predominance of older, larger fish. If either trout species is in decline, it does not seem likely that this is largely attributable to current angling effort.

7.3 Food/Predation

Although gut analyses were not conducted on all gillnet specimens (due to severe time constraints associated with the distances to be travelled), remains of small fish (species unknown) were found in the stomach contents of large cutthroat. It seems safe to assume that Powell Lake cutthroat predate significantly upon other fish species, including small rainbow trout and kokanee (Scott and Crossman, 1975). Since the productive capacity of the system is low, judging by nutrient levels, cutthroat possibly limit the survival/production of other species, as evidenced by the numerical and size dominance obtained from gillnet sampling (and as reported for the sport catch).

In this regard, it is interesting to speculate about the numerous small Dolly Varden captured near the Eldred River in Goat Lake. Although this species is often a significant predator of other fish (Scott and Crossman, 1975), it appears to be subdominant to cutthroat, shifting to bottom-feeding in the presence of the latter species in some B.C. coastal lakes (Andrusak and Northcote, 1970). In a lake where most

Table 6: Age composition from Powell-Goat lakes cutthroat trout scale samples, and associated biomass estimates.

	AGE						
	2+	3+	4+	5+	6+	7+	8+
Number of fish	7	24	6	3	4	4	1
% of total	14	49	12	6	8	8	2
Mean length (mm)	208	242	285	335	389	403	539
Total biomass (kg)	0.6	3.5	1.5	1.1	2.5	2.7	1.6
(%)	4	26	11	8	19	20	12

Table 7: Age composition from Powell-Goat lakes rainbow trout scale samples, and associated biomass estimates.

	AGE				
	3+	4+	5+	6+	7+
Number of fish	2	1	4	5	1
% of total	15	8	31	39	8
Mean length (mm)	202	254	290	324	355
Total biomass (kg)	0.2	0.2	1.0	1.7	0.4
(%)	6	6	29	49	11

of the bottom is saline and anoxic and where much of the basin is undoubtedly rocky, suitable areas for bottom feeding are undoubtedly limited. Based on 1985 field observations and aerial photography, the portion of Goat Lake near the mouth of the Eldred River is one of very few muddy shallow areas in the Powell-Goat lakes system where significant benthic production and feeding might be expected. It is conjecture, but on the basis of (i) concentration of Dolly Varden in this area, (ii) their small size, and (iii) the absence of any larger Dolly Varden in net captures, all seem to indicate heavy pressure from the cutthroat population.

Certainly, the low numbers of kokanee in the catch (Tables 2 and 3) suggest a high rate of predation by cutthroat. It is cautioned, however, that the different characteristics in the Goat Lake catch may simply reflect chance and/or other factors.

7.4 Spawning/Rearing of Juvenile Fish

Circuli counts and anterior scale radii (ASR) measurements were conducted on the 49 cutthroat and 13 rainbow trout scale samples from the July 1985 gillnet captures. In addition, similar measurements were taken from 11 juvenile cutthroat and 9 juvenile rainbow captured during July and September electrofishing (Appendix VIII).

The primary objective was to identify time of lake entry (fish age) for lake-caught fish, and any similarities (or differences) in scale patterns between lake-caught and stream-caught specimens. Anterior Scale Radius measurements were highly variable, both between and within age groups, and no distinct patterns were discernible. Cumulative circuli counts to successive annuli also displayed considerable variability, but there was sufficient consistency to lump them into three basic patterns for lake-caught trout, both cutthroat and rainbow.

Results are summarized in Tables 8 and 9 for cutthroat and rainbow, respectively. The reader is cautioned that these results are presented as trends only and have not been confirmed statistically (due to insufficient sample size). Furthermore, in general, there was not the distinct difference between stream growth and lake growth that is often seen on fish scales from productive lakes. This hampers interpretation, and again attests to low productivity throughout the system. However, for both cutthroat and rainbow, some degree of lake entry as underyearlings does seem indicated by pattern 3 (higher circuli numbers to first annulus, accentuated in later years; Tables 8 and 9). These

Table 8: Circuli counts for scale samples from cutthroat trout captured in July 1985 gillnetting of Powell-Goat lakes.

Pattern No.	Sample Size (no. of fish)	Cumulative Circuli Counts to Successive Annuli						
		Ann 1	Ann 2	Ann 3	Ann 4	Ann 5	Ann 6	Ann 7
1.	26	7.5	17.3	29.4	42.1*	52.2	63.0	77
2.	4	7.8	19.5	37.0	54.0*	76	88	
3.	19	9.2	25.7	39.3	56.0*	67.4	80.6	92.0

* first evidence of spawning in sample.

Table 9: Circuli counts for scale samples from rainbow trout captured in July 1985 gillnetting of Powell-Goat lakes.

Pattern No.	Sample Size (no. of fish)	Cumulative Circuli Counts to Successive Annuli						
		Ann 1	Ann 2	Ann 3	Ann 4	Ann 5	Ann 6	Ann 7
1.	2	8.5	17.5	32.0	44.0*	54.5		
2.	7	8.4	21.9	34.0	54.0*	67.2	79.6	84
3.	4	9.8	27.5	44.0	63.5*	80.0	90	

* first evidence of spawning in sample.

fish represent 39% and 31% of the total cutthroat and rainbow samples, respectively. Both trout species also indicate an intermediate pattern (pattern 2; entry at age 1+?), and one strongly suggesting at least two years of stream residence (perhaps up to 3 years in some cases) before lake entry (pattern 1). While the latter represented only 15% of the total rainbow sample, it dominated (53%) that of cutthroat. This is consistent with the predominance (though low numbers) of overyearling cutthroat in sampling of accessible stream areas.

Juvenile scale samples were too few and limited to conclude very much (Appendix VIII). However, age 1+ stream-caught cutthroat (n = 5) all evidenced 7 or 8 circuli to the first annulus, supporting the speculation that patterns 1 and 2 for lake-caught fish reflect at least one year's stream residence prior to lake entry. No age 1+ or older rainbow were caught in accessible streams. With one exception, those sampled in the Powell-Daniels system (again, 5 in all) indicated 5 or 6 circuli to the first annulus (Appendix VIII). No rainbow from the lake-caught sample had less than 7 circuli to the first annulus (Appendix VII). Although the number of samples is small, and it may be possible that some Powell-Daniels rainbow lay down 7 or more circuli to the first annulus, there is no indication that these streams are important rainbow recruitment sites (through displacement) for Powell Lake.

7.5 Past Stocking of Powell Lake

Fish Culture Section (B.C. Fisheries Branch) records show that a total of 520,000 rainbow trout eggs were used to stock Powell Lake from 1926 to 1937. Then, in 1950, 10,000 rainbow fry were released to the Powell River. Unfortunately, no other details regarding these stocking attempts (or reasons for their discontinuation) are on record. However, Mr. William Todd[6], who fished Powell Lake in the early 1930's, reports that rainbow in the 0.5 kg-0.7 kg range predominated in the catch at that time. There has been no further (official)[7] stocking of the system, with any species, since the 1950 release to the Powell River.

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6. Retired, Sidney, B.C.
7. Rumour has it that unofficial local attempts at rainbow culture may have been made, and may still be occurring.

8.0 DISCUSSION

8.1 Current Production and Dynamics of Fish Populations in the Powell Lake System

At the outset, it must be fully recognized that most of the data presented refer to what is essentially a single point in time (July/September 1985). Consequently, a great deal of speculation is used in trying to establish what the population dynamics might be for the system. On the other hand, all biological data at any point in time are a reflection of the prevailing physical and chemical constraints on productivity plus such factors as exploitation rates (e.g., sportfishing harvest). The objectives of this discussion are to: (i) determine what is most indicated, (ii) what the implications are in terms of fisheries management, and (iii) what enhancement opportunities exist, if any.

Clearly, on the basis of the water quality data, Powell Lake and its attendant drainage have a very limited productive capability. In view of this, the reported sport catch of approximately one cutthroat per angler day (P. Jantz, pers. comm.) is surprisingly high, as it exceeds the average catch per unit effort (0.87 fish/angler day) for the Lower Mainland. Furthermore, the large catch in the July 1985 gillnetting (164 fish total) was exceptionally high for a large oligotrophic coastal lake (J. Balkwill[8], pers. comm.), and suggests the existence of a relatively large population of fish for a system of this type. In view of this, and the relatively high numbers and biomass of older fish (age 5+ and older) in both the cutthroat and rainbow populations, it can only be concluded that existing fishing pressure is light, that the production/abundance of fish primarily reflects natural controls, and that the system may be operating at, or near, natural capacity at present.

The biological data seem to indicate a rather delicate natural balance in the system's fish populations. Cutthroat are strongly dominant both in terms of numbers and size, and likely control the other fish populations (including rainbow trout), largely by predation. The low numbers of kokanee and rainbow suggest that predation by cutthroat is intensive. The apparently limited distribution and stunted size of Dolly Varden also seems to reflect a high level of competition for limited resources.

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8. i/c Inventory Operations, B.C. Fisheries Branch, Victoria.

Sampling of tributary streams accessible to lake fish revealed relatively low numbers of juveniles. It would appear that rates of natural recruitment are low, even from accessible streams with suitable habitat. Furthermore, small recruits (of all species) entering the lake are undoubtedly a food source for predaceous cutthroat, and, likely, cannibalism serves to some extent in controlling the size of the cutthroat population itself.

Given the system's very limited productive capability as a result of low nutrient supply (particularly phosphorus), all of the above do indicate that a critical balance does exist, and is likely close to natural capacity.

8.2 Enhancement Capability

Under the right circumstances and using the appropriate techniques, enhancement may be used to increase fish production over existing levels in lakes and streams. For instance, where spawning habitat is limited, stocking and/or spawning habitat improvement (to improve natural recruitment) may result in increased production. However, the provision of more young fish (recruits) to a system will result in improved catch, only if the system has the surplus food resources to support them. In the case of the Powell Lake system, the reverse appears indicated. There seem to be large numbers of fish competing heavily for available food resources, ultimately being dominated by predaceous cutthroat. Under such circumstances, the provision of more recruits to the lake (by stocking or habitat improvement) could simply result in wasted funds, time, and effort (additional fish lost to predation or natural mortality due to lack of food resources); or, worse, could disrupt the current balance by increasing intraspecific and/or interspecific competition.

In some systems with limited nutrient availability, fertilization may be used to artificially increase natural production capabilities. However, from both a logistical and financial viewpoint, it would be impractical to consider fertilization of Powell Lake. Besides the lake's sheer enormity, the ongoing loss of nutrients to the stagnant, saline depths would necessitate that fertilization be regular and ongoing (perhaps indefinitely). The cost would likely be hundreds of thousands of dollars a year. Consequently, any consideration of enhancement strategies for the Powell Lake system must be based on natural levels of productivity and, consistent with concerns expressed above, must include extreme caution. Relative to its productive capability, Powell Lake is already providing a good fishery for Powell

River anglers, and this must not be jeopardized by upsetting natural balances (e.g., increased effort and catch).

A final consideration is the desirability of enhancing the Powell Lake fishery, should this prove possible. Due to the lake's size and frequently "choppy" conditions, it may only be fishable by those with substantial power boats. This, no doubt, is a factor in the obvious lack of angling pressure at present. Consequently, fisheries enhancement of Powell Lake (if biologically feasible) may not be of benefit to the general public.

8.3 Species-Specific Enhancibility

The original proposal of MacMillan-Bloedel Ltd. and the Powell River Salmon Society was to stock the system with rainbow trout. Previous stocking with this species, and at least one report of a predominant rainbow fishery in the 1930's (section 7.5), would seem to support this proposal. However, there is no indication of what the species complex was prior to stocking, what the final outcome of the stocking program was (general improvement or deterioration of the fishery?), or why stocking was terminated (lack of return?, decreasing fish size?).

On the basis of current information, rainbow would not seem the best candidate for enhancement. Even if some capacity for fisheries enhancement does exist, a proportion of any juvenile rainbow released in the lake will be lost to cutthroat predation. If food resources are limited (as suspected) undoubtedly a large proportion would become food for cutthroat; and due to increased competition, surviving rainbow would likely experience increased natural mortality rates. At the same time, the additional pressure on wild rainbow recruits could have the net effect of reducing overall growth and/or survival of rainbow trout (a sub-dominant stock) in the lake.

Assuming that some level of cannibalism does occur with Powell Lake cutthroat, enhancement attempts with this species could also be ineffective due to predation. Furthermore, there is the same risk as that suggested for rainbow, that surviving recruits could increase intraspecific competition to the overall detriment of the stock. Given the interspecific dominance of cutthroat in the system, it seems most likely that the ultimate outcome could be a general decline in fish size (reduced growth rates due to increased competition for limited food resources), as opposed to numbers.

Since Dolly Varden is another species that typically predates upon small fish, any enhancement of this species could increase competition with cutthroat, possibly to the detriment of the latter. Furthermore, the data suggest that Dolly Varden are not successful in Powell Lake, and consequently the species is not a good candidate for enhancement, in any event.

The remaining species for consideration is kokanee. Several management strategies proposed by the Large Lake Management Committee (Anon., 1986) recommend kokanee enhancement to increase production of predaceous trout in certain types of large lakes. However, with its low nutrient availability and what appear to be relatively unexploited (lightly fished) fish populations, these management strategies do not apply to Powell Lake (E. Parkinson[9], pers. comm.). Kokanee production in the lake is likely limited not only by cutthroat predation but also by low production of mid-water zooplankton, and there is probably little point in attempting to increase numbers of this species.

Of all the species, cutthroat would be the best with which to conduct trial releases to determine if any potential for enhancement does exist in the system. However, because of the risk that excessive releases of this species could have a net detrimental effect on the wild stock (general reduction in fish size), the size of any trial releases must be conservative. A rate of 1 or 2 recruits per hectare (12,000 to 24,000 total) should be adequate for detection in the fishery (E. Parkinson, pers. comm.). All fish released must be marked (fin and/or maxillary clips) to enable positive identification in the catch.

