HABITAT AND FISH POPULATION ASSESSMENT OF THE LOWER ELK RIVER (STRATHCONA PARK) IN RELATION TO SPORT FISHERIES ENHANCEMENT POTENTIAL

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ABSTRACT

Fish habitat and populations of the Elk River, Strathcona Park, Vancouver Island were investigated by the Fish Habitat Improvement Section in the summer and fall of 1978 as part of an overall program regarding possible rehabilitation of the Elk Valley. A decline in sport fisheries values in the Elk River and Upper Campbell Lake has occurred as a result of habitat alteration and destruction in the stream. Sports fish, including rainbow trout, cutthroat trout and Dolly Varden char were not abundant in the Elk River as adult resident or juvenile populations. Local abundance of juvenile salmonids was noted in some stable tributaries and mainstem side channels. Analysis of scales from a sample of Upper Campbell Lake fish indicated higher survival of fish which had spent one or more years rearing in a stream environment. A general enhancement strategy is outlined and recommendations for stream habitat improvement are made.

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF APPENDICES

1.0 INTRODUCTION

Fisheries values of the Elk River were considered good in the past. Haig-Brown (1939) considered angling on the Elk as perhaps the greatest of mountain streams within the Campbell River system. Angling was centered on resident cutthroat trout which spread through the stream in late July and August (Haig-Brown, 1946). Further fisheries value was attributed to the Elk River for its role as the primary spawning stream for Upper Campbell Lake fish (rainbow and cutthroat trout, and Dolly Varden char). McMynn and Larkin (1953) indicate the Elk River, after flooding of Upper Campbell Lake, as having roughly 57,000m^2 of spawning area. The lake prior to flooding and up until the mid to late 1960's, was recognized as a productive fishery, with catches of up to 4.5kg (10lb) cutthroat trout reported.

Both the Elk River and Upper Campbell Lake fisheries have severely declined since these early records. Creel census data from Upper Campbell Lake indicates the success rate of anglers has dropped from roughly 1.0 fish per hour in the early 1960's to roughly 0.2 fish per hour in recent years (W.R. Sjolund, pers. comm.). The stream fishery is certaily nothing like it was in the late 1930's as reported in Haig-Brown (1946). As the Elk River is the major site of recruitment to Upper Campbell Lake, the demise of both fisheries can be related in part to destruction of fish habitat in the stream. Other factors, specifically those related to impoundment of the lake, may play a more important role in their effects on lake productivity. McMynn and Larkin (1953) suggest some possible effects of reservoir creation and operation (eg. drawdown) on the fishery.

Fish production in the Elk River has been affected by habitat alteration and destruction in relation to instability of the floodplain and subsequent widening of the active channel. Specific mechanisms and causes are discussed in other sections of this study (Karanka and Kellerhals, in prep.). Preliminary air-photo analysis suggests that fish habitat loss has occurred in the following areas:

(1) Severe reduction in overhanging vegetation and undercut banks, qualities normally associated with stable rivers, due to widening of the active channel through bank erosion.

(2) Reduction in deep, stable pool areas with cover.

(3) A change in debris character from stable, bank associated material creating good fish habitat, to transient, "non-productive" debris.

Further problems are associated with excessive substrate movement and effects on spawning areas and food production.

The purpose of this project was to assess the problems of fish production within the Elk River, both as a stream fishery and as the primary site for recruitment to Upper Campbell Lake. Current status of the fish population was studied and important fish production areas were identified. Recommendations for enhancement of both stream and lake populations are made.

2.0 METHODS

Fish populations of the Elk River were studied by the "Ecological Diagnosis" method outlined by Ptolemy et al (1977). Briefly, this involves detailed habitat assessment followed by intensive fish sampling in sites representative of habitat types. Inferences about the fish population as a whole can then be made. Habitat assessment was done by detailed air-photo analysis and ground reconnaissance. All tributaries and mainstem areas were walked, and observations were keyed to large scale mapping in the lower 2 reaches. Upper areas (Reaches III and IV) did not have detailed mapping or air photos.

Fish population assessment was conducted by electrofishing and snorkel observations. An overview of fish distribution and habitat utilization, as well as relative abundance of adult and older juvenile fish, was obtained by snorkeling. This was the only method used in deep mainstem areas where electrofishing was not possible. In habitats where electrofishing could be done, such as tributary streams, side channels and mainstem edge habitat, fish population estimates were carried out. A sample of adult fish was taken from Upper Campbell Lake by netting and angling for scale analysis.

3.0 RESULTS

3.1 Habitat Assessment

Detailed description of fish habitat within the Elk River drainage was collected during the summer of 1978. A brief summary of habitat characteristics is contained in this report. Much more detailed information is available, including Resource Analysis Branch (R.A.B.) point sample cards and keyed maps of habitat type, substrate and gradient. This information was not included because of volume constraints.

The Elk River was broken into 4 mainstem reaches, plus tributaries (Figure 1). Some general physical parameters of reaches and tributaries are summarized in Table 1. Representative photographs are included in Appendix I.

TABLE 1 Summary of some physical parameters of streams within the Elk River drainage, Strathcona Park, 1978.

AREA	ACCESSIBLE LENGTH	CHANNEL WIDTH		GRADIENT	MAJOR SUBSTRATE TYPES	CHANNEL THREAD		FLOW CHARACTER	POOL/RUN/ RIFFLE	DEBRIS	
		ACTIVE	WETTED							AMOUNT	STABILITY
Elk R.-Reach I	6.25km	198m	26m	0.6%	gravel, sand	74% 26%	single (S) multiple (M)	rolling (broken)	1/93/7	high	low
Elk R.-Reach II	5.0	44	20	1.1	gravel, cobble, sand	95% 5%	S M	rolling - broken	1/50/50	high	med-low
Elk R.-Reach III	1.5	14	11	2.5	bedrock, boulder, cobble, gravel	100%	S	tumbling - broken - swirling	10/30/60	low	low
Elk R.-Reach IV	3.5	23	9	1.4	gravel, cobble, sand	80% 20%	S M	rolling - broken (tumbling)	1/40/60	med	med-high
Drum Cr.	0.8	10	9.5	0.2- 2.0	cobble, gravel sand	100%	S	rolling	/75/25	low	med
Idsardi Cr.	0.5	15	6.5	0.2-10.0	boulder, cobble	100%	S	broken	/20/80	low	low
Unnamed Cr.	0.5	7	6	0.2- 3.0	gravel, cobble	100%	S	rolling - broken	/80/20	med	med-high
Cervus Cr.	0.4	10	9	0.4- 1.0	cobble, gravel	100%	S	rolling	/70/30	low	low
Filberg Cr.	1.2	10	5	0.2-15.0	boulder, cobble, gravel	100%	S	rolling - broken	/40/60	med	high
Tlools Cr.	$>$7.5	9	8	0.2- 6.0	boulder, cobble, gravel	100%	S	rolling - broken (tumbling)	10/30/60	med	high

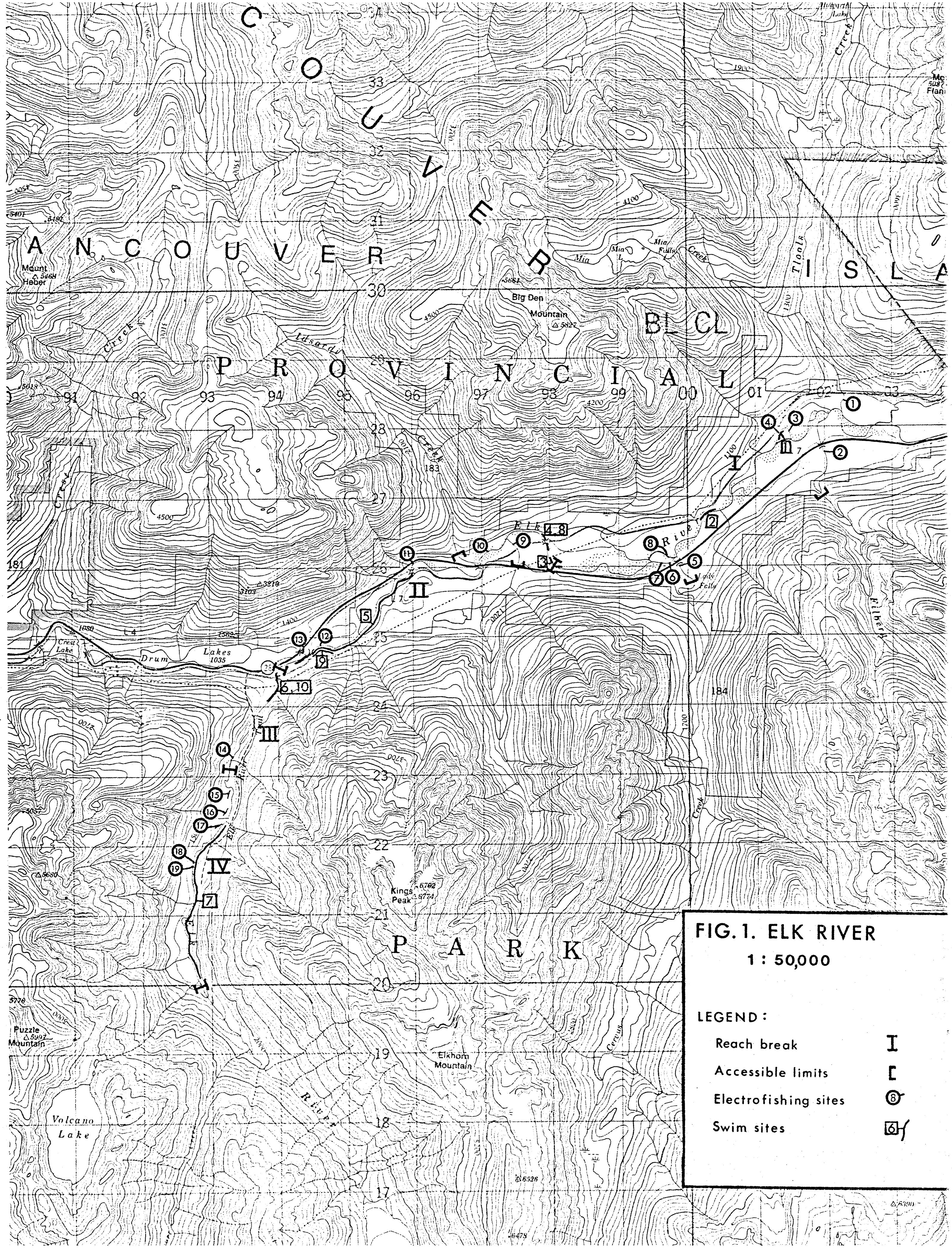


FIG. 1. ELK RIVER

1 : 50,000

Elk River

The lower 2 reaches of the Elk River, from Upper Campbell Lake to the Elk River trail 11.25km upstream, covered the area affected by Hydro division and past clear cut logging. The upper 2 reaches remain in a pristine mature forest environment.

Reach I, covering roughly 6.25km from Upper Campbell Lake to just below the Gorge, was the area most visibly affected by floodplain erosion problems. Fish habitat was composed primarily of relatively deep glides over gravel substrate. Nearly all of this lower reach, including the numerous side channels, flowed over open gravel areas which offered little in the way of stable, complex habitat. Debris was abundant throughout Reach I, however most was transitory in nature and did not provide stable cover areas.

Reach II, extending upstream to the beginning of the Elk River trail, was much more confined than Reach I and did not have extensive side channel development. Slope and general substrate size were greater in this reach. Fish habitat was split between glides and shallow cobbled riffles. Debris was again abundant, though not to the extent of Reach I, and appeared slightly more stable.

Reach III represents the very confined bedrock canyon section extending roughly 1.5km from the beginning of the Elk River trail. This high gradient section was typified by a stepped profile with many pocket pools and small chutes over bedrock and boulder substrates.

Reach IV covered the stream from Reach III to Volcano Creek roughly 3.5km upstream and the upper limit of our investigations. Fish habitat was similar to that of Reach II although slope and riffle percentage were slightly greater. Stability in terms of bank processes and debris was much greater in Reach IV, due to presence of virgin forest. Stable side channels with a high degree of habitat complexity were quite numerous in the forested floodplain.

Tributaries

Six tributaries were assessed during this study, all in the lower river (Reaches I and II). Upper river tributaries were not distinguished from side channels. Lower river tributaries were generally short in terms of accessible habitat. Only Tlools Creek was accessible for significantly greater than 1km.

Both Cervus and Idsardi Creeks had impassable falls less than 0.5km from the Elk River. Habitat in the lower 0.4km of Cervus Creek was low gradient run - riffle over cobble and gravel substrate, before being stopped abruptly at Lady Falls. Idsardi Creek rose gradually over boulder cobble substrate to the falls at 0.5km.

Filberg Creek was accessible for roughly 1.2km. The lower 600m was a fairly complex environment parallelling the Elk Valley. Past 600m gradient increased over boulders and cobbles up to a point where fish habitat was no longer viable.

Unnamed Creek was rendered impassable roughly 0.5km from the Elk River by a poorly placed culvert under Highway 28. Between the highway and the Elk River, this stream was composed of farily stable, complex fish habitat. Low gradient habitat extended roughly 0.5km above the highway.

Drum Creek drains Drum Lakes, and is the route of Heber River/Crest Creek diversion. Fish habitat in the 0.8km of stream was primarily fast glide - riffle over cobble and gravel substrate. Overall complexity was low.

The most significant of Elk River tributaries in terms of accessible habitat was Tlools Creek. Greater than 7.5km of this stream, up to Tlools Lake, was accessible as potential fish habitat. The lowest 2.5km was a fairly high gradient boulder - cobble environment, beyond which the stream decreased in gradient to headwater lakes. The stream appeared very stable, as moss and algae covered many instream boulders.

3.2 Fish Population Assessment

Detailed fish population assessment was conducted by swimming and electrofishing. Snorkel observations were collected from representative sections in the Elk River, while electrofishing results and fish population estimates were carried out at 19 sites. Locations are indicated on Figure 1.

3.2.1 Snorkel observations

Swim surveys were intended to assess both distribution and abundance of fishes at representative sites. It quickly became apparent that fish were very scarce and results were restricted to general observations on habitat utilization. Observations are summarized in Table 2.

Adult population

Very few adult salmonids were seen in late September in any of the four reaches. Only 2 were observed in the lower river under good visibility conditions; 1 Dolly

TABLE 2 Summary of snorkel observations from the Elk River, Strathcona Park, 1978.

DATE	LOCATION	LENGTH	OBSERVATIONS
Sept. 20, 1978	Reach I - side channel at sample site no. 4.	0.09km	Fry and yearlings were seen seeking refuge under cobbles. Quite a few of these fish had marks from previous electrofishing.
Sept. 20, 1978	Reach I - mainstem along ERT road.	0.23km	Eight sculpins 60-70mm in length were observed. Good spawning substrate was present.
Sept. 20, 1978	Reach I - II break area	0.18km	No fish seen. Black fly larvae abundant.
Sept. 20, 1978	Reach II - Gorge pool to high bank.	0.23km	One Dolly Varden, 180mm in length was seen in the Gorge pool. In the riffle-rapid section below a number of fish were seen, including rainbow of 100mm and 80mm and 14 fry of 50-60mm. All were seen along the right bank between last peice of bedrock and start of riffle near cliff; all were in fringe habitat composed of stable debris (logs, roots).
Sept. 20, 1978	Reach II - above Drum Creek to ERT bridge.	2.3km	A total of 15 fish were observed over the 2.3km snorkeled. Two adults, 1 DV and 1 Ct of 350mm, were seen in one pool. One yearling rainbow was seen at the head of a pool. Fry were seen at various locations; 4 in an isolated pool with debris (2 @ 35mm, 2 @ 65mm), 1 along edge of Drum Creek pool in rip-rap, 1 in boulders at bottom of a pool, 2 in shallow glide associated with bottom and 4 amongst debris along banks.
Sept. 20, 1978	Reach III - entrance to canyon section at trail beginning.	0.24km	No fish were seen here.
Sept. 22, 1978	Reach IV - Volcano Creek to side channels above reach break.	3.0km	Stage became flood during swim with visibility reduced to 2-3m. Many 1+ Dolly Varden and cutthroat were seen throughout. All were seen in stable areas with debris or boulders with debris. Despite poor visibility 2 large cutthroat were seen. Invertebrates were not abundant, with occasional caddis and mayfly larvae.
Oct. 31, 1978	Reach II - Gorge pool	0.08km	No fish observed.
Oct. 31, 1978	Reach II - Drum Creek pool to long corner pool.	0.48km	Only 3 fish were seen; 1 fry in Drum Creek pool rip-rap, 1 adult Dolly Varden (0.8kg) under a log jam, and 1 Dolly Varden of 180mm in the corner pool.
Oct. 31, 1978	Reach III - lower section and entrance to canyon at trail.	0.12km	Eight large adult Dolly Varden were seen in the step pools. These were in obvious spawning coloration. Maximum size was roughly 1kg. Two juvenile cutthroat, 130 to 180mm were also seen.

Varden and 1 cutthroat. Two cutthroat were seen in the upper river (Reach IV) with poor (2.5m) visibility.

Adult Dolly Varden were found in the Elk River in late October. All were in heavy spawning coloration. These fish were seen in the lower end of Reach III in step pools, and in a log jam below Drum Creek. None were seen in the Gorge pool.

Juvenile population

Very few juvenile fish were observed in the swim surveys. For example, only 13 fish were seen in a 2.3km section of Reach II, 12 of which were fry. Yearling cutthroat and Dolly Varden were judged much more abundant in the upper reaches (III and IV), however in absolute terms were still scarce.

With few exceptions juvenile salmonids were seen only in peripheral habitat such as shallow side channels and stable debris. Yearlings, especially cutthroat and Dolly Varden in the upper river, were found in association with stable peripheral debris. Mid-channel areas were very occasionally utilized, as 2 cutthroat were seen in Reach III step pools and 1 each of rainbow and Dolly Varden were found in pools of the lower reaches.

3.2.2 Fish population and biomass estimates

Results of population and biomass estimates are summarized in Table 3. A more complete description of sample sites and results is included in Appendix 1.

Distribution

Results presented in Table 3 indicate that cutthroat trout were largely restricted to samples from Reaches III and IV. One exception was noted, as cutthroat were found in the relatively small and stable Unnamed tributary. Cutthroat are apparently present in upper reaches of Tlools Creek (E.F. Burns, pers. comm.). Although no cutthroat were identified in the lower two reaches of the mainstem, difficulty in distinguishing rainbow from cutthroat at very small sizes may have produced some error.

Just as cutthroat were found in upper river areas, rainbow were much more abundant in lower river areas. Rainbow fry were found only at one site in the upper two reaches, while they were sampled throughout the lower two reaches and tributaries. Dolly Varden were found in upper and lower areas.

TABLE 3 Summary of electrofishing and population estimates from the Elk River, Strathcona Park, 1978.