8.4 Future Enhancement Potential

There may be some potential to increase trout production in the Eldred River and/or Powell-Daniels system. However, to do so would be premature at this point. Firstly, it is unknown if any additional recruitment from these streams would be beneficial to the lake populations (and fishery). Secondly, due to lack of public access, attempts at developing stream-resident populations would be inappropriate. Low stream productive capacity for resident trout would also negate this option.

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9. Lake Fisheries Scientist, Fisheries Research and Development, B.C. Fisheries Branch, Vancouver.

However, if it can be shown (through trial releases) that Powell Lake is capable of supporting increased trout recruitment, then further consideration could be given to enhancement of migratory trout (lake recruit) production in these streams (spawning and early rearing). This might include barrier removal or fishway construction, if cost-effective.

By the same token, provision of fish access above barriers in several smaller streams (e.g., Jim Brown, Washout and Giovanno creeks) might also be a future consideration. It must be emphasized again, however, that such undertakings could only be considered after it has been determined that Powell Lake is capable of supporting higher trout recruitment levels.

9.0 CONCLUSIONS AND RECOMMENDATIONS

1. All evidence indicates that existing fish populations in Powell Lake are large relative to the lake's low productive potential.

2. The high numbers and biomass of older fish in the trout populations indicate that fishing pressure is light, and that current production levels are primarily controlled by natural phenomena.

3. If the principal natural control is a lack of accessible spawning and/or rearing habitat in streams, resulting in inadequate recruitment to the lake, then enhancement of lake populations might be achieved by stocking and/or provision of fish passage to presently inaccessible habitat.

4. On the other hand, if the principal control is the lake's low productive potential (limited nutrient and food availability), no significant level of enhancement would be achievable.

5. Again, all evidence seems to suggest the latter. It would appear that large predaceous cutthroat in Powell Lake are exerting severe pressures on the other species present, controlling their population size in a limited environment.

6. Stocking trials might be conducted to prove or disprove this hypothesis, but no habitat enhancement (i.e., fish passage improvements) should be considered at present. Such undertakings

might be recommended if trial stocking indicates the lake has a capacity to support increased recruitment.

7. The dominant species, cutthroat trout, should be used for any stocking trials at this time.

8. Due to the real possibility that such releases might result in over-recruitment of the lake (and detrimental impacts on wild fish), the size of the releases should be conservative. A rate of 1 or 2 fish per hectare, or 12,000 to 24,000 fish in total, should not be exceeded pending an initial evaluation (e.g., creel census plus netting program).

9. All hatchery fish should be marked to enable positive identification in the fishery.

10. Since it is speculated that a delicate balance may currently exist in the lake's biology, even small trial releases must not be conducted in the absence of a firm commitment to adequately monitor the results through the sport catch. This should not be limited to enumerating returns of tagged fish, but should also include careful screening to detect any shifts in catch trends (species, size, numbers, age, etc.) of other species.

11. Gillnetting should be conducted to augment catch data and to most clearly evaluate the effect of the trial releases and monitor any changes in wild fish stocks.

12. If the return of stocked fish is low, and/or if any negative trends appear (e.g., reduced growth rates), stocking trials should be discontinued.

13. Furthermore, if in the course of monitoring the catch it is detected that numbers of older/larger trout are rapidly declining, more conservative catch regulations should be implemented.

ACKNOWLEDGMENTS

The following contributions to this study are acknowledged and greatly appreciated; Ross Neuman and Rob Knight assisted in all phases of preparation and data collection; Phil Jantz and Ralph Escott provided insight, guidance, and field support, Kevin Devito conducted the scale analyses, assisted by various FIU staff; Eric Parkinson provided helful consultation, and J.C. Wightman reviewed the report, prior to its typing by Paper Chase. Lastly, a special note of thanks to Percy Logging Ltd. and MacMillan Bloedel Ltd. for the use of the vehicle that became known as "Dead Tim's Crummy".

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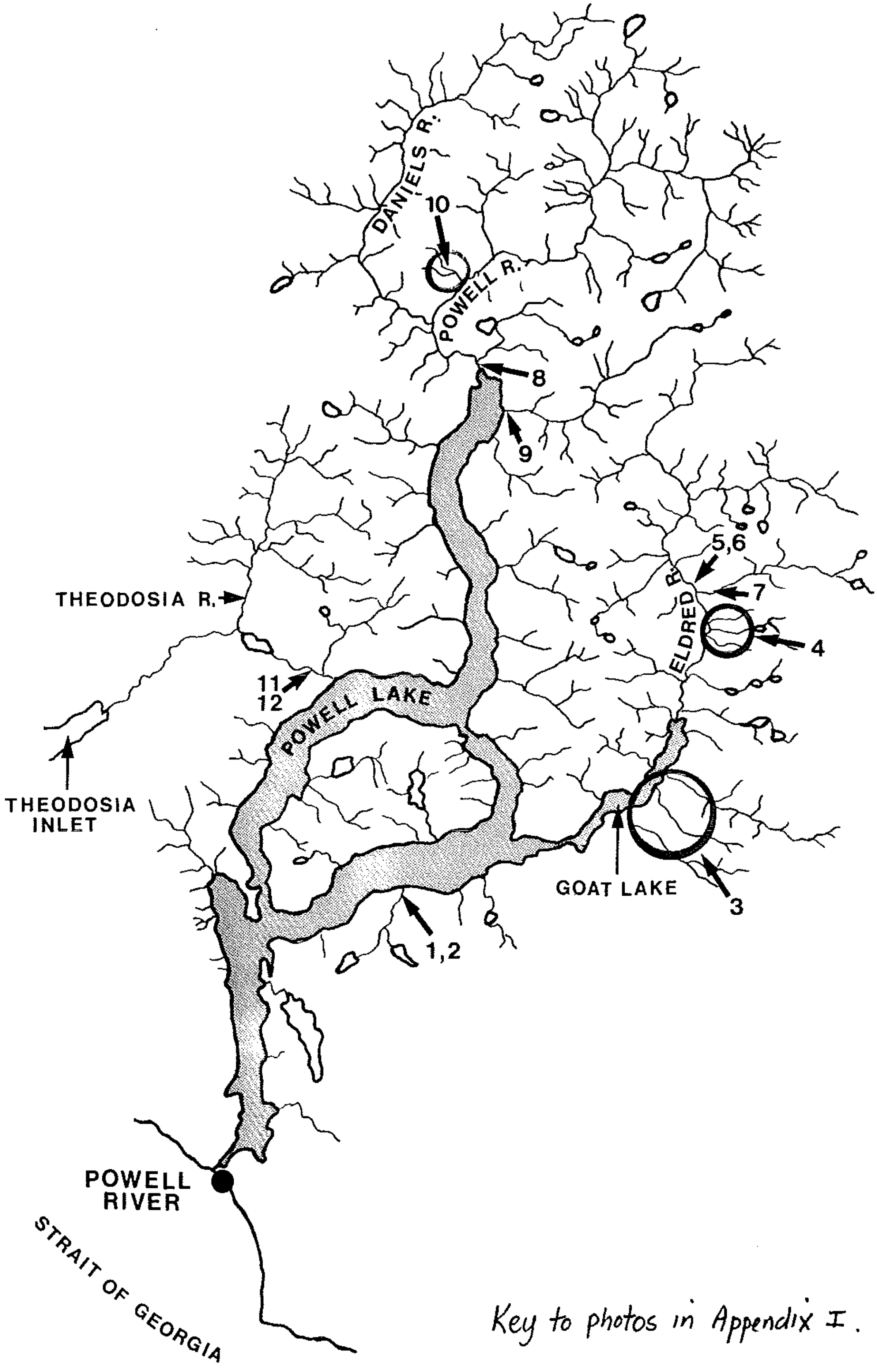
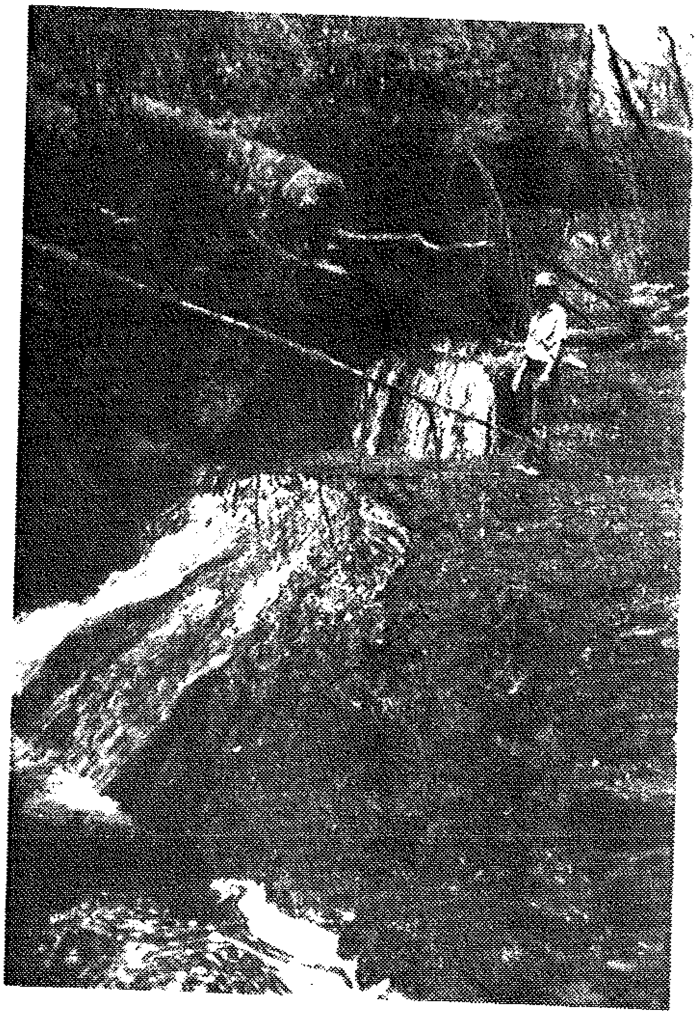
Appendix I. Photo documentation of high gradient and fish barriers in Powell Lake tributary streams.



Key to photos in Appendix I.



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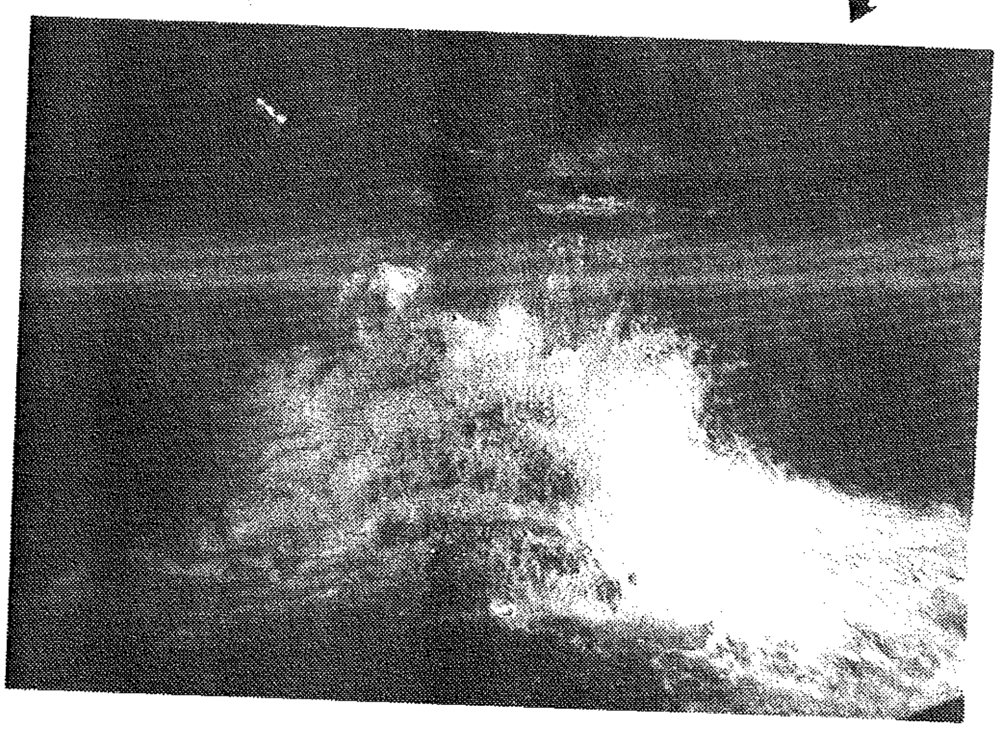