SITE	LOCATION	UNITS	RAINBOW 0+	RAINBOW 1+	RAINBOW 2+	CUTTHROAT 0+	CUTTHROAT 1+	CUTTHROAT 2+	DOLLY VARDEN 0+	DOLLY VARDEN 1+	DOLLY VARDEN 2+	TOTAL FRY	TOTAL SALMONIDS
1	Tlools Creek below E.R.T. road	N/m^2	0.60	0.12	0.03				0.55	0.03		1.15	$1.33/m^2$
		B/m^2	0.94	1.31	1.03				1.14	0.28		2.08	$4.70g/m^2$
2	Filberg Creek above highway bridge	N/m^2	0.02							0.02		0.02	0.04
		B/m^2	0.03							0.67		0.03	0.70
3	Reach I side channel 500m upstream of Filberg Creek	N/m^2	0.18						0.01			0.19	0.19
		B/m^2	0.26						0.04			0.30	0.30
4	Reach I side channel 800m upstream of Filberg Creek	N/m^2	0.23						0.02			0.25	0.25
		B/m^2	0.27						0.03			0.30	0.30
5	Cervus Creek	N/m^2	0.43						0.19	0.04		0.62	0.66
		B/m^2	0.84						0.19	0.38		1.03	1.41
6	Reach I side channel 300m upstream of Cervus Creek	Sample only	X										
7	Reach I side channel 300m upstream of Cervus Creek	N/m^2	0.57						0.04	< .01		0.61	0.61
		B/m^2	0.66						0.08	0.05		0.74	0.79
8	Reach I mainstem edge 300m upstream of Cervus Creek	N/m^2	0.09									0.09	0.09
		B/m^2	0.07									0.07	0.07
9	Unnamed tributary above Gorge	N/m^2	0.02			0.12	0.02		0.22	0.09		0.36	0.47
		B/m^2	0.05			0.20	0.29		0.25	1.01		0.50	1.80
10	Reach II mainstem edge 200m below highway bridge	N/m^2	0.09									0.09	0.09
		B/m^2	0.09									0.09	0.09
11	Reach II mainstem edge 80m below E.R.T. bridge	N/m^2	0.22						0.02	0.02		0.24	0.26
		B/m^2	0.46						0.03	0.20		0.49	0.69
12	Reach II mainstem edge 100m below Drum Creek	N/m^2	0.47						0.03	0.01		0.50	0.51
		B/m^2	0.74						0.03	0.14		0.77	0.91
13	Drum Creek	N/m^2	0.19									0.19	0.19
		B/m^2	0.21									0.21	0.21
14	Reach III mainstem	Sample only					X		X	X			
15	Reach IV mainstem riffle	N/m^2	0.04			0.04			0.40			0.48	0.48
		B/m^2	0.09			0.06			0.60			0.75	0.75
16	Reach IV mainstem pool	N/m^2				0.05	0.09		0.09	0.05		0.14	0.28
		B/m^2				0.06	0.70		0.10	0.37		0.16	1.23
17	Reach IV side channel	N/m^2				0.36	0.28			0.16		0.36	0.80
		B/m^2				0.56	3.04			0.98		0.56	4.58
18	Reach IV side channel	N/m^2				0.05				0.10		0.05	0.15
		B/m^2				0.07				1.41		0.07	1.48
19	Reach IV side channel	N/m^2					0.05		0.11	0.05		0.11	0.21
		B/m^2					0.60		0.16	0.43		0.16	1.18

Biomass density and distribution

Generally, biomass density was low throughout the Elk River system. Maximum levels of just over 4.5 grams/m^2 were recorded in Tlools Creek and in stable, debris filled upper river side channels (sites 1 and 17 respectively, Table 3). Note that different species are present at these sites, with rainbow and Dolly Varden in Tlools Creek, and cutthroat and Dolly Varden in the upper side channel. Only 7 of 17 population estimate sites had biomass density of greater than 1g/m^2, of which 3 sites were upper side channels (sites 17, 18 and 19) and 3 sites were lower river tributaries (sites 1, 5 and 9). Just 1 mainstem Elk River site had more than 1g/m^2; that was site 16, a small mainstem pool in the uppermost reach. Maximum biomass found in lower mainstem areas was 0.9g/m^2 at site 13 just below Drum Creek.

It should be noted that all mainstem samples sites, with the exception of site 16, represent edge habitat. As snorkel observations suggest mid-channel areas were largely barren of fish, it was assumed these samples covered most of the vaiable fish habitat. Biomass estimates, if applied to the whole river, would therefore represent a vast over-estimate of population size as barren mid-channel areas have not been incorporated into calculations.

High biomass density was determined by presence of older age groups of salmonids. All areas with stable, complex habitat associated with yearling fish habitat, such as some tributaries and side channels, had relatively high biomass. Sites which were lacking in this type of habitat, such as mainstem edge habitat and open gravel side channels, were found to have relatively low biomass despite moderate fry density (eg. sites 7 and 15). Some of the lower mainstem samples (sites 8 and 10) had very low biomass of even fry. Upper reaches of some tributaries (eg. Filberg Creek, site no. 2) had poor numbers of fry, perhaps a result of lack of spawning gravel in the high gradient system.

3.3 Late Summer Standing Crop

Present status of fish populations within the Elk River are difficult to determine without a spawning population census. An attempt to quantify "smolt" output and subsequent adult returns, as is often done for anadromous salmonids (Ptolemy et al, 1976; Tredger, 1979), has not been made in this case due to poor knowledge of many aspects of life-history, including absolute survival rates of fry, 1+ and 2+ migrants in Upper Campbell Lake. The total number of fish present in late summer represents the late summer standing crop, and has been estimated by applying biomass and population number estimates from representative sites to cover the entire stream. Results are included in Appendix III and are summarized in Table 4. A rough estimate of spawning population size in the Elk River has been calculated.

TABLE 4 Late summer population number and biomass estimates and estimated spawning population size in the Elk River drainage, Strathcona Park, 1978.

	AGE GROUP	$\hat{N}_T$	$\hat{B}_{T(kg)}$	SPAWNING POPULATION[a]
Dolly Varden	0+	38,000	67	2,000
	1+	3,600	35	
Rainbow	0+	60,000	92	3,200
	1+	4,700	51	
	2+	1,200	40	
Cutthroat	0+	3,600	5	200
	1+	2,400	21	

a this was estimated on the basis of the following:

alevins to late summer fry (25%)
egg to fry (15%)
roughly 1000 eggs/female
sex ratio of 1 male:1 female

The significance of spawning population estimates derived in this manner is questionable, as a number of assumptions have been made. Perhaps the most important factor to consider is the magnitude of fry migration, voluntary or otherwise, to the lake system. Observations throughout the summer period suggest that particularly after flood events, fry abundance was dropping, and presumably large numbers of fry were swept into the lake. If this were the case, then estimates of spawning population from late summer fry numbers is an under-estimate; magnitude dependent on extent of fry migrations.

3.4 Life-History of Elk River Salmonids

The small number of adult salmonids observed during snorkel surveys suggests that the majority of fish produced in the Elk River reside in Upper Campbell Lake. The stream resident population appears restricted to small numbers of cutthroat and Dolly Varden. Population size may be somewhat greater in the upper two reaches as compared to the lower river.

Greater numbers of adults appear in the Elk River during spawning migrations. Dolly Varden were found in the river on October 31, 1978. The spawning fish observed were composed of three age groups; 1+, 2+ and 3+. The 1+ Dolly's represented fairly high numbers of precocious males in the sample. Rainbow and cutthroat trout were not observed during spawning runs. McMynn and Larkin (1953) indicate rainbow spawn in late spring (June), while cutthroat spawn in late winter (February) in the Upper Campbell - Buttle Lake area. No activity was observed in late March, 1979 as the stream remained very cold (3.5^{o}C).

Growth

Small samples of adult cutthroat and rainbow trout were collected from Upper Campbell Lake, while Dolly Varden were sampled in the Elk River and tributaries during spawning time. It was assumed that all fish were of Elk River origin. Age-length curves from these samples are included as Figures 2 through 4, values from other sources are shown for comparative purposes.

Analysis of these curves indicates there was a great difference in size between similar age groups of each species captured in the lake as compared to the stream environment. For example, age 2+ rainbow captured in Upper Campbell Lake averaged 76mm greater in fork length than those captured in the Elk River. This phenomenon is demonstrated for all three salmonid species present, and represents better growth conditions present in the lake environment. The age-length curve for Dolly Varden (Figure 4) is somewhat less convincing in this respect, as results may have been masked by the presence of stream residents. All Dolly Varden were sampled in the Elk River during spawning time, and as it was assumed that all were from Upper Campbell Lake as opposed to stream resident stock, there is a possibility of error in that some may have been resident stock, thus reducing length-at-age. This possibility is supported by the much larger 2+ Dolly's sampled in 1951 (Figure 4).

FIG. 2. Age - Length relationship : Rainbow

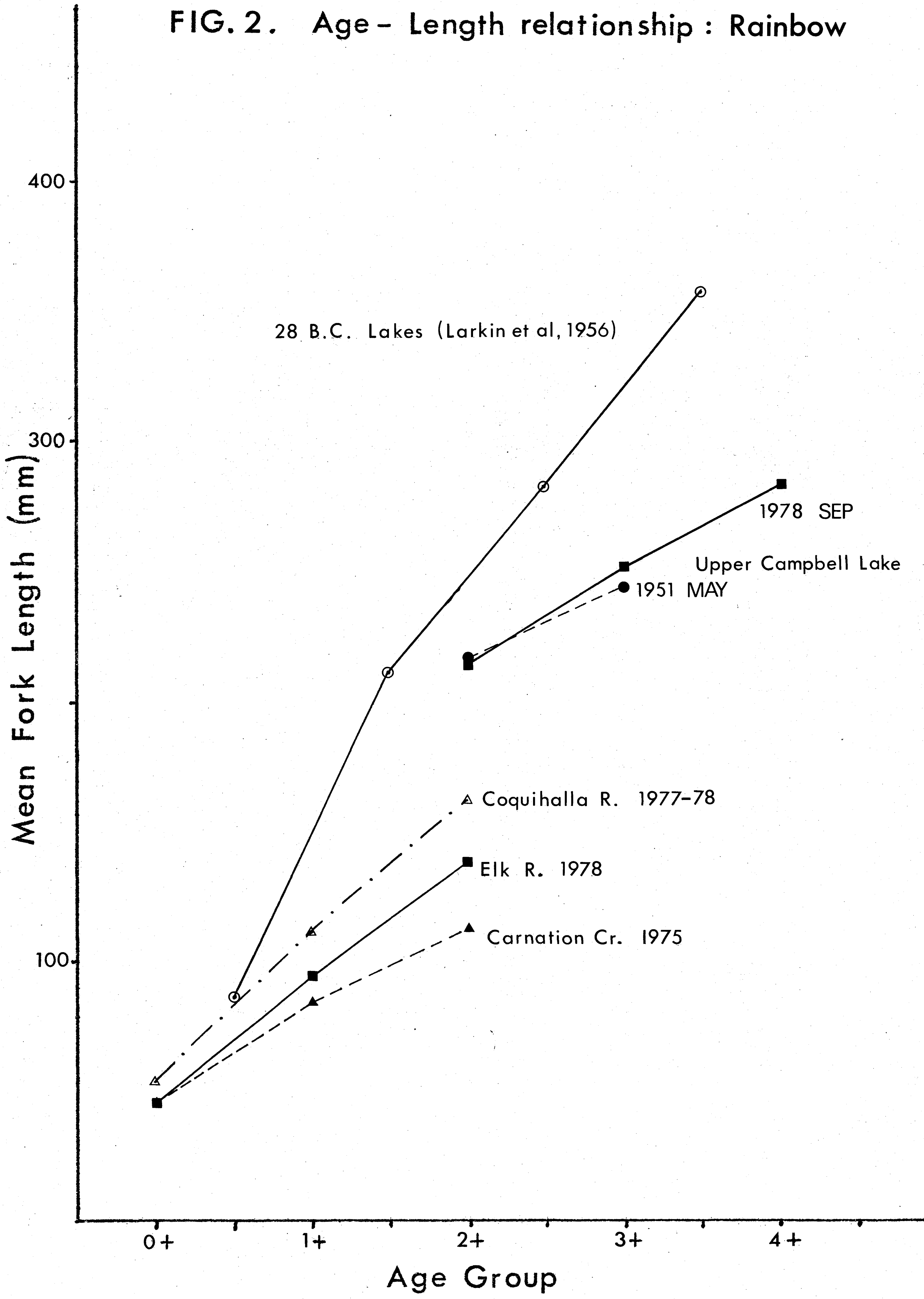


FIG. 3. Age - Length relationship : Cutthroat

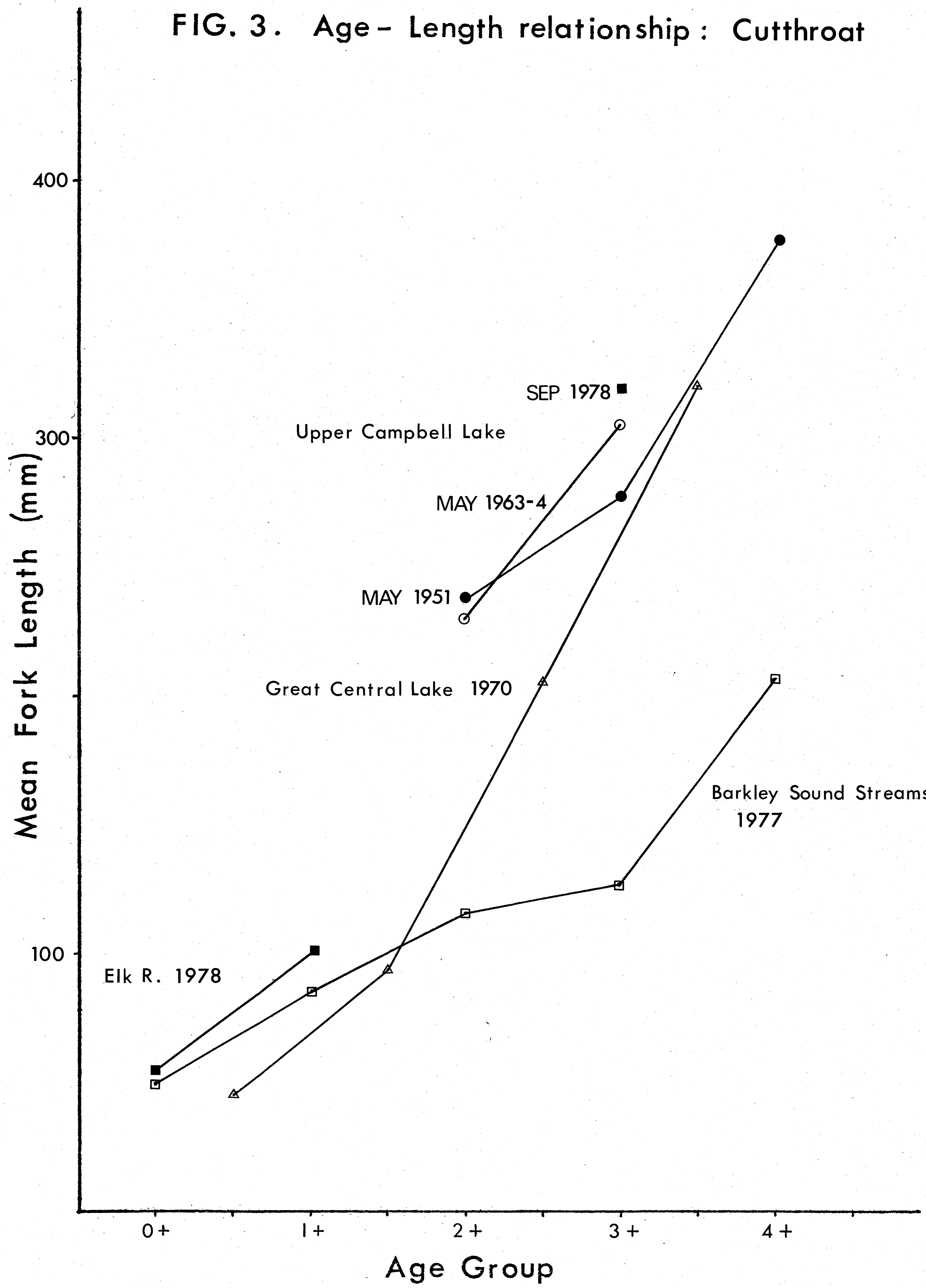
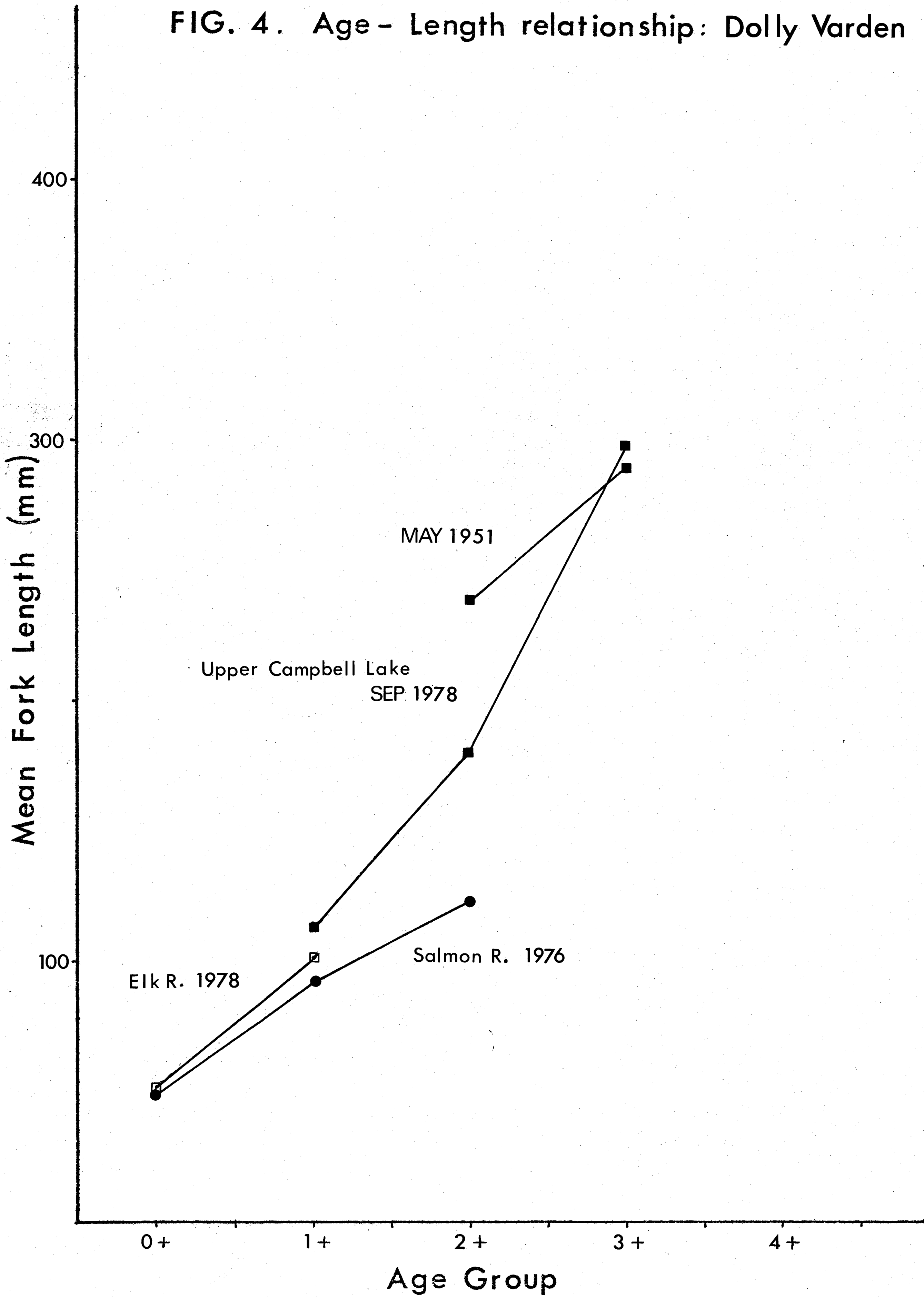


FIG. 4. Age - Length relationship: Dolly Varden



Age-length relationships indicate no apparent differences in size of rainbow trout and older (3+) Dolly Varden between 1951 and 1978. The 1951 samples however were collected in May and would therefore represent greater length-at-age if sampling was carried out in September as in 1978. The very small sample of cutthroat trout indicates that although 1978 samples were greater in length, had sampling time been similar, length-at-age would have been much closer.