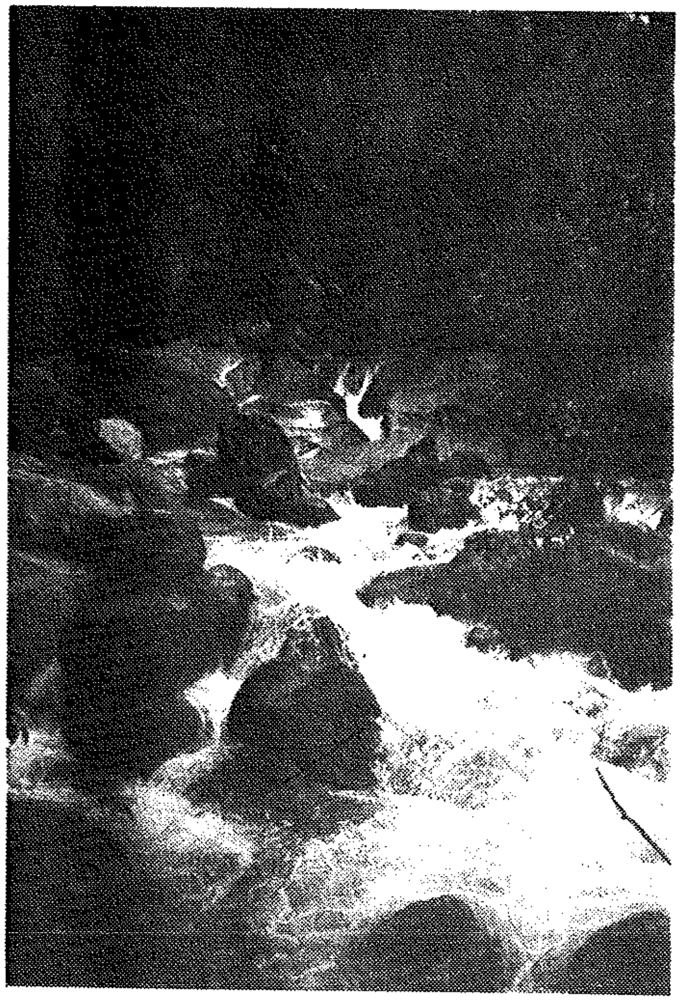

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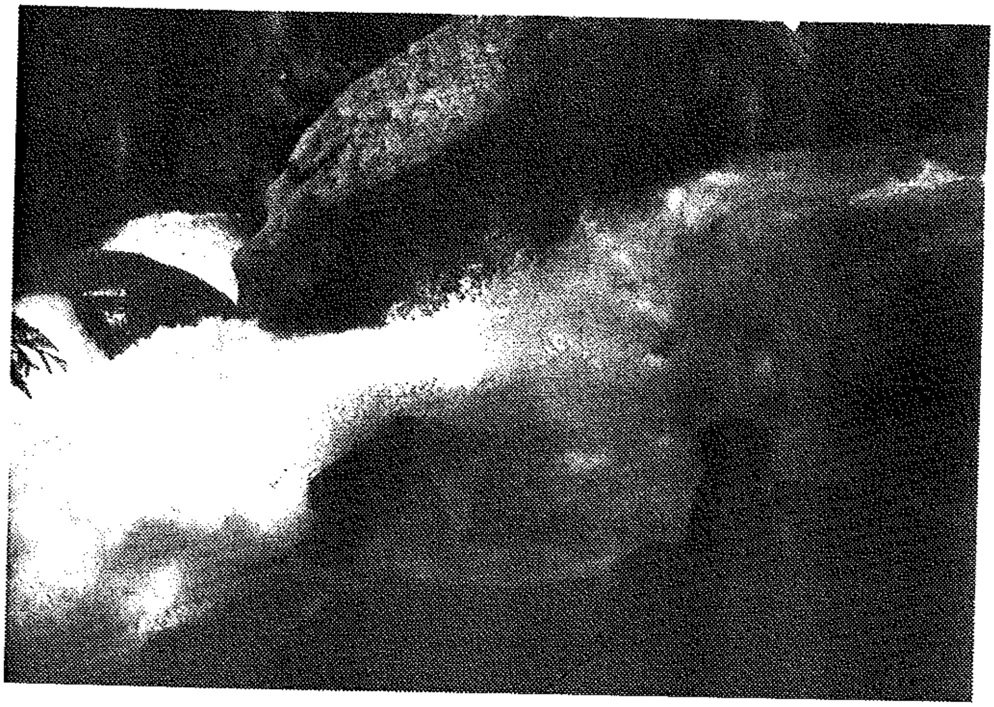

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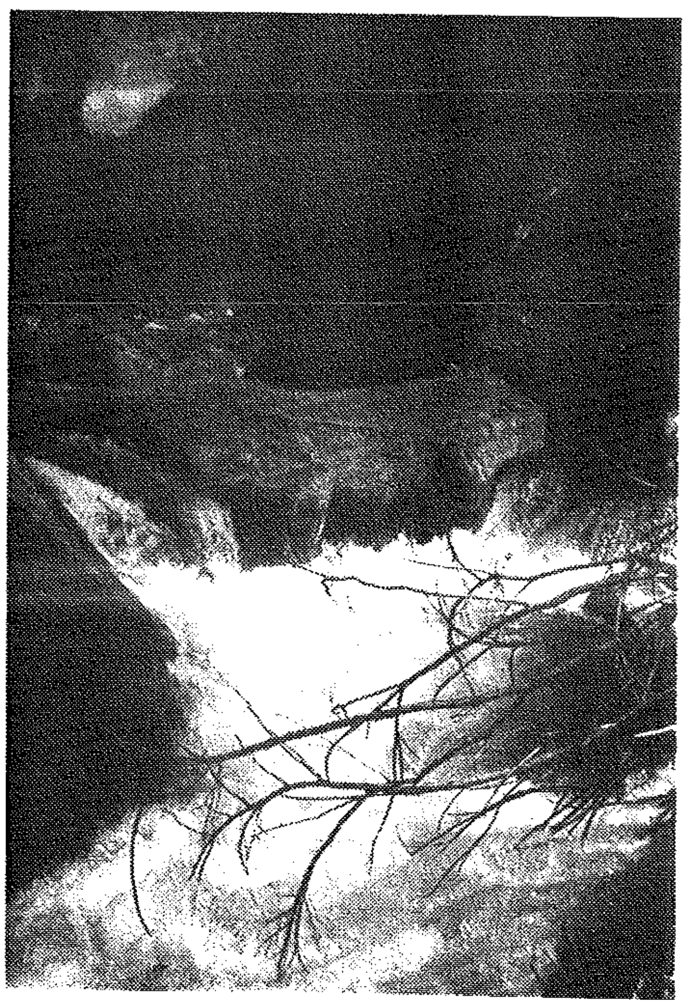

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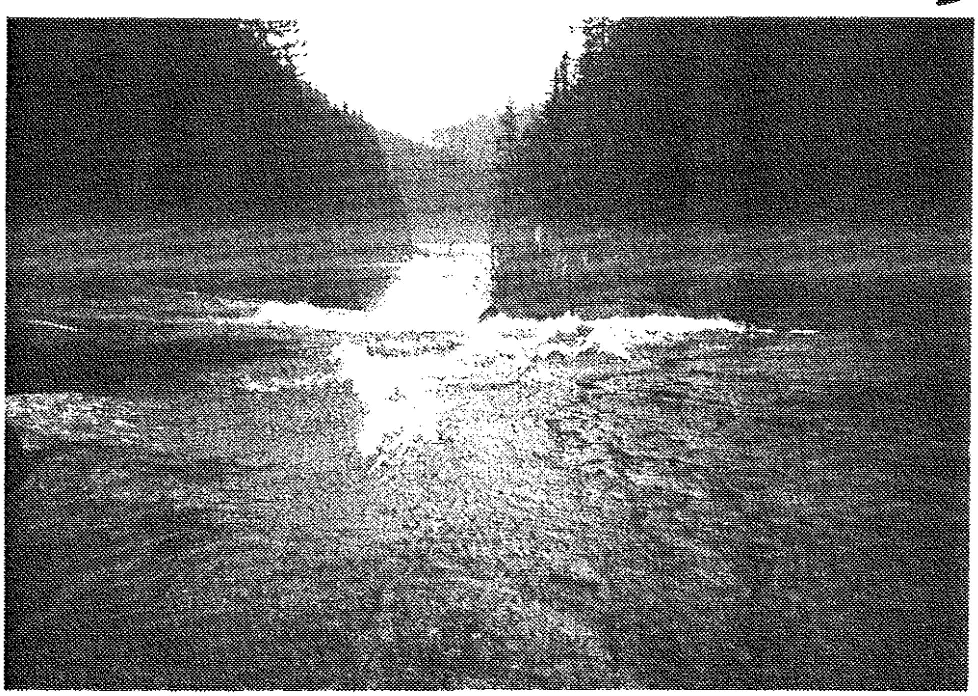

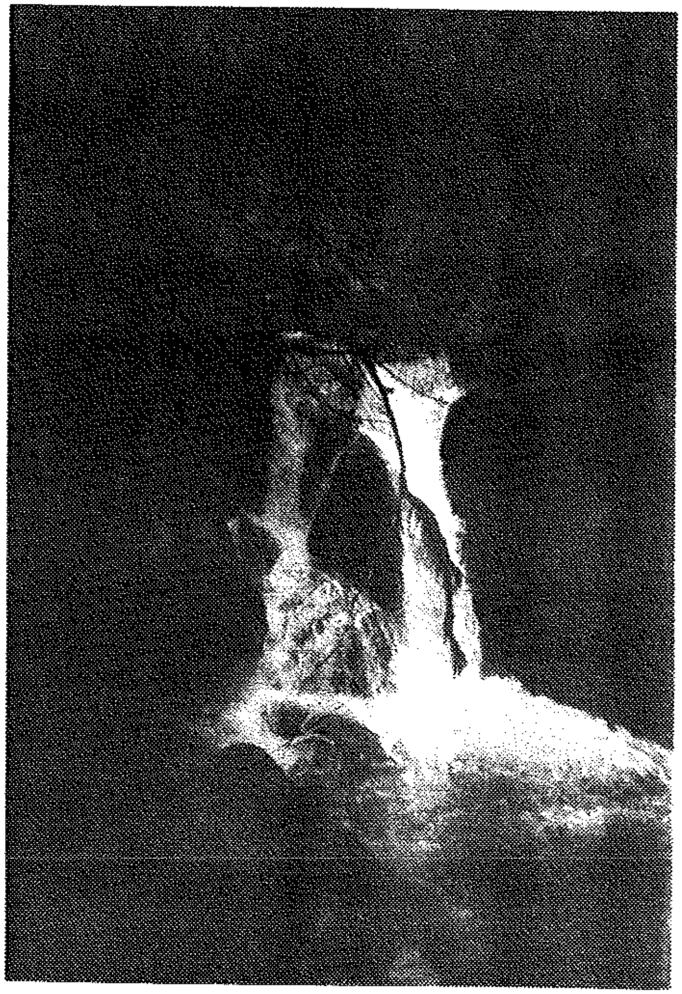

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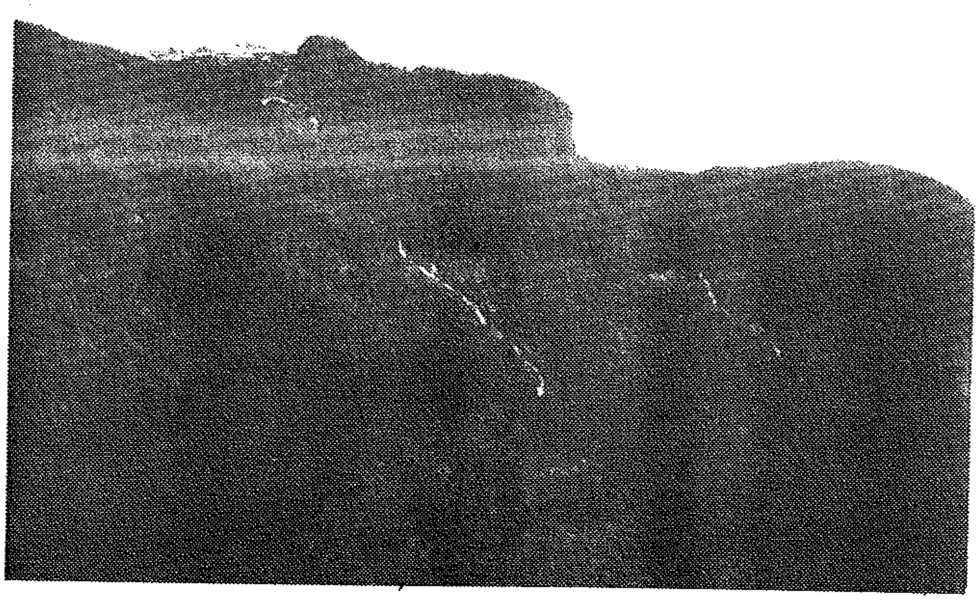

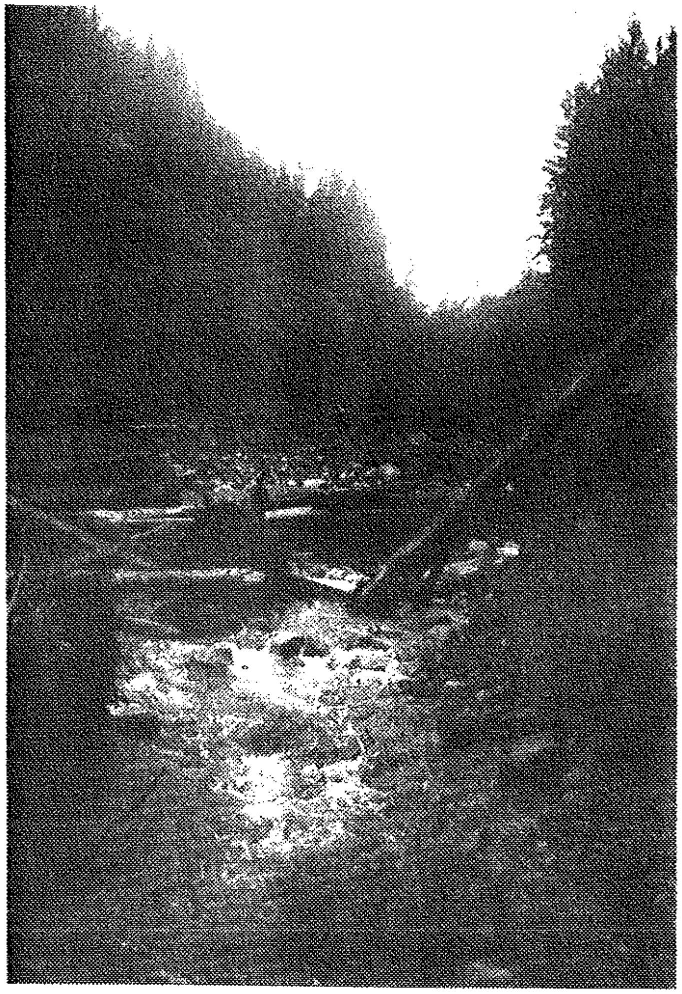

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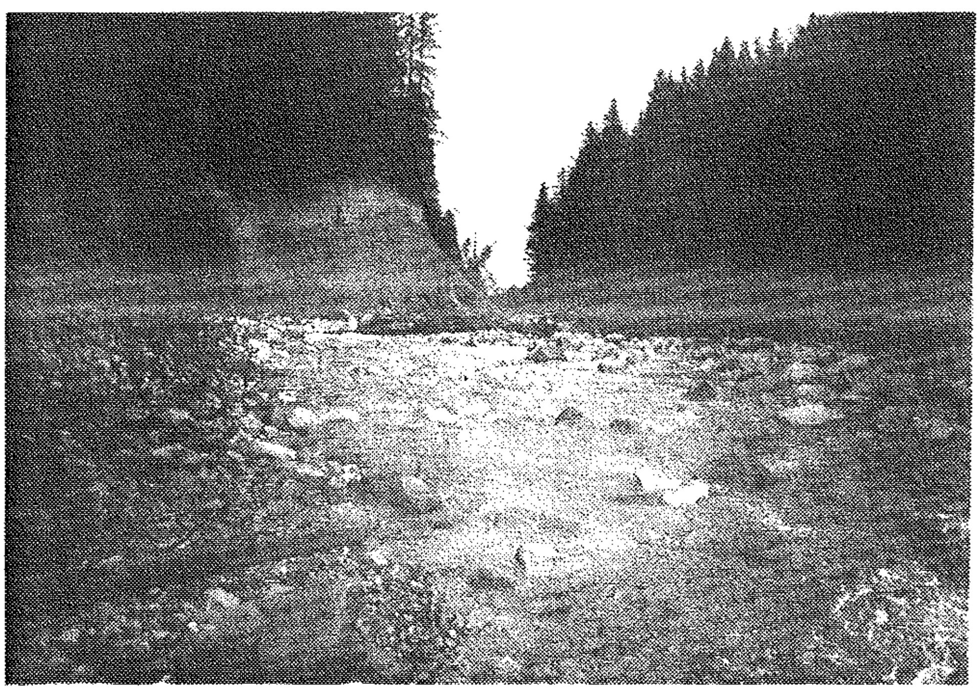


Appendix II. Habitat and fish capture results at 1985 electrofishing sites in the Powell Lake drainage.