Lakeward migration patterns

Analysis of scale samples from Upper Campbell Lake salmonids can give an insight into roughly when a change from stream to lake dwelling existence took place. A change in environment, whether differences occur primarily in food items, productivity or some other physiological response, may reflect on growth rate and thus be detectable on scales. This phenomenon of having differing growth rates in different environments, or "growth stanzas" (Parker and Larkin, 1959), is well known for anadromous salmonids. Examples of stream and lake growth stanzas are often less clear, however they do exist for both cutthroat (Narver, 1975; Bjornn, 1961), rainbow trout (Sebastian, 1979) and Dolly Varden char (Bjornn, 1961).

There are often difficulties, especially for piscivorous species such as cutthroat and Dolly Varden, in deciding whether a growth curve inflection was caused by a change in diet from a planktivorous to a piscivorous existence or simply a change in environment. Certainly a change in environment will make available different food sources, however these changes are apparently more subtle in terms of growth rate than a switch to a forage fish diet. By examining adult fish scales, particularly near the focus, and comparing them to juvenile scales, one can generally ascertain by viewing differences or similarities in growth patterns where that growth took place. Evidence in Carlander (1969) and that outlined on Figures 2 through 4 indicates that growth is faster in the lake environment.

An attempt to visually determine the length of time spent rearing in the Elk River was made from the adult fish collected during this study (Table 5). These results indicate that all three species have some segment of the population dependent on stream rearing overwinter. The only reliable sample presented is that of rainbow trout, in which 68% of fish sampled in Upper Campbell Lake had spent at least 1 year in the stream (presumably the Elk River). Difficulties were encountered in distinguishing late 0+. migrants from early 1+. migrants, as time of annulus formation is not precisely known. Cutthroat and Dolly Varden samples were too small to make any generalizations.

TABLE 5 Summary of migration patterns of juvenile salmonids to Upper Campbell Lake as determined by scale analysis

SPECIES	YEAR OF SAMPLE	n READABLE	% MIGRATING TO LAKE FRY		1.-1+		2.-2+	
Cutthroat	1951	8	50	(4)	50	(4)	0	
	1963-4	10	10	(1)	80	(8)	10	(1)
	1978	2	0		0		100	(2)
Rainbow	1978	25	32	(8)	32	(8)	36	(9)
Dolly Varden	1978	8	50	(4)	25	(2)	25	(2)

Early growth patterns have been analyzed for rainbow trout in relation to lake migration (Table 6). These results further outline the differences in growth in stream and lake environments as indicated on the age-length curves (Figures 2 through 4). Trout which spend 2. to 2+. years in the stream environment had relatively small fork length compared to those which migrated to the lake as fry or 1+ fish. Most rapid second year growth appears to have taken place in fish entering the lake as 1+. Bjornn (1961) found similar growth patterns in 2 Idaho lakes for both cutthroat and Dolly Varden, as those fish which entered the lakes during their first summer had markedly different growth patterns than those which spent more than 1 year in a stream. Samples of cutthroat and Dolly Varden from Upper Campbell Lake were not large enough to analyze in this manner. A growth change, occurring just beyond 2nd annulus formation, appears to have taken place at approximately 140mm fork length on the 2 cutthroat captured. This corresponds quite well with the findings of Narver (1975) in Great Central Lake in which cutthroat trout were discovered to spend 2 to 3 years in streams before migrating to the lake. The possibility of a diet change causing the observed growth acceleration was not ruled out, however. Stenton (1957) found a lake entry related growth acceleration for Yellowstone cutthroat at 70mm in Kiakho Lake in southeastern B.C.

TABLE 6 Mean fork lengths of rainbow trout at annulus formation as a function of age at migration to Upper Campbell Lake, 1978.

	MIGRATION AGE	n	1st ANNULUS	2nd ANNULUS	GROWTH CHANGE
Rainbow	0+-1.	7	70	195	70
	1.-1+	8	66	233	93
	2.-2+	9	71	122	138

Lake survival rates

It is assumed an equal number of 0+, 1+ and 2+ rainbow estimated as standing crop (Table 4) migrated to the lake, resulting in 60,000 fry, 4,700 1+ and 1,200 2+. Scale samples have indicated roughly 32% of lake rainbow were 0+ migrants, 32% 1+ migrants and 36% 2+ migrants. Combining these two estimates, the relative survival rates can be calculated. Survival of 1+ migrants was estimated as approximately 14 times fry survival, while 2+ survival was 60 times that of fry (Table 7).

TABLE 7 Relative lake survival rates of age groups of migrant rainbow trout in the Elk River - Upper Campbell Lake system.

	AGE GROUP OF MIGRATION		
	0+	1+	2+
standing crop ($\hat{N}$)	60,000	4,700	1,200
$\hat{no}$. of migrants	60,000	4,700	1,200
% lake population	32	32	36
relative survival	1	14	60

Analysis of cutthroat and Dolly Varden is not reliable because of small sample size. It is generally accepted that survival of salmonids in the lake environment is a function of size and therefore age. Fry survival is normally quite poor, especially in situations involving large predators (eg. cutthroat and Dolly Varden). Sebastian (1979) found the "critical length" for survival of rainbow trout in Okanagan Lake as being roughly 90mm; any entering at smaller sizes did not show up in adult scale analysis. This is obviously the case in Upper Campbell Lake, as even though large numbers of fry enter the lake environment, a very small percentage survive to even "catchable" size.

4.0 SUMMARY OF RESULTS

(1) Fish habitat in terms of stable channel with instream and overhanging cover was lacking throughout most of the Elk River drainage. Stable, complex areas were found only in lower reaches of some tributaries, in side channels of the upper river (Reach IV) and in Tlools Creek. Mainstem habitat, particularly in the lower reaches (I and II), was generally without cover, as debris was not stable and flat gravel banks were predominant. Upper river habitat was more stable and complex.

(2) Adult salmonids were not abundant in the Elk River. The major portion of fish populations spend most of their life in Upper Campbell Lake; stream resident populations were very small.

(3) Juvenile cutthroat trout were found only in complex, stable habitat as outlined in (1) above. With one exception, all were sampled in the upper two reaches. Juvenile rainbow were found throughout the mainstem and lower river tributaries, while they were scarce in upper river areas. Dolly Varden were found in most areas sampled.

(4) Yearling cutthroat and rainbow were generally restricted to the complex, stable habitats, while Dolly Varden were somewhat more cosmopolitan. Fry in the mainstem were restricted to peripheral areas and side channels, and shallow, cobbled riffles. This latter habitat was more abundant in the upper 3 reaches.

(5) Juvenile population estimates found low biomass density throughout. Highest biomass levels were found in stable, complex areas, while lowest levels were recorded in lower mainstem glide edge habitat. Presence of habitat suitable for 1+ rearing was a major factor in determining high biomass density.

(6) Late summer standing crop estimates indicate rainbow trout as the most abundant species, followed by Dolly Varden and cutthroat. Late summer fry numbers suggest that many fry must have migrated to Upper Campbell Lake through the summer period.

(7) Scale analysis indicate that rainbow surviving in the lake were composed of roughly 32% which had entered the lake as fry, 32% as yearlings and 36% as 2 year fish. Smaller samples of Dolly Varden indicated roughly 50% entered as fry, 25% as 1 year olds and 25% as 2 year olds. Only 2 cutthroat were analyzed, both appearing as 2 year stream fish.

(8) Survival of rainbow fry in Upper Campbell Lake was very low relative to 1 and 2 year stream fish. Rainbow with 1 year of stream growth survived roughly 14 times greater than fry, while 2 year stream fish survived 60 times greater than fry.

5.0 DISCUSSION

5.1 Habitat Quality and Fish Distribution

Results of habitat assessment and fish sampling have revealed a number of finite habitats which presently hold importance as fish production areas. These areas are present in both upper and lower river areas, and represent importance for different species.

Spawning habitat and fry recruitment

Because of the extent of gravel substrate in the whole of the Elk River, spawning area was not considered a limiting factor in the environment. In fact, McMynn and Larkin (1953) indicated that near 57,000m^2 of spawning area would be available after flooding of Upper Campbell Lake. Ample numbers of fry in most sample sites further suggest adequate spawning area exists. Low fry numbers in some mainstem sites were thought to be more a reflection of poor rearing habitat (i.e. low carrying capacity) than of low fry recruitment. Some of the steep tributaries (eg. Filberg Creek) may have been lacking in spawning habitat in upper areas, however most covered quite short stretches of stream. Only in Tlools Creek, where the extent of utilization by Upper Campbell Lake spawners is not known, would low recruitment be a major problem.

Fry numbers in many Reach IV side channels were not high, especially when compared to yearling numbers (cutthroat and Dolly Varden). This was probably a direct result of juveniles seeking out areas with suitable cover not present in the mainstem.

In spite of the large area suitable for spawning, a potential problem exists because of substrate movements during flood events. Extremely high flows normally occurring in late fall cause massive bedload movement, especially in the lower mainstem. Fall spawning species such as Dolly Varden, if constructing redds in mainstem areas, would certainly lose most of their eggs. The potential for high flows in spring and early summer also exists, endangering rainbow and cutthroat recruitment. In October, Dolly Varden were found spawning in more stable areas, including Unnamed tributary and step-pools of Reach III. Because of flood potential these relatively stable areas must be considered of prime importance as spawning habitat.