Lost Lake outlet stream DATE July 11/85 AREA approx. 15 M^2 SITE 1

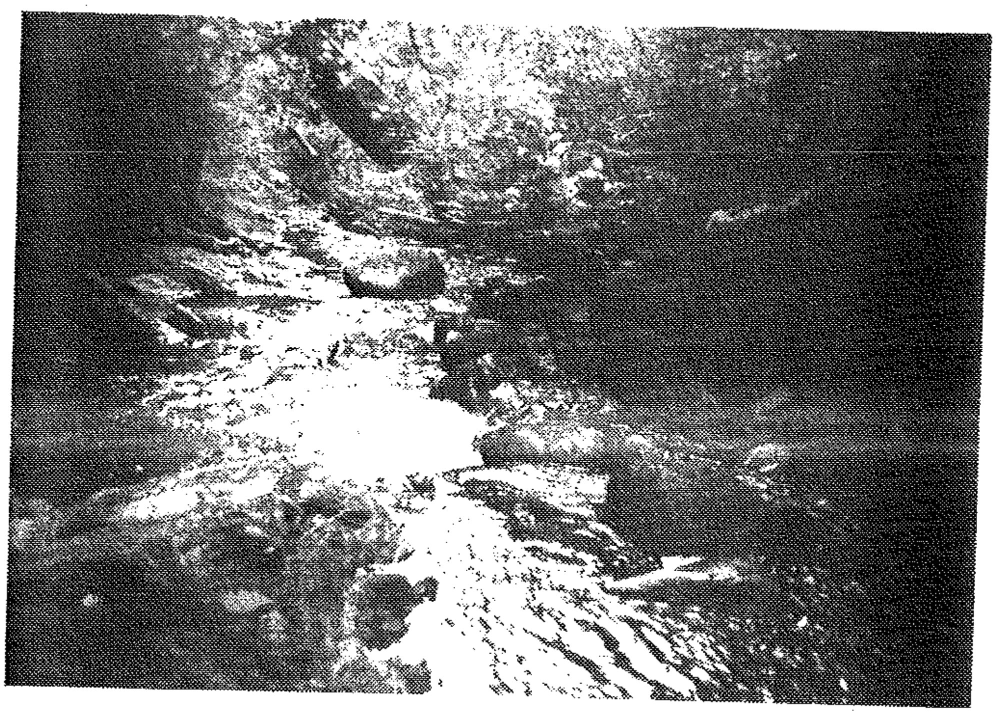
LENGTH approx. 10 M REACH Bottom

SPECIES	AGE	fl-RANGE	$\overline{fl}$	MEAN WEIGHT	C_1	$\tilde{p}$	$\tilde{n}$	TOTAL BIOMASS	DENSITY NO./M^2	BIOMASS G/M^2	NO./LINEAR METER
CT	0+	46	46.00	0.97	1	0.7	1.43	1.39	0.10	0.09	0.14
CT	1+	91	91.00	7.54	1	0.7	1.43	10.78	0.10	0.72	0.14
SC	2	52-148	80.30	5.38	10	0.7	14.29	76.88	0.95	5.13	1.43
Σ Salmonids									0.20	0.81	
Σ All Species									1.15	5.94	

Habitat Description: 50% riffle / 30% glide / 20% pool

% Total Cover: 15% Substrate Type[2]: $B_{20}C_{25}LG_{10}SG_{15}F_{25}Br_5$ $\bar{X}$ Depth: 0.15 m

Cover Type[1]: Boulder/cobble Temperature: 19.0 °C $\bar{X}$ Velocity: 0.3 m/s



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

Washout Creek
(Outlet of Inland Lake)

DATE July 11 /85 AREA 31.6 M^2 SITE 2

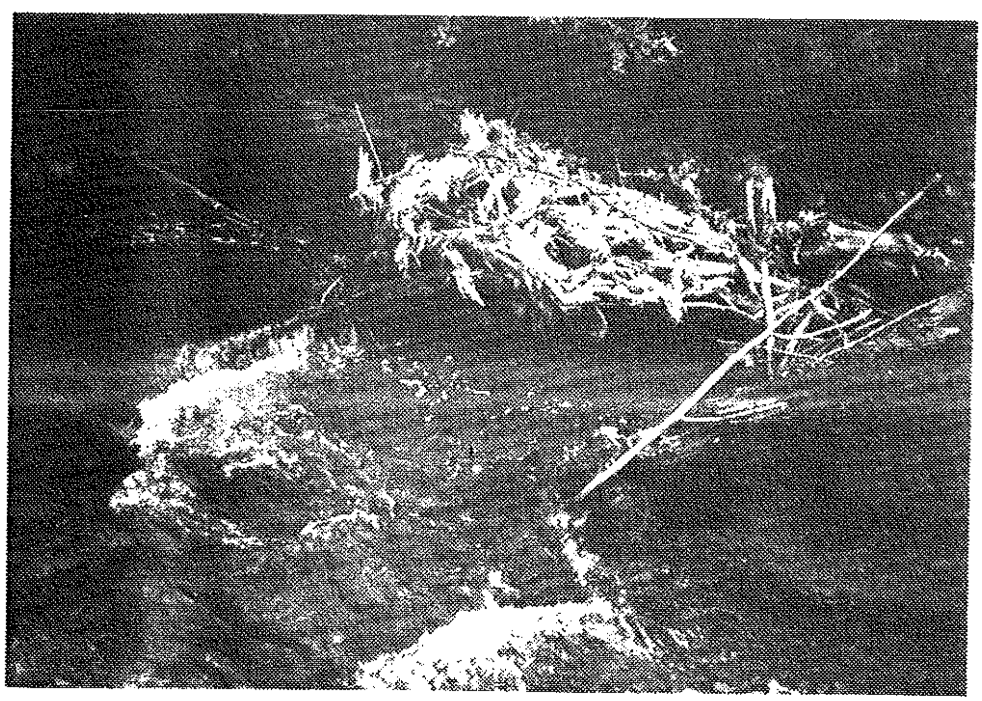
LENGTH 7.3 M REACH Bottom

SPECIES	AGE	fl-RANGE	$\overline{fl}$	MEAN WEIGHT	C_1	$\hat{p}$	$\hat{n}$	TOTAL BIOMASS	DENSITY NO./M^2	BIOMASS G/M^2	NO./LINEAR METER
CT	0+	57-69	62.00	2.38	3	0.7	4.29	10.21	0.14	0.32	0.59
CT	1+	94	94.00	8.31	1	0.7	1.43	11.88	0.05	0.38	0.20
SC	Σ	47-168	77.88	5.30	42	0.7	60.00	318.00	1.90	10.06	8.22
Σ Salmonids									0.19	0.70	
Σ All Species									2.09	10.76	

Habitat Description: 50% pool / 40% glide / 10% riffle

% Total Cover: 20% Substrate Type[2]: B, C20 LG15 SG15 Sand50 $\bar{X}$ Depth: 0.4 m

Cover Type[1]: debris Temperature: 21.0°C $\bar{X}$ Velocity: 0.2 m/s



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

Olsen Creek DATE Sept. 18/85 AREA 25.7 M^2 SITE 3

LENGTH 9.0 M REACH LOWER

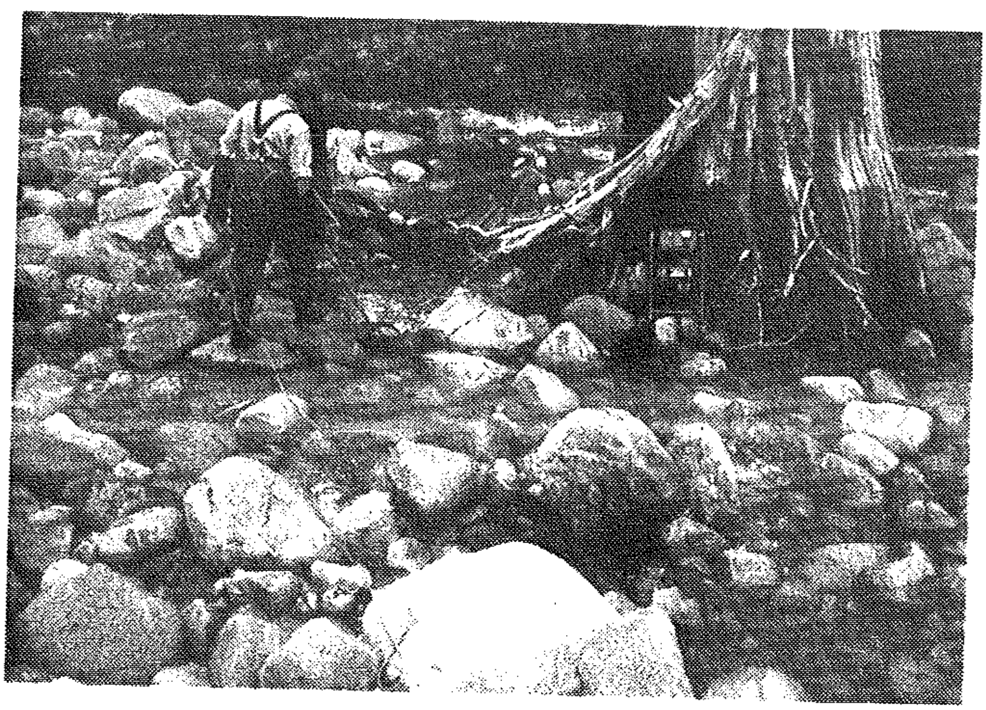
SPECIES	AGE	fl-RANGE	$\overline{fl}$	MEAN WEIGHT	C_1	$\hat{p}$	$\hat{n}$	TOTAL BIOMASS	DENSITY NO./M^2	BIOMASS G/M^2	NO./LINEAR METER
RB	0+	49	49.00	1.06*	1	0.7	1.43	1.51	0.06	0.06	0.22
CT	0+	68	68.00	2.83*	1	0.7	1.43	4.04	0.06	0.16	0.22
SC		165	165.00	46.72	1	0.7	1.43	66.81	0.06	2.60	0.22
Σ Salmonids									0.12	0.22	0.44
Σ All Species									0.18	2.82	0.66

Habitat Description: 50% riffle / 30% step pool / 20% glide

% Total Cover: 40% Substrate Type[2]: B_{60} C_{25} G_{10} $Sand_5$ $\bar{X}$ Depth: 0.15 m

Cover Type[1]: boulder/cobble Temperature: 13.0 °C $\bar{X}$ Velocity: 0.3 m/s

* estimated (employing condition factor of 0.90×10^{-5} g/fl³)



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

Olsen Creek DATE Sept. 18/85 AREA approx. 20 M² SITE (36) Spot-shock

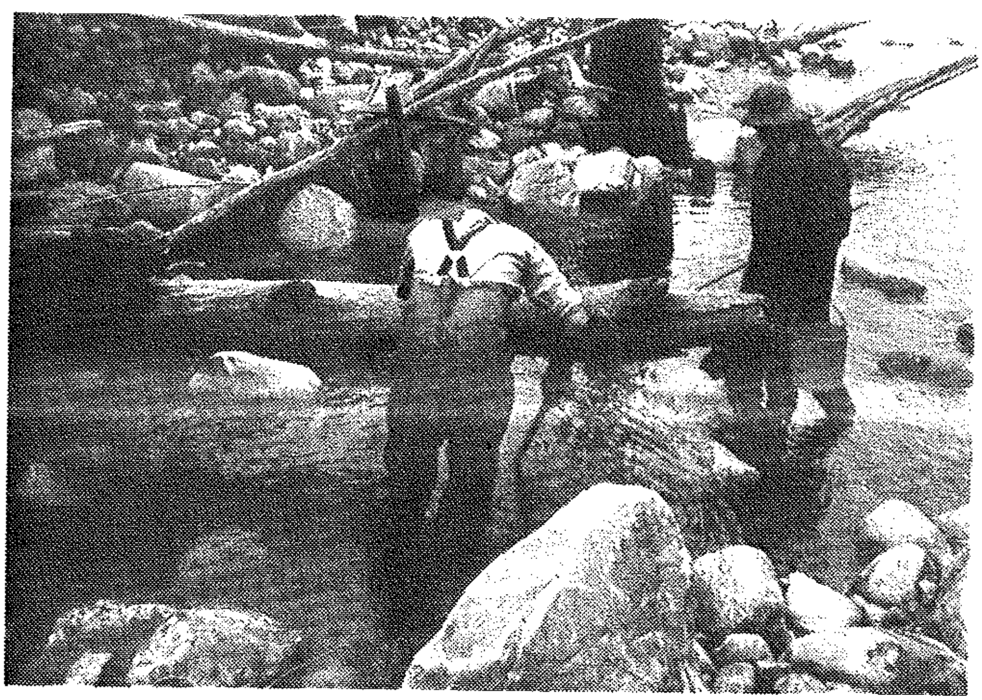
LENGTH ______ M REACH Lower

SPECIES	AGE	fl-RANGE	$\overline{fl}$	MEAN WEIGHT	C_1	$\tilde{p}$	$\tilde{n}$	TOTAL BIOMASS	DENSITY NO./M²	BIOMASS G/M²	NO./LINEAR METER
RB	0+	40-66	51.25	1.22	4	0.7	5.71	6.97	0.29	0.35	
Σ Salmonids									0.29	0.35	
Σ All Species									"	"	

Habitat Description: 100% sidepool

% Total Cover: 40% Substrate Type²: B_{30} C_{40} G_{10} $Sand_{20}$ X̄ Depth: 0.4 m

Cover Type¹: logs/debris/boulders Temperature: 13.0 °C X̄ Velocity: ≈ 0 m/s



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

Eldred River DATE Sept. 19/85 AREA 93.1 M^2 SITE 4

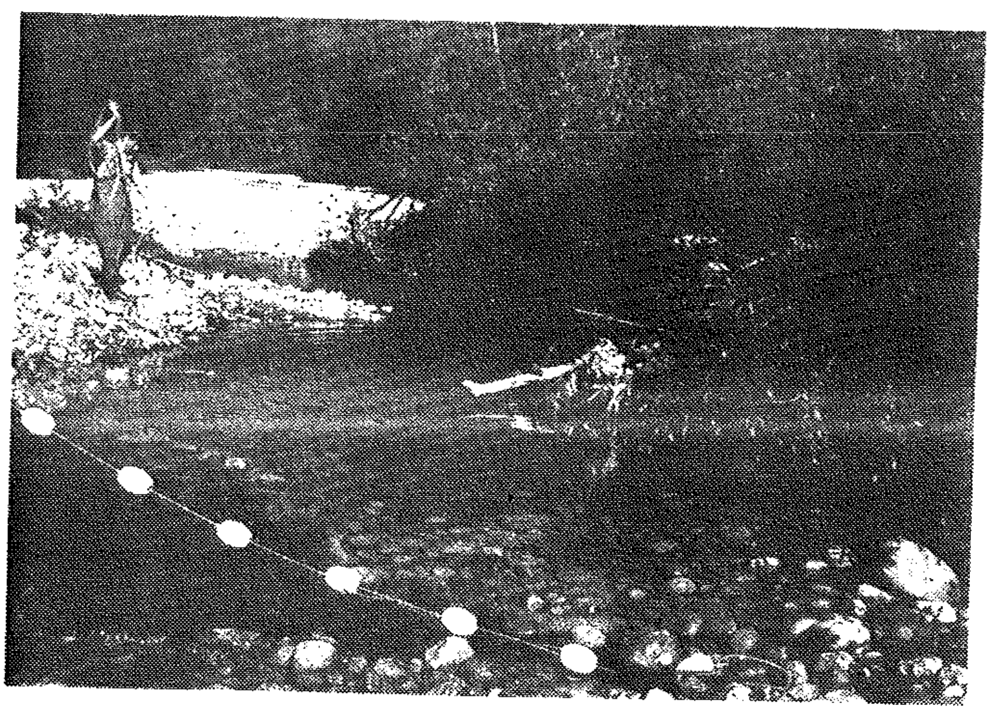
LENGTH 18.0 M REACH Lower

SPECIES	AGE	fl-RANGE	$\overline{fl}$	MEAN WEIGHT	C_1	$\tilde{p}$	$\tilde{n}$	TOTAL BIOMASS	DENSITY NO./M^2	BIOMASS G/M^2	NO./LINEAR METER
RB	0+	43-51	47.00	1.25	2	0.7	2.86	3.58	0.03	0.04	0.16
CT	0+	42-68	51.19	1.29	16	0.7	22.86	29.46	0.25	0.32	1.27
CT	1+	114-125	121.33	16.02	3	0.7	4.29	68.66	0.05	0.74	0.24
SC		55-108	76.44	4.63	9	0.7	12.86	59.54	0.14	0.64	0.71
Σ Salmonids									0.33	1.10	
Σ All Species									0.47	1.74	

Habitat Description: 50% pool / 45% glide / 5% riffle

% Total Cover: 30% Substrate Type[2]: B5 C40 LG25 SG15 Sand 15 $\bar{X}$ Depth: 0.4 m

Cover Type[1]: 10% debris (parr) 20% cobble (fry) Temperature: 12.5°C $\bar{X}$ Velocity: 0.2 m/s



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

Powell River DATE Sept 17/85 AREA 80.2 M^2 SITE 5

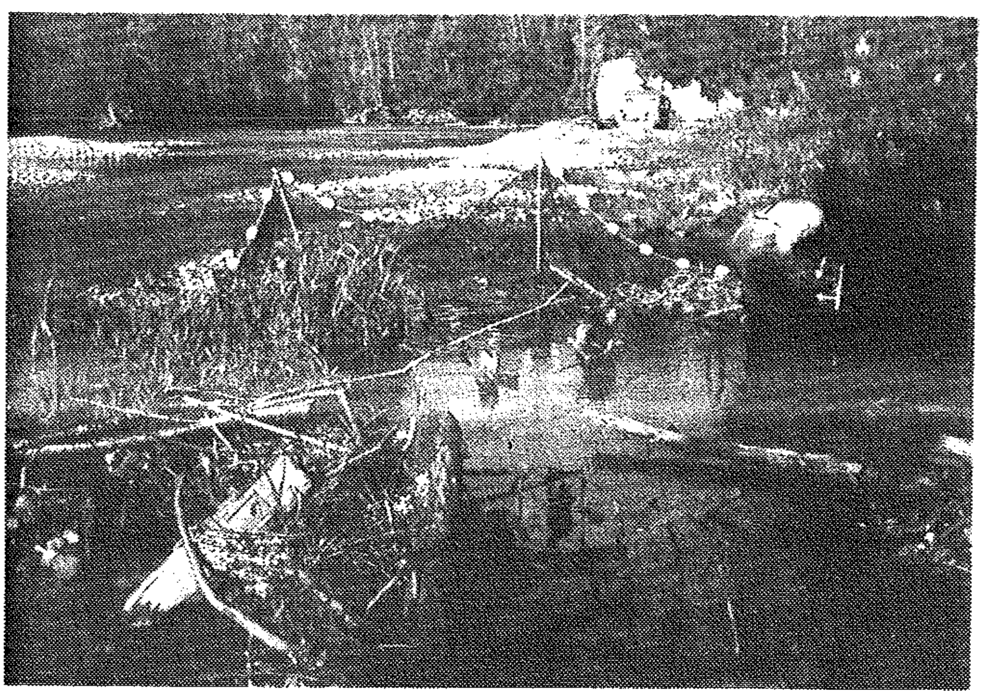
LENGTH 18.7 M REACH Middle

SPECIES	AGE	fl-RANGE	$\overline{fl}$	MEAN WEIGHT	C_1	$\tilde{p}$	$\tilde{n}$	TOTAL BIOMASS	DENSITY NO./M^2	BIOMASS G/M^2	NO./LINEAR METER
RB	0+	38-71	47.18	1.07	17	0.7	24.29	25.91	0.30	0.32	1.30
RB	1+	87-90	88.50	6.45	2	0.7	2.86	18.43	0.04	0.23	0.15
RB	2+	163	163.00	40.28	1	0.7	1.43	57.54	0.02	0.72	0.08
DV	0+	64-65	64.67	3.30	3	0.7	4.29	14.14	0.05	0.18	0.23
DV	1+	104-110	100.67	12.76	3	0.7	4.29	54.68	0.05	0.68	0.23
Σ Salmonids									0.46	2.13	
Σ All Species									"	"	

Habitat Description: 45% glide / 25% pool / 20% riffle / 10% backwater

% Total Cover: 30% Substrate Type[2]: $B_1 C_5 LG_{20} SG_{15}$ Sand 40 F_{20} $\bar{X}$ Depth: 0.25 m

Cover Type[1]: debris Temperature: 12.0°C $\bar{X}$ Velocity: 0.15 m/s



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

Powell River DATE Sept. 16/85 AREA 39.1 M^2 SITE 6

LENGTH 12.0 M REACH Upper

SPECIES	AGE	fl-RANGE	$\overline{fl}$	MEAN WEIGHT	C_1	$\tilde{p}$	$\tilde{n}$	TOTAL BIOMASS	DENSITY NO./M^2	BIOMASS G/M^2	NO./LINEAR METER
RB	0+	35-66	50.50	1.54	2	0.7	2.86	4.39	0.07	0.11	0.24
DV	0+	50-58	54.00	1.94	5	0.7	7.14	13.83	0.18	0.35	0.60
DV	1+	102	102.00	12.95	1	0.7	1.43	18.50	0.04	0.47	0.12
Σ Salmonids									0.29	0.93	
Σ All Species									"	"	

Habitat Description: 45% riffle / 30% glide / 20% pool / 10% rapids

% Total Cover: 40% Substrate Type[2]: B_{40} C_{30} LG_{10} SG_5 Sand 15 $\bar{X}$ Depth: 0.30 m

Cover Type[1]: boulder/cobble Temperature: 10.5 °C $\bar{X}$ Velocity: 0.25 m/s

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

Daniels River DATE Sept. 17/85 AREA 48.6 M^2 SITE 7

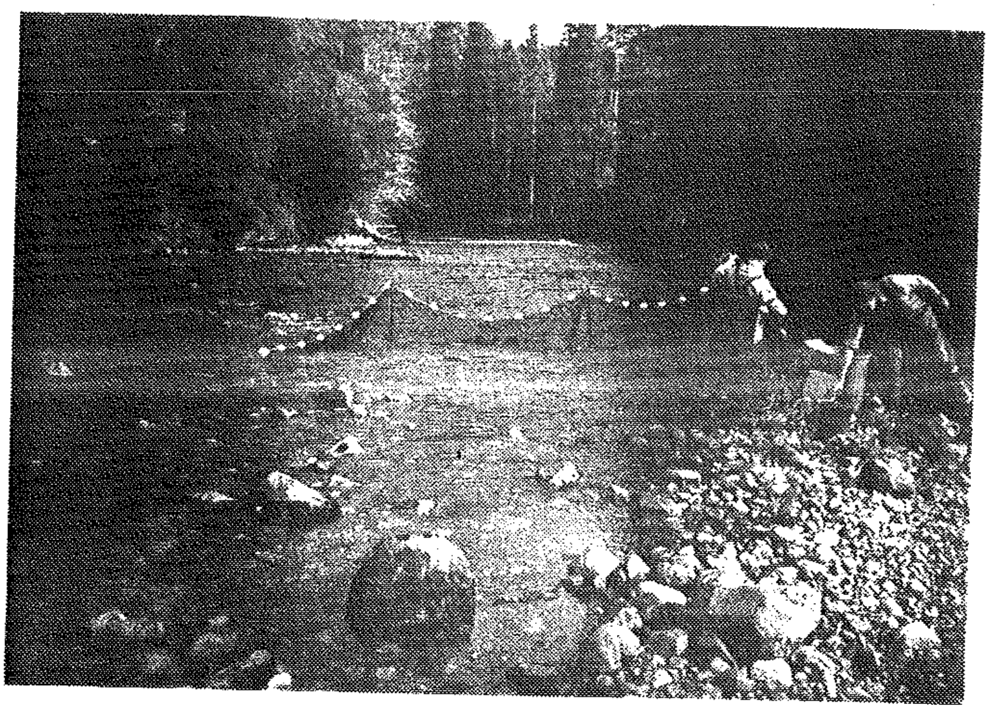
LENGTH 9.0 M REACH Lower

SPECIES	AGE	fl-RANGE	$\overline{fl}$	MEAN WEIGHT	C_1	$\hat{p}$	$\hat{n}$	TOTAL BIOMASS	DENSITY NO./M^2	BIOMASS G/M^2	NO./LINEAR METER
RB	0+	42-52	47.57	1.07	7	0.7	10.00	10.74	0.21	0.22	1.11
DV	0+	53	53.00	1.82	1	0.7	1.43	2.59	0.03	0.05	0.16
Σ Salmonids									0.24	0.27	
Σ All Species									"	"	

Habitat Description: 60% glide / 40% riffle

% Total Cover: 30% (fry) Substrate Type[2]: B10 C75 LG5 SG5 Sand5 $\bar{X}$ Depth: 0.3 m