Rearing habitat

At first glance fry habitat appeared virtually unlimited throughout the Elk River. Shallow side channels and peripheral mainstem areas in Reach I were quite abundant, and shallow cobbled riffles were numerous throughout Reaches II and IV. Although the side channels and cobbled riffles held substantial numbers of fry, mainstem edge habitat was often found with densities amongst the lowest discovered in the entire stream. This is thought to be related to poor habitat quality, particularly as regards stable cover components and flood events.

Yearling habitat, in terms of stable, complex rearing environment was quite scarce in the Elk River system. Mainstem areas, particularly in the lower 2 reaches, had very few areas with stable bank undercuts or debris. Most areas were plagued with wide active channel and open gravel banks; debris was transitory. Reach III, with many stable bedrock and boulder controlled pools, and Reach IV had more areas of stability. Numbers of yearlings observed in these areas, particulary cutthroat in upper reaches, underlined this fact.

The environment with highest biomass and numbers of yearling salmonids was stable, complex habitat associated with side channels and lower reaches of some tributaries. Habitat such as this is generally known to be important for cutthroat trout (Lowry, 1965; Nilsson, 1971), and becomes even more critical as winter habitat (Bustard, 1974). Upper river side channels and one lower river tributary were found holding yearling cutthroat. Only Tlools Creek contained yearling rainbow. Because use of these areas may be related to refuge from flood waters, etc., the extent to which these are used is not known. There is a possibility that areas closer to the mainstem would be utilized more heavily by yearlings.

5.2 Sport Fisheries Enhancement

Strategies and objectives

Major objectives of enhancement are to increase populations of both lake resident and stream resident salmonids. Because of present conditions within the Elk River resident populations appear least likely to benefit in the immediate future. In the long term, as the stream becomes more stable and positive effects on food availability and cover conditions occur, resident populations may build up. In terms of returning to pre-impoundment angling values, as described by Haig-Brown (1939, 1946) any project may be doomed to failure. The Elk River in those times was a much more extensive and stable system, and itself was tributary to a larger river and lake system. For the present, the stream fishery will largely be dependent on spawning migrations of the three species involved.

In terms of producing fish for the Upper Campbell Lake fishery, a clear strategy is implied from the results of this study. Two major findings revealed by this study, (1) relatively poor survival of fry in Upper Campbell Lake, and (2) very small population of yearling and older age groups of salmonids due primarily to lack of suitable habitat, suggest that fish must be induced to stay in the stream environment for longer periods of time before migrating to the lake. If, as a population, length of stream residence of salmonids were increased, then a significant increase in overall survival of fish in the lake environment would result. This would be an effect of more fish reaching a size which would better their chances of survival in the lake. The way to accomplish this is to increase the amount of habitat suitable for rearing older (larger) salmonids, particularly in terms of overwinter survival and refuge from flood events.

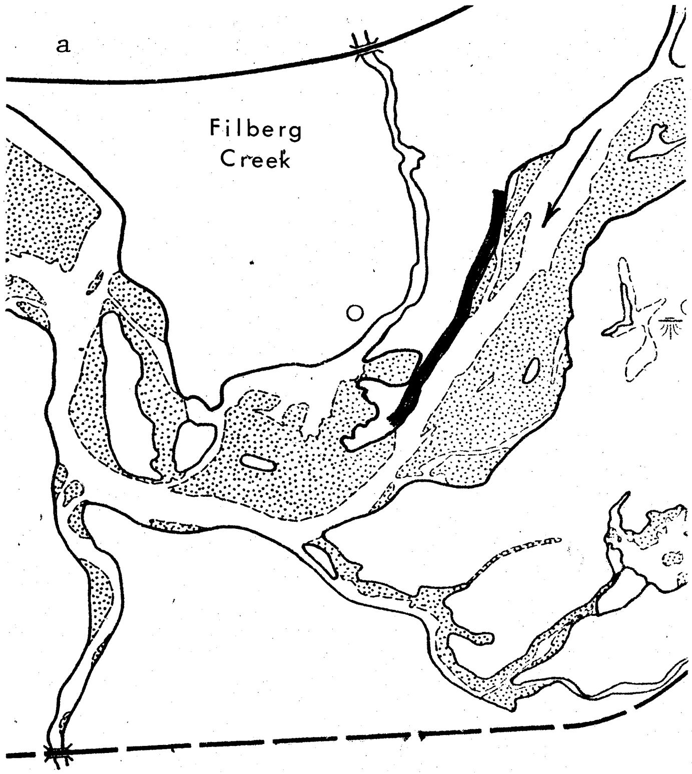
Enhancement methods

The following discussion centers on possible enchancement techniques applicable to the Elk River system. Specific locations are not noted throughout, as in some instances many possible locations exist. Many small stream enhancement techniques involving bank deflectors, rip-rap groups, etc. (Parkinson and Slaney, 1975) often prescribed will not be useful in the Elk River because of the overall size of the stream, its lack of stability and discharge regime. Some of these techniques may be applicable to tributary streams.

Any works undertaken must be located in areas such that river processes will not render them ineffective in a short period of time. Locations should be chosen as either stable, in terms of consistency of channel location, or in areas where stability can be artificially induced through bank protection and dyking. This is of great importance in the lower river (Reach I) where channel shifts and avulsions are quite common. Hydrological input is essential in this respect.

(1) Bank protection. Because of the limited area presently available for winter habitat and flood refuge, protection of the existing areas from further reduction by erosion should be a priority. Such areas include lower reaches of Filberg Creek and some sloughs present in the lower river (Figure 5). Other similar locations exist in varying levels of priority. Specific methods for bank protection must be learned from a river hydrologist.

a



b

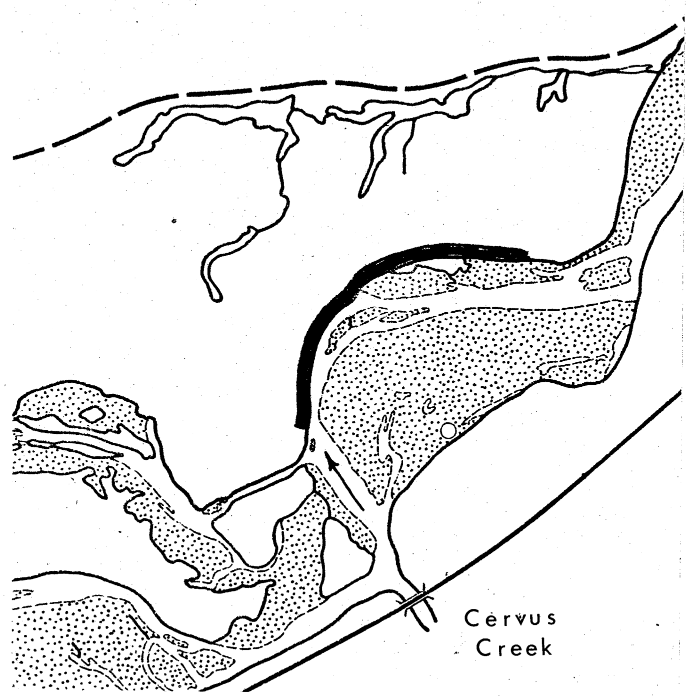


FIGURE 5

Two examples of high priority bank protection areas. "a" shows the lower reach of Filberg Creek, which is potentially in danger of destruction if erosion were allowed to continue on the indicated bank. "b" represents a slough which may be utilized as winter or refuge habitat. Continued erosion will eventually route the main channel to this area. Such a slough has potential for modification.

(2) Side channel modification. Creation of stable, complex side channels could be undertaken, especially in Reach I, in an attempt to reproduce the productive type of habitat located in Reach IV side channels. Two methods may be feasible, depending on input from a river hydrologist:

(a) present sloughs and backwaters could be modified to ensure greater utilization by salmonids. Minor alterations to flow regimes by diversion or excavation could attract more fish into these areas (eg. Figure 5b). Tributary streams, especially in areas which flow parallel to the river such as Filberg Creek, could be complexed by debris introductions once protection is insured. Diversion of portions of some tributary streams (eg. Tlools Creek) into old Elk River side channels is another possibility.

(b) present side channels within the active channel could be modified into stable, complex habitat by dyking, channel excavation and debris placements (Figure 6). Dyking would basically keep flood waters out of the area, allowing a stable channel and revegetation to result. Channel excavation to a level below the present water table would result in sufficient flow to create good rearing environment under stable, complex conditions. Again specific locations and methods must be worked out by a hydrologist, however approximately 3 extensive developments are envisioned at this time. A project similar to this has been carried out on the Chemainus River by Federal Fisheries to facilitate pink salmon spawning (Anon, 1979).

(3) Stable mainstem debris. Anchoring of large, stable debris in channel areas judged stable may increase salmonid production. Stable debris was utilized throughout all reaches of the Elk River. Because of the magnitude of flood events it may be appropriate to initially concentrate efforts near to side channels and sloughs which may act as refuge areas, thereby increasing chances of such debris being utilized.

(4) Mainstem rip-rap placement. Placement of rip-rap material throughout the mainstem as an erosion control measure would be prohibitively costly (R. Kellerhals, pers. comm.). Potential use of rip-rap exists however, in the course of normal activities of highway and logging road protection. As bank armouring for road protection is inevitable, placement of material in such a way as to benefit the fish population (eg. pool creation) could be achieved at very small additional cost.

(5) Drum Creek. Habitat utilization in Drum Creek was found as primarily peripheral. Because of Drum Lakes, the potential of this stream as a rearing area is high. An increase in cross sectional distribution of the juvenile fish, by instream cover (boulder) placement, should bring about an increase in the juvenile fish population.

(6) Unnamed Creek culvert modification. Presently about 0.5km of potentially productive fish habitat is alienated by an impassable culvert at the Highway 28 crossing. Provision of fish passage by backflooding of the culvert with rip-rap or gabions is recommended.