Cover Type[1]: boulder/cobble Temperature: 11.0 °C $\bar{X}$ Velocity: 0.2 m/s



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

Daniels River DATE Sept. 17/85 AREA 30.7 M^2 SITE 8

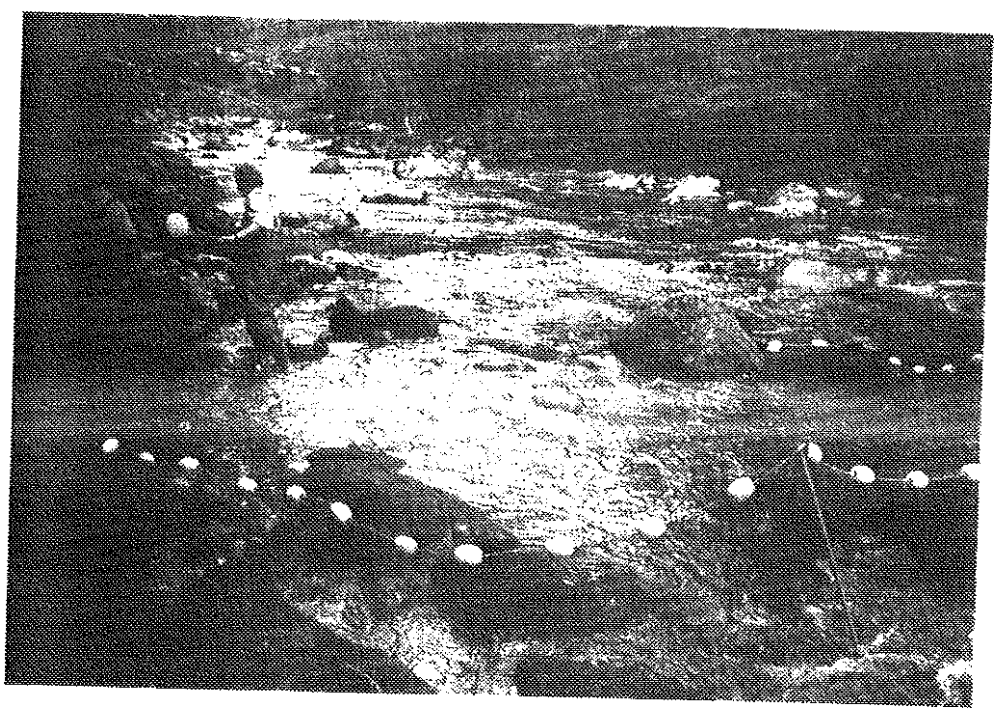
LENGTH 9.3 M REACH Middle

SPECIES	AGE	fl-RANGE	$\overline{fl}$	MEAN WEIGHT	C_1	$\tilde{p}$	$\tilde{n}$	TOTAL BIOMASS	DENSITY NO./M^2	BIOMASS G/M^2	NO./LINEAR METER
RB	0+	41-57	49.00	1.25	2	0.7	2.86	3.58	0.09	0.12	0.31
RB	1+	87-131	109.00	14.33	2	0.7	2.86	40.94	0.09	1.33	0.31
DV	0+	58-67	62.00	2.94	3	0.7	4.29	12.60	0.14	0.41	0.46
Σ Salmonids									0.32	1.86	
Σ All Species									"	"	

Habitat Description: 40% glide / 30% pocket pool / 30% riffle

% Total Cover: 50% Substrate Type[2]: B60 C30 G5 Sand 5 $\bar{X}$ Depth: 0.4 m

Cover Type[1]: boulder/cobble Temperature: 11.0°C $\bar{X}$ Velocity: 0.3 m/s



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 III. Results of swim surveys in the Powell River, September, 1985.

SWIM NO: 1.   NAME: Lower Powell River

LOCATION: Confluence of Powell and Daniels River to a point 1400 m downstream.   Length 1400 m

TECHNIQUE: two swimmers, on separate sides of the stream, concentrating on "hot-spots."

DATE: Sept. 16/AM WEATHER: rain VISIBILITY: 1.0 - 1.5 m (poor)

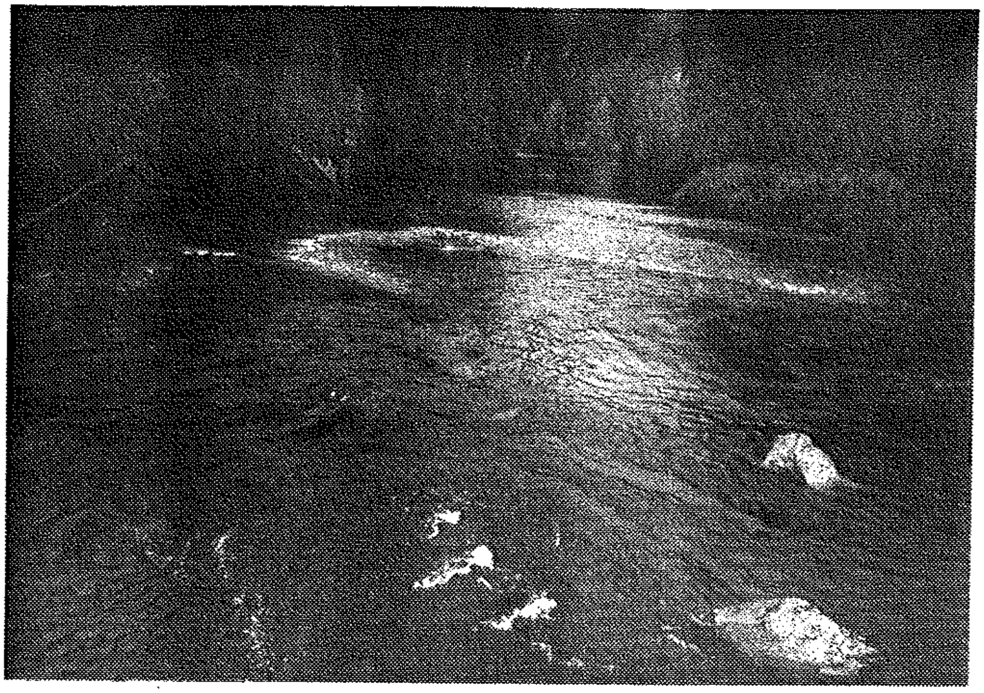
NUMBER OF SWIMMERS (LANES): 2

OBSERVATIONS: –   NOTE: FOR ROUGH ESTIMATE OF TOTAL FISH NUMBERS, MULTIPLY COUNTS BY 2.5.

SPECIES.	< 20 cm					20 - 30 cm					> 30 cm				
	LANE COUNTS					LANE COUNTS					LANE COUNTS				
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
RAINBOW	1	4				2	0				0				
TOTAL RBT	5					2									

Personnel:
lane 1: B. Griffith (west side)
lane 2: R. Neuman (east bank)
lane 3:
lane 4:
lane 5:

Comments:
i/ primarily deep (to very deep) run/pool/backeddy type habitat.
ii/ some excellent bouldery and/or debris cover at edge - mostly vacant.
iii/ all sorts of submerged aquatic vegetation (moss) but very little benthos.



Top of swim 1 (Powell/Daniels confluence) looking downstream.
NOTE: deep water habitat in background.

Near bottom of swim 1, looking upstream. NOTE: rapid habitat with large boulders (in background) and slow deep run (in foreground).

SWIM NO: 2 NAME: Middle Powell River

LOCATION: Commencing 4.7 km upstream of Powell Lake: Length 1000 m terminating 3.7 km upstream of Powell Lake.

TECHNIQUE: two swimmers, on opposite sides of the stream, concentrating on "hot-spots."

DATE: Sept. 16/PM WEATHER: rain VISIBILITY: ca. 2.0 m

NUMBER OF SWIMMERS (LANES): 2

OBSERVATIONS:

NOTE: FOR ROUGH ESTIMATES OF TOTAL FISH NUMBERS, MULTIPLY COUNTS BY 2.5.

SPECIES.	< 20 cm					20 - 30 cm					> 30 cm				
	LANE COUNTS					LANE COUNTS					LANE COUNTS				
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
RAINBOW	8	10				6	1								
TOTAL RBT	18					7									

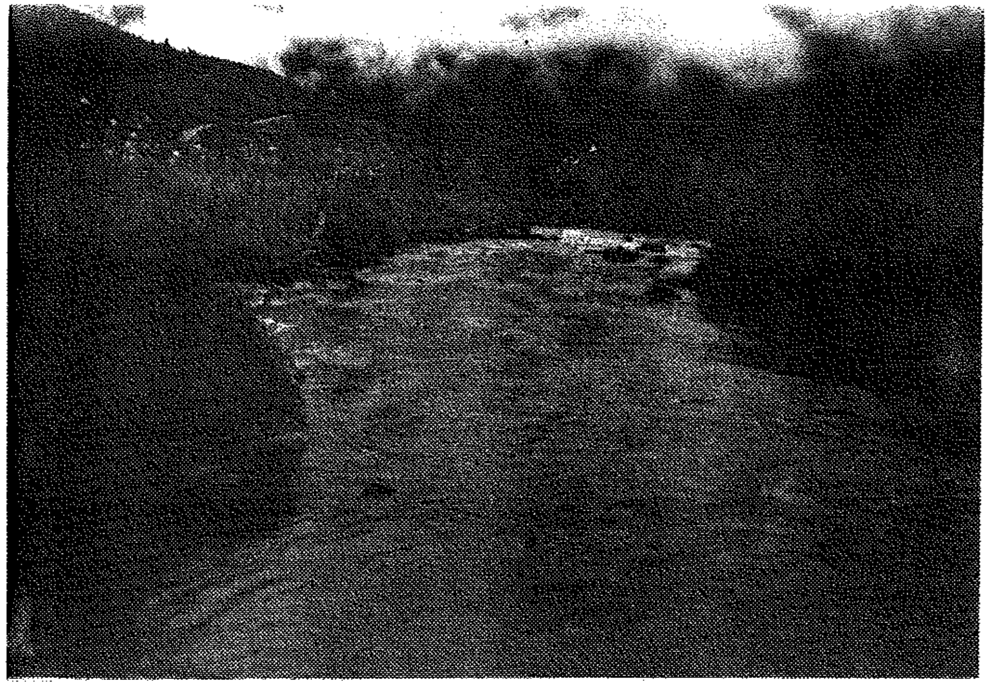
Personnel: lane 1: R. Griffith (west side)
lane 2: R. Neuman (east side)
lane 3:
lane 4:
lane 5:

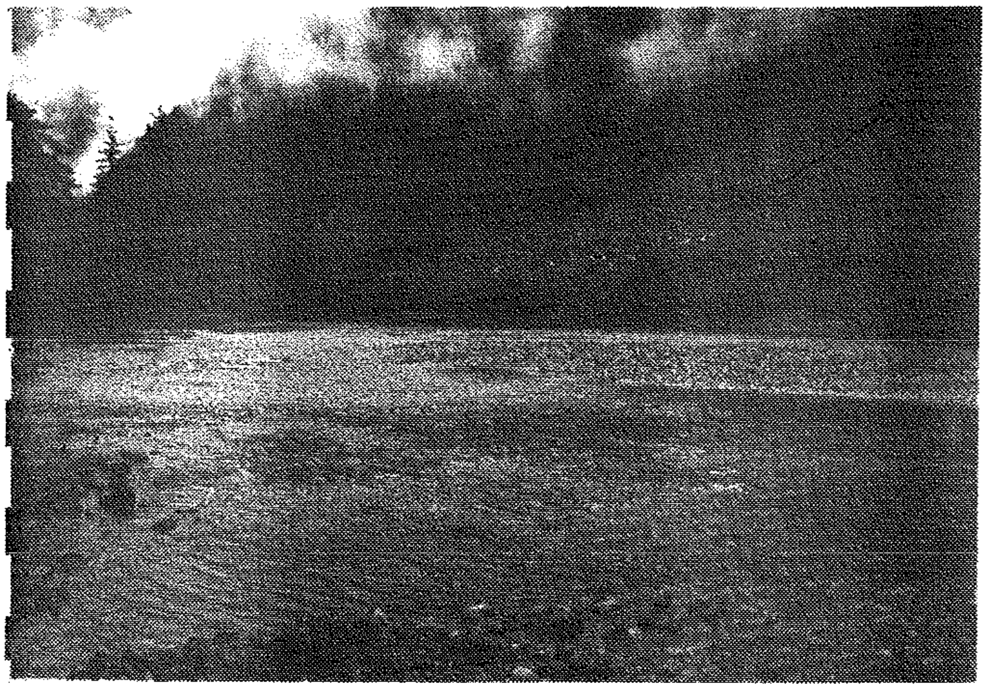
Comments:

i) approx 40% of swim length was heavy duty rapids with large to huge (>5m) boulders; most fish observed here (pocket water, backeddies)

ii) other 60% mostly deep run with sidepools etc.; little debris cover; few fish seen.

Top of swim 2, looking downstream





Bottom of swim 2, looking upstream. NOTE: abundant gravels, and lack of habitat complexity

Bottom of swim 2, looking downstream. NOTE: commencement of rapids with large boulders (in background)

Appendix IV. Analytical results for water samples taken from the Powell, Daniels, and Eldred rivers, Sept. 1985.