(7) Recruitment increases. At present recruitment is thought to be sufficient in most locations. Development of side channels may require that fry be introduced to effect maximum utilization.

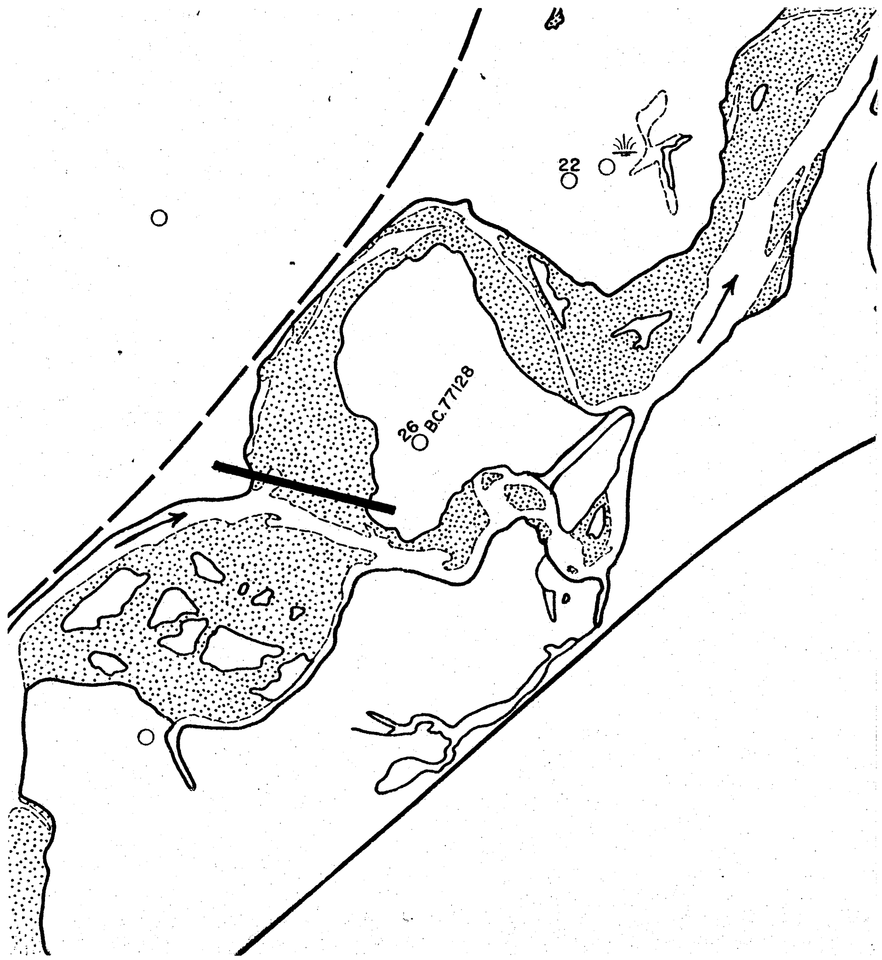


FIGURE 6 One potential location for side channel protection and modification, upstream of Filberg Creek. Dyking would isolate the channel from particularly flood waters, while modification such as channel excavation and cover placements would create stable, complex habitat. Revegetation would also be stimulated.

The basic strategy behind all the possible enhancement methods outlined above is essentially the same; to produce habitat suitable to rear larger numbers of salmonids for longer periods of time before migrating to Upper Campbell Lake. The three species involved will likely benefit in different circumstances, depending on specific habitat preferences. How the fish will respond to any treatments can only be tested by trial and error.

Enhancement opportunities outlined in this report represent generic forms and are by no means exhaustive. Specific recommendations can only be made on consultation with a river hydrologist or engineer. Initial involvement must be largely experimental as techniques are not well tested and success is not certain. This is particularly true for side channel modification and development.

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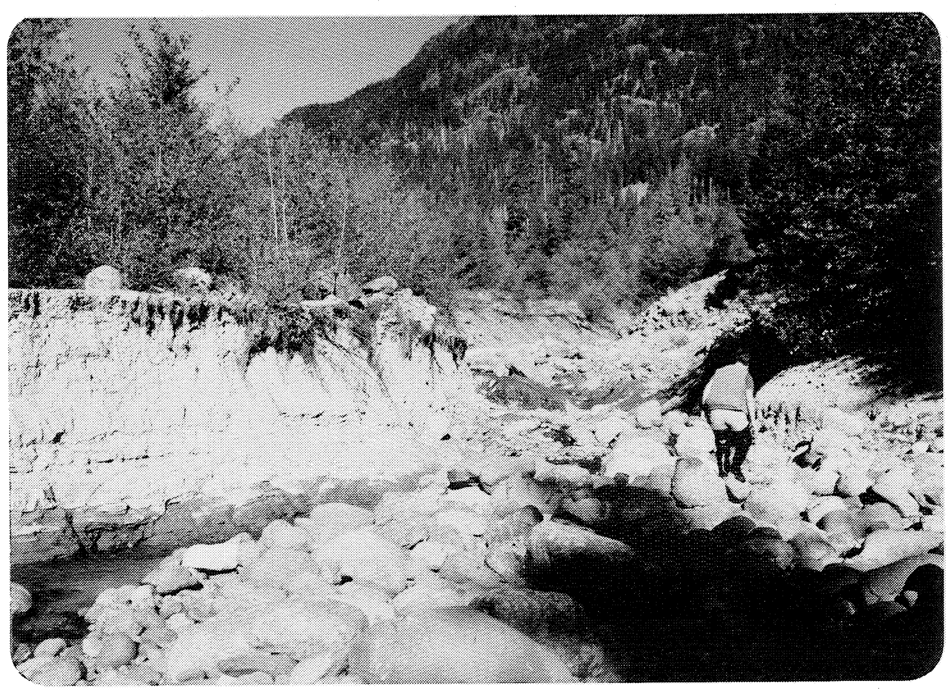
APPENDIX I Representative photographs of the Elk River system.

1. Tlools Creek near Mia Creek confluence, 1.75km upstream from the Elk River. This confined and stable boulder-cobble habitat was typical of the mid-section of Tlools Creek.

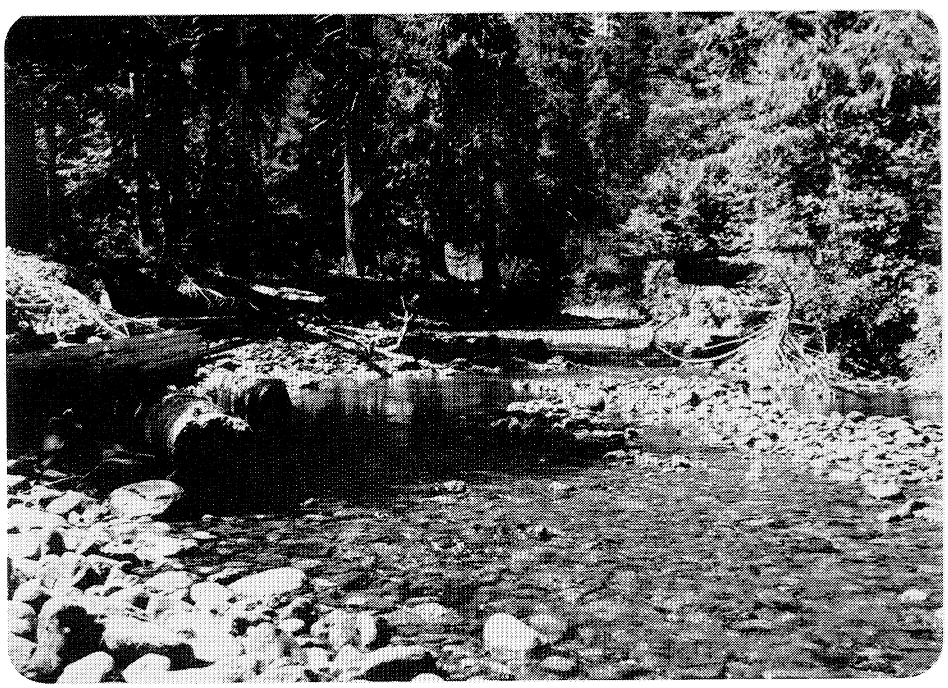
2. An example of complex habitat in the lower 600m of Filberg Creek. Debris jams with associated pools were common in the lower section of this stream.

3. Complex habitat in the Unnamed tributary. This stable, moderately high quality habitat extended roughly 0.5km to culverts under Highway 28, and for a further 0.5km above the highway.



4. Lower Idsardi Creek. The lower part of this creek appears to have been forced to change its course by highway construction.

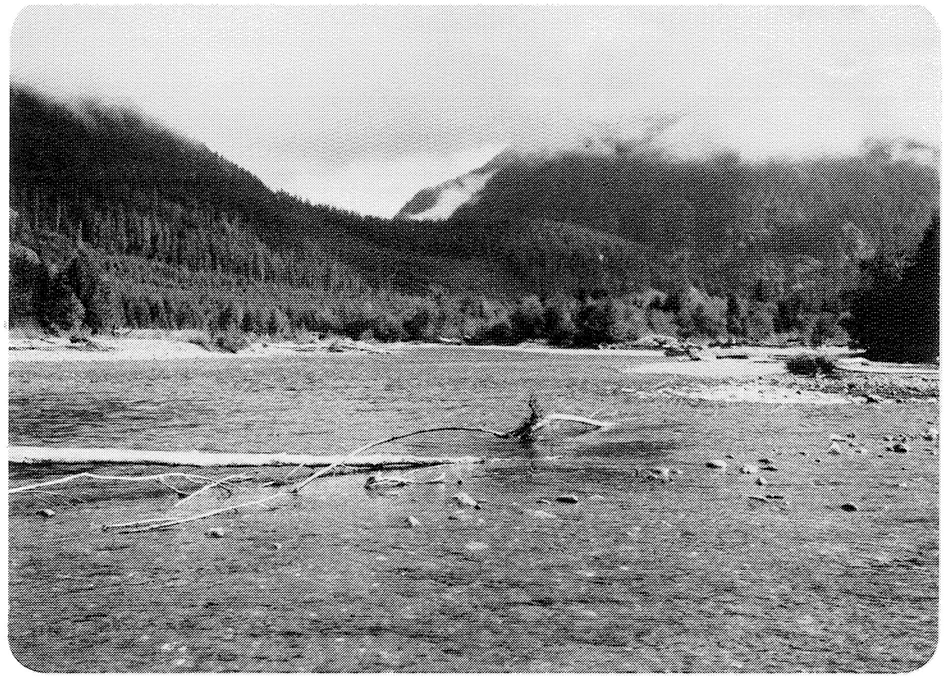
5. Cervus Creek deep run habitat. Fish were restricted to edge habitat at this site.