ENVIRONMENTAL LABORATORY
Report for form 00011566

Fish & Wildlife Br. - Fish Program ATTN: GRIFFITH R P

Site: NOSITE POWELL RIVER

From :85/09/17:0000 To :85/09/17:0000
Depth Range 0.0 0.0 Tide
Sample State Fresh Water Sample 85012448

Parameter Description	Analytical Technique	Result	Units
Residue Filterable = TDS	Gravimetric 105C	?	mg/L
4 mg/L. Sample was received frozen.			
Nitrogen NO3+NO2 Dis	Froz. Aut. Cadmium Red'n	< 0.02	mg/L
Nitrogen NO3 Diss(N)	Calculated Result	< 0.02	mg/L
Nitrogen NO2 Diss(N)	Froz. Auto. Diazotiz'n	< 0.005	mg/L
Phosphorus Total	Froz. Dig. Aut. Ascorbic Ac	0.005	mg/L
Conductance Specific	Special Analysis		

3 uS/cm
Sample received frozen.
The cost of this special analysis was $ 8.40

MINISTRY OF ENVIRONMENT
ENVIRONMENTAL LABORATORY
Report for form 00011565

Fish & Wildlife Br.- Fish Program ATTN: GRIFFITH R P

Site: NOSITE DANIELS RIVER

From :85/09/17:0000 To :85/09/17:0000
Depth Range 0.0 0.0 Tide
Sample State Fresh Water Sample 85012446

Parameter Description	Analytical Technique	Result	Units
Residue Filterable = TDS	Gravimetric 105C	?	mg/L
4 mg/L. Sample was received frozen.			
Nitrogen NO3+NO2 Dis	Froz.Aut.Cadmium Red'n	0.05	mg/L
Nitrogen NO3 Diss(N)	Calculated Result	0.05	mg/L
Nitrogen NO2 Diss(N)	Froz.Auto.Diazotiz'n	< 0.005	mg/L
Phosphorus Total	Froz.Dig.Aut.Ascorbic Ac	0.005	mg/L
Conductance Specific	Special Analysis		

7 uS/cm
Sample received frozen.
The cost of this special analysis was $ 8.40

MINISTRY OF ENVIRONMENT
ENVIRONMENTAL LABORATORY
Report for form 00011567

Fish & Wildlife Br. - Fish Program ATTN: GRIFFITH R P

Site: NOSITE ELDRED RIVER SITE 1

From : 85/09/19: 1300 To : 85/09/19: 1300
Depth Range 0.0 0.0 Tide
Sample State Fresh Water Sample 85012458

Parameter Description	Analytical Technique	Result	Units
Residue Filterable = TDS	Gravimetric 105C	?	mg/L
4 mg/L. Sample was received frozen.			
Nitrogen NO3+NO2 Dis	Froz. Aut. Cadmium Red'n	0.05	mg/L
Nitrogen NO3 Diss(N)	Calculated Result	0.05	mg/L
Nitrogen NO2 Diss(N)	Froz. Auto. Diazotiz'n	< 0.005	mg/L
Phosphorus Total	Froz. Dig. Aut. Ascorbic Ac	0.005	mg/L
Conductance Specific	Special Analysis		

9 uS/cm
Sample received frozen.
The cost of this special analysis was $ 8.40

Appendix V. Water quality data on file for Powell Lake.

MINISTRY OF THE ENVIRONMENT

WATER QUALITY REPORT FOR SAMPLE 002492W

TO: WATER INVESTIGATIONS BR
1106 COOK ST.
VICTORIA, B.C. V8V 3Z9
ATTENTION OF: C MCKEAN

FOR SITE: 1130046 POWELL LAKE

SAMPLING DATE(S): MAR 4/80 1200 HRS
SAMPLE TYPE: FRESH WATER
SAMPLING DEPTH: 0
SAMPLED BY: W.I.B. - ENVIRON. STUDIES
DATE RECEIVED BY LABORATORY: MAR 06/80

0040101	PH	6.5 REL UNIT	0050101	RESIDUE:TL 105C	12. MG/L
0060101	RES:FIX.550C	4. MG/L	0080101	RES: N-FILT.105	1. MG/L
0090102	RES:FX.NFIL 550	L 1. MG/L	0110101	SPECIFIC CONDUC	19. UMHO/CM
0150101	TURBIDITY	0.4 J.T.UNIT	0241701	COLOUR:TAC	6. T.A.C.
1020101	ALKALINITY:TOT	4.3 MG/L	1030101	CARBON:ORGANIC	2. MG/L
1041702	CHLORIDE:DISSOL	2.9 MG/L	1081703	NITROGN:AMMONIA	0.007 MG/L
1091703	NITROGN:NO2 NO3	0.10 MG/L	1120003	NITROGN:ORGANIC	0.07 MG/L
1130101	NITROGN:KJELDAH	0.08 MG/L	1140001	NITROGEN:TOTAL	0.18 MG/L
1181703	PHOSPHORUS:ORT	L 0.003 MG/L	1191703	PHOSPHORUS :TOT DISSOLVED	L 0.003 MG/L
1190103	PHOSPHORUS :TOT	0.003 MG/L	1201702	SILICA:REACTIVE	2.4 MG/L
1211701	SULPHATE:DISSOL	L 5.0 MG/L	1230101	TANNIN&LIGNIN	0.3 MG/L
1240101	CARBON:INORG.	L 1. MG/L	2530210	CADMIUM TOTAL	L 0.0005 MG/L
2541802	CALCIUM DISSOLVED	1.0 MG/L	2540303	CALCIUM TOTAL	1.1 MG/L

SAMPLE NO. 002492W CONTINUED ON NEXT PAGE.

MINISTRY OF THE ENVIRONMENT

WATER QUALITY REPORT FOR SAMPLE 002492*

2560210	COPPER TOTAL	0.001 MG/L	2570214	IRON TOTAL	L 0.01 MG/L
2560210	LEAD TOTAL	L 0.001 MG/L	2591801	MAGNESIUM DISSOLVED	0.3 MG/L
2590303	MAGNESIUM TOTAL	0.3 MG/L	2600214	MANGANESE TOTAL	L 0.01 MG/L
2620204	MOLYBDENUM TOTAL	L 0.0005 MG/L	2630210	NICKEL TOTAL	L 0.01 MG/L
2641703	POTASSIUM DISSOLVED	0.2 MG/L	2651703	SODIUM DISSOLVED	1.9 MG/L
2660210	ZINC TOTAL	L 0.005 MG/L	2670214	ALUMINUM TOTAL	0.03 MG/L

THE APPROXIMATE COST OF THE ABOVE TESTS IS $ 141.80

THERE IS NO CHARGE FOR THE FOLLOWING TESTS

0300101	COMP.DIL.COND.	N UMHO/CM

REMARKS:

FOR ENVIRONMENTAL LABORATORY

WATER QUALITY REPORT FOR SAMPLE 002493W

TO: WATER INVESTIGATIONS BR
1106 COOK ST,
VICTORIA,B.C. V8V 3Z9
ATTENTION OF: C MCKEAN

FOR SITE: 1130046 DOWELL LAKE

SAMPLING DATE(S): MAR 4/80 1200 HRS
SAMPLE TYPE: FRESH WATER
SAMPLING DEPTH: 50
SAMPLED BY: W.I.B. - ENVIRON. STUDIES
DATE RECEIVED BY LABORATORY: MAR 06/80

0040101	PH	6.8 REL UNIT	0050101	RESIDUE:TL 105C	12. MG/L
0060101	RES:FIX.550C	4. MG/L	0080101	RES: N-FILT.105	1. MG/L
0090102	RES:FX.NFIL 550	L 1. MG/L	0110101	SPECIFIC CONDUC	18. UMHO/CM
0150101	TURBIDITY	0.4 J.T.UNIT	0241701	COLOUR:TAC	4. T.A.C.
1020101	ALKALINITY:TOT	4.3 MG/L	1030101	CARBON:ORGANIC	1. MG/L
1041702	CHLORIDE:DISSOL	2.8 MG/L	1061703	NITROGN:AMMONIA	L 0.005 MG/L
1091703	NITROGN:NO2 NO3	0.10 MG/L	1120003	NITROGN:ORGANIC	0.07 MG/L
1130101	NITROGN:KJELDAH	0.07 MG/L	1140001	NITROGEN:TOTAL	0.17 MG/L
1181703	PHOSPHORUS:ORT	L 0.003 MG/L	1191703	PHOSPHORUS :TOT DISSOLVED	L 0.003 MG/L
1190103	PHOSPHORUS :TOT	L 0.003 MG/L	1201702	SILICA:REACTIVE	2.4 MG/L
1211701	SULPHATE:DISSOL	L 5.0 MG/L	1240101	CARBON:INORG.	L 1. MG/L
2530210	CADMIUM TOTAL	L 0.0005 MG/L	2541802	CALCIUM DISSOLVED	1.0 MG/L
2540303	CALCIUM TOTAL	1.1 MG/L	2560210	COPPER TOTAL	0.001 MG/L

SAMPLE NO. 002493W CONTINUED ON NEXT PAGE.

WATER QUALITY REPORT FOR SAMPLE 002493W

2570214	IRON TOTAL	L 0.01 MG/L	2580210	LEAD TOTAL	L 0.001 MG/L
2591801	MAGNESIUM DISSOLVED	0.3 MG/L	2590303	MAGNESIUM TOTAL	0.3 MG/L
2600214	MANGANESE TOTAL	L 0.01 MG/L	2620204	MOLYBDENUM TOTAL	0.0005 MG/L
2630210	NICKEL TOTAL	L 0.01 MG/L	2641703	POTASSIUM DISSOLVED	0.2 MG/L
2651703	SODIUM DISSOLVED	1.8 MG/L	2660210	ZINC TOTAL	L 0.005 MG/L
2670214	ALUMINUM TOTAL	L 0.02* MG/L			

THE APPROXIMATE COST OF THE ABOVE TESTS IS $ 134.60

THERE IS NO CHARGE FOR THE FOLLOWING TESTS

0300101	COMP.DIL.COND.	N UMHO/CM

REMARKS:

FOR ENVIRONMENTAL LABORATORY

MINISTRY OF THE ENVIRONMENT

WATER QUALITY REPORT FOR SAMPLE 002494W

TO: WATER INVESTIGATIONS BR
1106 COOK ST,
VICTORIA,B.C. V8V 3Z9
ATTENTION OF: C MCKEAN

FOR SITE: 1130046 DOWELL LAKE

SAMPLING DATE(S): MAR 4/80 1200 HRS
SAMPLE TYPE: FRESH WATER
SAMPLING DEPTH: 150
SAMPLED BY: W.I.B. - ENVIRON. STUDIES
DATE RECEIVED BY LABORATORY: MAR 06/80

0040101	PH	6.6 REL UNIT	0050101	RESIDUE:TL 105C	122. MG/L
0060101	RES:FIX.550C	90. MG/L	0071701	RES:FILT.105C	120. MG/L
0080101	RES: N-FILT.105	1. MG/L	0090102	RES:FX.NFIL 550	L 1. MG/L
0110101	SPECIFIC CONDUC	221. UMHO/CM	0150101	TURBIDITY	0.5 J.T.UNIT
0241701	COLOUR:TAC	3. T.A.C.	0300101	COMP.DIL.COND.	235. UMHO/CM
1020101	ALKALINITY:TOT	13.3 MG/L	1030101	CARBON:ORGANIC	1. MG/L
1041702	CHLORIDE:DISSOL	57.7 MG/L	1061703	NITROGN:AMMONIA	0.034 MG/L
1091703	NITROGN:NO2 NO3	0.11 MG/L	1100001	NITROGEN:NO3	0.11* MG/L
1111701	NITROGEN:NO2	L 0.005* MG/L	1120003	NITROGN:ORGANIC	0.08 MG/L
1130101	NITROGN:KJELDAH	0.11 MG/L	1140001	NITROGEN:TOTAL	0.22* MG/L
1181703	PHOSPHORUS:ORT	L 0.003 MG/L	1191703	PHOSPHORUS :TOT DISSOLVED	0.003 MG/L
1190103	PHOSPHORUS :TOT	0.004 MG/L	1211701	SULPHATE:DISSOL	L 5.0 MG/L
1240101	CARBON:INORG.	5. MG/L	2530210	CADMIUM TOTAL	L 0.0005 MG/L

SAMPLE NO. 002494W CONTINUED ON NEXT PAGE.

WATER QUALITY REPORT FOR SAMPLE 002494A

2541802	CALCIUM DISSOLVED	2.8 MG/L	2540303	CALCIUM TOTAL	2.9 MG/L
2560210	COPPER TOTAL	0.002 MG/L	2570214	IRON TOTAL	L 0.01 MG/L
2580210	LEAD TOTAL	L 0.001 MG/L	2591801	MAGNESIUM DISSOLVED	3.9 MG/L
2590303	MAGNESIUM TOTAL	3.9 MG/L	2600214	MANGANESE TOTAL	0.43 MG/L
2620204	MOLYBDENUM TOTAL	L 0.0005 MG/L	2630210	NICKEL TOTAL	L 0.01 MG/L
2641703	POTASSIUM DISSOLVED	1.1 MG/L	2651703	SODIUM DISSOLVED	32.7 MG/L
2660210	ZINC TOTAL	L 0.005 MG/L	2670214	ALUMINUM TOTAL	L 0.02* MG/L

THE APPROXIMATE COST OF THE ABOVE TESTS IS $ 136.60

THERE IS NO CHARGE FOR THE FOLLOWING TESTS

1250801	SULPHIDE:TOTAL	E MG/L

REMARKS:

[signature]
FOR ENVIRONMENTAL LABORATORY

MINISTRY OF THE ENVIRONMENT

WATER QUALITY REPORT FOR SAMPLE 204462W

TO: AQUATIC STUDIES BRANCH
765 BROUGHTON ST.
VICTORIA, B.C. V8V 1X5
ATTENTION OF: I BOYD

FOR SITE: 1130046 POWELL LAKE

SAMPLING DATE(S): MAY 5/82 0000 HRS
SAMPLE TYPE: FRESH WATER
SAMPLING DEPTH: 0
SAMPLED BY: AQUATIC STUDIES BR., MOE
CHARGE TO: AQUATIC STUDIES
DATE RECEIVED BY LABORATORY: MAY 07/82

0022001	COLOUR:TRUE	5. REL UNIT	0040101	PH	6.6 REL UNIT
0050101	RESIDUE:TL 105C	14. MG/L	0060101	RES:FIX,550C	3. MG/L
0080101	RES: N-FILT,105	L 1. MG/L	0090102	RES:FX.NFIL 550	L 1. MG/L
0110101	SPECIFIC CONDUC	16. UMHO/CM	0150101	TURBIDITY	0.4* N.T.U.
1000003	SPECIAL ANALYS.	K MG/L	1000001	SPECIAL ANALYS.	K MG/L
1041702	CHLORIDE:DISSOL	2.1 MG/L	1081704	NITROGN:AMMONIA	0.007 MG/L
1091703	NITROGN:NO2 NO3	0.09 MG/L	1120003	NITROGN:ORGANIC	0.07 MG/L
1130101	NITROGN:KJELDAH	0.08 MG/L	1140001	NITROGEN:TOTAL	0.17 MG/L
1181703	PHOSPHORUS:ORT	L 0.003 MG/L	1191703	PHOSPHORUS :TOT DISSOLVED	0.004 MG/L
1190103	PHOSPHORUS :TOT	0.010 MG/L	1201708	SILICA:REACTIVE	2.6 MG/L
2530210	CADMIUM TOTAL	L 0.0005 MG/L	2560210	COPPER TOTAL	L 0.001 MG/L
2580210	LEAD TOTAL	0.001 MG/L	2630210	NICKEL TOTAL	L 0.01 MG/L
2641703	POTASSIUM DISSOLVED	0.2 MG/L	2651703	SODIUM DISSOLVED	1.5 MG/L

SAMPLE NO. 204462W CONTINUED ON NEXT PAGE.

ENVIRONMENTAL LABORATORY
MINISTRY OF THE ENVIRONMENT

METAL SCAN FOR SAMPLE 204462W

[illegible]4	ARSENIC TOTAL	L 0.25 MG/L	2660214	ZINC TOTAL	L 0.01 MG/L
[illegible]0214	LEAD TOTAL	L 0.10 MG/L	2530214	CADMIUM TOTAL	L 0.01 MG/L
2630214	NICKEL TOTAL	L 0.05 MG/L	2600214	MANGANESE TOTAL	L 0.01 MG/L
2570214	IRON TOTAL	0.02 MG/L	2590214	MAGNESIUM TOTAL	0.23 MG/L
2620214	MOLYBDENUM TOTAL	L 0.01 MG/L	2550214	CHROMIUM TOTAL	L 0.01 MG/L
2720214	VANADIUM TOTAL	L 0.01 MG/L	2560214	COPPER TOTAL	L 0.01 MG/L
2680214	COBALT TOTAL	L 0.10 MG/L	2670214	ALUMINUM TOTAL	0.04 MG/L
2540214	CALCIUM TOTAL	1.00 MG/L			
1070003	HARDNESS	3.42 MG/L			

THE COST OF THE ABOVE TESTS IS $20.00

REMARKS:

....
FOR ENVIRONMENTAL LABORATORY

MINISTRY OF THE ENVIRONMENT

WATER QUALITY REPORT FOR SAMPLE 013686W

TO: AQUATIC STUDIES H.Q.
1106 COOK STREET
VICTORIA BC V8V 3Z9
ATTENTION OF: C MCKEAN

FOR SITE: 1130046 POWELL LAKE

SAMPLING DATE(S): AUG 13/80 0000 HRS
SAMPLE TYPE: FRESH WATER
SAMPLING DEPTH: 100
SAMPLED BY: AQUATIC STUDIES BR., MOE
DATE RECEIVED BY LABORATORY: AUG 15/80

0022001	COLOUR:TRUE	L 5. REL UNIT	0040101	PH	6.5 REL UNIT
0050101	RESIDUE:TL 105C	34. MG/L	0060101	RES:FIX,550C	24. MG/L
0080101	RES: N-FILT,105	2.* MG/L	0090102	RES:FX,NFIL 550	L 1. MG/L
0110101	SPECIFIC CONDUC	53. UMHO/CM	0150101	TURBIDITY	0.3 J.T.UNIT
0241701	COLOUR:TAC	2. T.A.C.	1010101	ALKALINITY:PHNL	L 0.5 MG/L
1020101	ALKALINITY:TOT	5.9* MG/L	1030101	CARBON:ORGANIC	1. MG/L
1041702	CHLORIDE:DISSOL	11.7 MG/L	1061701	FLUORIDE:DISSOL	L 0.1 MG/L
1070002	HARDNES,T:CACO3	5.97 MG/L	1081703	NITROGN:AMMONIA	0.009 MG/L
1091703	NITROGN:NO2 NO3	0.13 MG/L	1100001	NITROGEN:NO3	0.13 MG/L
1111701	NITROGEN:NO2	L 0.005 MG/L	1120003	NITROGN:ORGANIC	0.03 MG/L
1130101	NITROGN:KJELDAH	0.04 MG/L	1140001	NITROGEN:TOTAL	0.17 MG/L
1150101	OXYGEN:BIOCHEM	L 10. MG/L	1160501	OXYGEN:CHEM,DMN	L 10. MG/L
1181703	PHOSPHORUS:ORT	L 0.003 MG/L	1191703	PHOSPHORUS :TOT DISSOLVED	L 0.003 MG/L

SAMPLE NO. 013686W CONTINUED ON NEXT PAGE.

MINISTRY OF THE ENVIRONMENT

WATER QUALITY REPORT FOR SAMPLE D13686W

1190103	PHOSPHORUS :TOT	0.004 MG/L	1201702	SILICA:REACTIVE	2.5 MG/L
1211701	SULPHATE:DISSOL	L 5. MG/L	1230101	TANNIN&LIGNIN	0.1 MG/L
1240101	CARBON:INORG.	2. MG/L	2541802	CALCIUM DISSOLVED	1.4 MG/L
2540303	CALCIUM TOTAL	1.4 MG/L	2591801	MAGNESIUM DISSOLVED	0.6 MG/L
2590303	MAGNESIUM TOTAL	0.7 MG/L	2641703	POTASSIUM DISSOLVED	0.3 MG/L
2651703	SODIUM DISSOLVED	6.8 MG/L			

THE APPROXIMATE COST OF THE ABOVE TESTS IS $ 125.60

THERE IS NO CHARGE FOR THE FOLLOWING TESTS

0300101	COMP.DIL.COND.	N UMHO/CM

REMARKS:

....
FOR ENVIRONMENTAL LABORATORY

MINISTRY OF THE ENVIRONMENT

WATER QUALITY REPORT FOR SAMPLE 013684W

TO: AQUATIC STUDIES H.Q.
1106 COOK STREET
VICTORIA BC V8V 3Z9
ATTENTION OF: C MCKEAN

FOR SITE: 1130046 POWELL LAKE

SAMPLING DATE(S): AUG 13/80 0000 HRS
SAMPLE TYPE: FRESH WATER
SAMPLING DEPTH: 1
SAMPLED BY: AQUATIC STUDIES BR., MOE
DATE RECEIVED BY LABORATORY: AUG 15/80

0022001	COLOUR:TRUE	5. REL UNIT	0040101	PH	6.7 REL UNIT
0050101	RESIDUE:TL 105C	12. MG/L	0060101	RES:FIX.550C	8. MG/L
0080101	RES: N-FILT.105	2. MG/L	0090102	RES:FX.NFIL 550	L 1. MG/L
0110101	SPECIFIC CONDUC	12. UMHO/CM	0150101	TURBIDITY	0.6 J.T.UNIT
0241701	COLOUR:TAC	2. T.A.C.	1010101	ALKALINITY:PHNL	L 0.5 MG/L
1020101	ALKALINITY:TOT	5.3 MG/L	1030101	CARBON:ORGANIC	1. MG/L
1041702	CHLORIDE:DISSOL	0.8 MG/L	1061701	FLUORIDE:DISSOL	L 0.10 MG/L
1070002	HARDNES.T:CACO3	2.91 MG/L	1081703	NITROGN:AMMONIA	0.022 MG/L
1091703	NITROGN:NO2 NO3	0.05 MG/L	1120003	NITROGN:ORGANIC	0.29 MG/L
1130101	NITROGN:KJELDAH	0.31 MG/L	1140001	NITROGEN:TOTAL	0.36 MG/L
1150101	OXYGEN:BIOCHEM	L 10. MG/L	1160501	OXYGEN:CHEM.DMN	L 10. MG/L
1181703	PHOSPHORUS:ORT	L 0.003 MG/L	1191703	PHOSPHORUS :TOT DISSOLVED	L 0.003 MG/L
1190103	PHOSPHORUS :TOT	0.005 MG/L	1201702	SILICA:REACTIVE	2.2 MG/L

SAMPLE NO. 013684W CONTINUED ON NEXT PAGE.

WATER QUALITY REPORT FOR SAMPLE 013684W

1211701	SULPHATE:DISSOL	L 5.0 MG/L	1230101	TANNIN&LIGNIN	0.2 MG/L
1240101	CARBON:INORG.	L 1. MG/L	2541802	CALCIUM DISSOLVED	1.0 MG/L
2540303	CALCIUM TOTAL	1.0 MG/L	2591801	MAGNESIUM DISSOLVED	0.10 MG/L
2590303	MAGNESIUM TOTAL	0.15 MG/L	2641703	POTASSIUM DISSOLVED	0.2 MG/L
2651703	SODIUM DISSOLVED	1.0 MG/L			

THE APPROXIMATE COST OF THE ABOVE TESTS IS $ 123.10

THERE IS NO CHARGE FOR THE FOLLOWING TESTS

0300101	COMP.DIL.COND.	N UMHO/CM

REMARKS:

FOR ENVIRONMENTAL LABORATORY

Appendix VI. Results of scale analyses for cutthroat trout samples from Powell and Goat lakes, July 1985.

PATTERN	AGE	SAMPLE NO.	LENGTH (mm)	NET NO.	CUMULATIVE CIRCULUS COUNTS TO ANNULI 1	2	3	4	5	6	7	8	+
1.	2+	46	192	2	9	21							26
		(27)*	190	3	8	16							24
	3+	4	268	1	6	17	30						41
		6	236	1	8	17	29						40
		7	235	1	8	18	28						34
		8	274	1	8	19	33						41
		9	234	1	8	17	30						36
		10	246	1	7	16	31						38
		13	220	1	10	21	31						36
		14	216	1	8	19	29						35
		24	243	1	7	16	29						39
		31	193	2	6	16	28						34
		(13)	249	3	7	18	32						39
		(18)	222	3	7	17	35						39
		(24)	214	3	7	15	29						35
		(25)	203	3	6	14	25						30
	4+	23	314	1	9	18	29	41(s)					46
		39	237	2	7	15	24	40(s)					43
		(7)	256	3	9	20	30	45(s)					48
		(17)	238	3	7	16	27	45					51
	5+	36	302	2	8	18	29	42	54(s)				58
		(5)	368	3	9	20	29	37	48(s)				52
		(31)	335	3	7	16	31	42(s)	51				59
	6+	(1)	411	3	7	18	27	39(s)	50(s)	61			65
	7+	(4)	417	3	6	18	30	47(s)	55	62(s)			74
		(34)	433	3	6	15	30	43(s)	55	66(s)	77(s)		-

*brackets indicate that fish was caught in Goat Lake net.

Appendix VI. Continued

PATTERN	AGE	SAMPLE NO.	LENGTH (mm)	NET NO.	CUMULATIVE CIRCULUS COUNTS TO ANNULI 1	2	3	4	5	6	7	8	+
2.	3+	1	285	1	8	21	40						50
		38	260	2	8	19	36						43
	4+	29	337	1	7	21	39	53					62
	6+	(33)	310	3	8	17	33	55(s)	76(s)	88			91
3.	2+	15	215	1	10	26							32
		16	214	1	11	27							32
		47	195	2	8	26							32
		50	210	2	10	28							34
		(8)	241	3	8	27							34
	3+	5	254	1	7	23	41						47
		21	290	1	10	28	44						49
		27	246	1	7	24	37						43
		42	224	2	8	24	38						43
		43	258	2	9	28	39						42
		44	242	2	9	25	39						44
		45	239	2	8	23	38						43
		(19)	245	3	11	27	37						40
	4+	26	327	1	10	30	44	62					70
	6+	25	466	1	8	23	38	58	70(s)	83			82
		30	364	1	12	29	43	60(s)	73	82(s)			86
	8+	(30)	539	3	9	26	37	52(s)	63(s)	76(s)	92	100(s)	103
	7+	34	427	2	9	22	38	52(s)	65	80(s)	90(s)		93
		(3)	336	3	10	22	37	52	66(s)	82	94(s)		99

Appendix VII. Results of scale analyses for rainbow trout samples from Powell and Goat lakes, July 1985.

PATTERN	AGE	SAMPLE NO.	LENGTH (mm)	NET NO.	CUMULATIVE CIRCULUS COUNTS TO ANNULI 1	2	3	4	5	6	7	8	+
1.	5+	40	278	2	9	17	35	47(s)	59				71
	5+	(2)*	291	3	8	18	29	41(s0	50(s)				51
2.	6+	2	314	1	8	18	32	53	74(s)	86(s)			97
	6+	3	326	1	8	20	31	61(s)	70(s)	84(s)			90
	6+	35	294	2	10	23	39	54(s)	68	84(s)			87
	4+	(9)	254	3	8	26	38	58					66
	5+	32	334	2	10	22	33	49	67(s)				70
	6+	22	349	1	7	24	33	48	59(s)	69			80
	7+	(6)	355	3	8	20	32	55(s)	65	75	84(s)		86
3.	3+	11	190	1	10	28	40						47
	3+	12	214	1	10	34	49						55
	5+	(15)	255	3	10	28	45	67(s)	80(s)				84
	6+	33	339	2	9	20	42	60	80(s)	90(s)			91

* Brackets indicate that fish was caught in Goat Lake net.

Appendix VIII. Results of scale analyses for stream-caught trout juveniles in Powell Lake drainage, 1985

Cut

STREAM	DATE	SAMPLE NO.	SIZE	AGE	CUMULATIVE CIRCULIS ANNULUS 1	ANNULUS 2	+
Olsen Cr.	Sept/85	6	68	0+			9
Eldred R.	Sept/85	8	68	0+			7
		9	114	1+	7		15
		10	125	1+	7		16
		11	62	0+			6
		12	125	1+	8		17
Washout Cr. (Inland Lake Outlet)	July/85	1	51	0+			5
		2	94	1+	8		15
		3	67	0+			6
		4	60	0+			5
Lost Lake Outlet	July/85	5	91	1+	8		14

Results of scale analyses for stream-caught rainbow trout juveniles, 1985

STREAM	DATE	SAMPLE NO.	SIZE	AGE	CUMULATIVE CIRCULIS ANNULUS 1	ANNULUS 2	+
Powell R.	Sept/85	13	87	1+	6		12
		14	163	2+	6	19	24
		15	71	0+			9
		16	58	0+			8
		17	90	1+	5		13
		18	66	0+			7
Daniels R.	Sept/85	19	131	1+	8		18
		20	87	1+	6		14
		21	57	0+			4