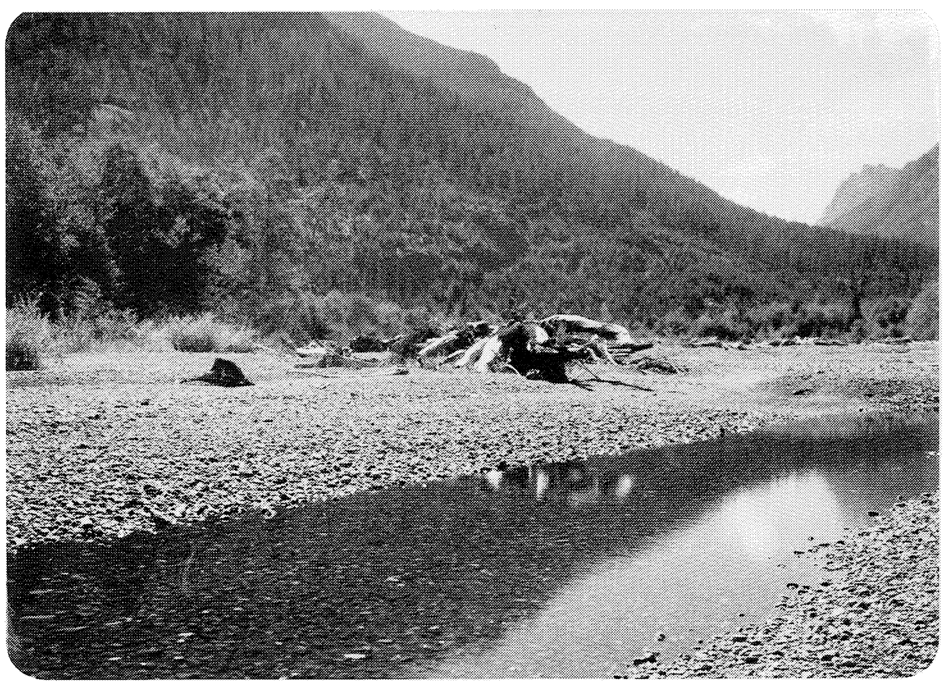
6. Drum Creek during the low flow period. At this time less than $0.15m^3/s$ (5cfs) was being carried through the Heber River diversion.

7. Mainstem Elk River - Reach I. Note active erosion on left bank and flat gravel on right bank.

8. Side channel located in Reach I.

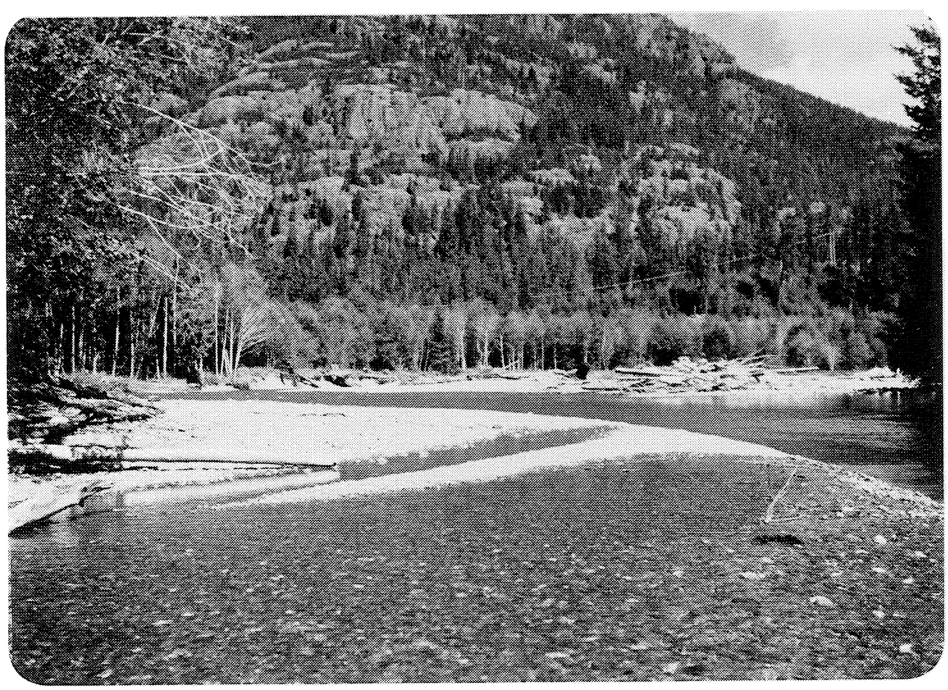


9. Reach I - note expansive active channel and transient debris.

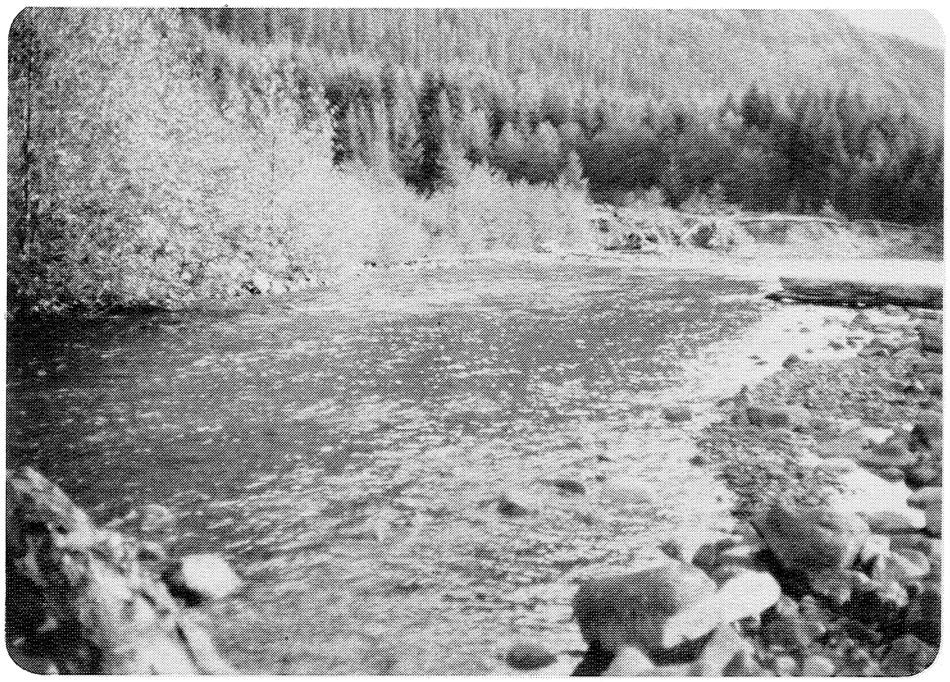


10. Reach I side channel. Note lack of cover components in the channel.

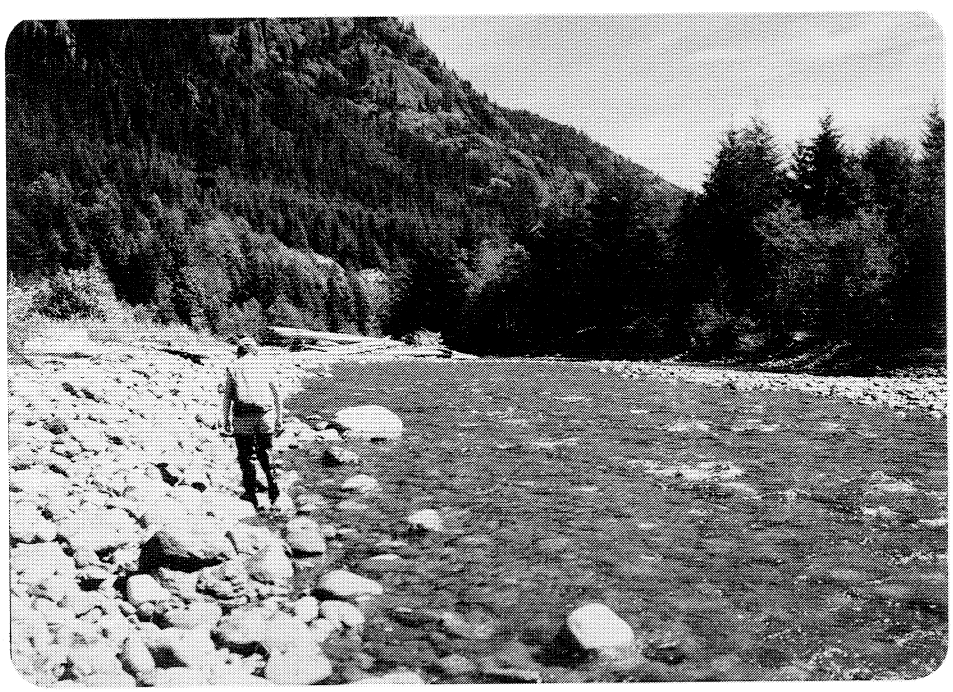
11. Reach I showing active channel with numerous debris piles.



12. Reach I at Cervus Creek confluence.

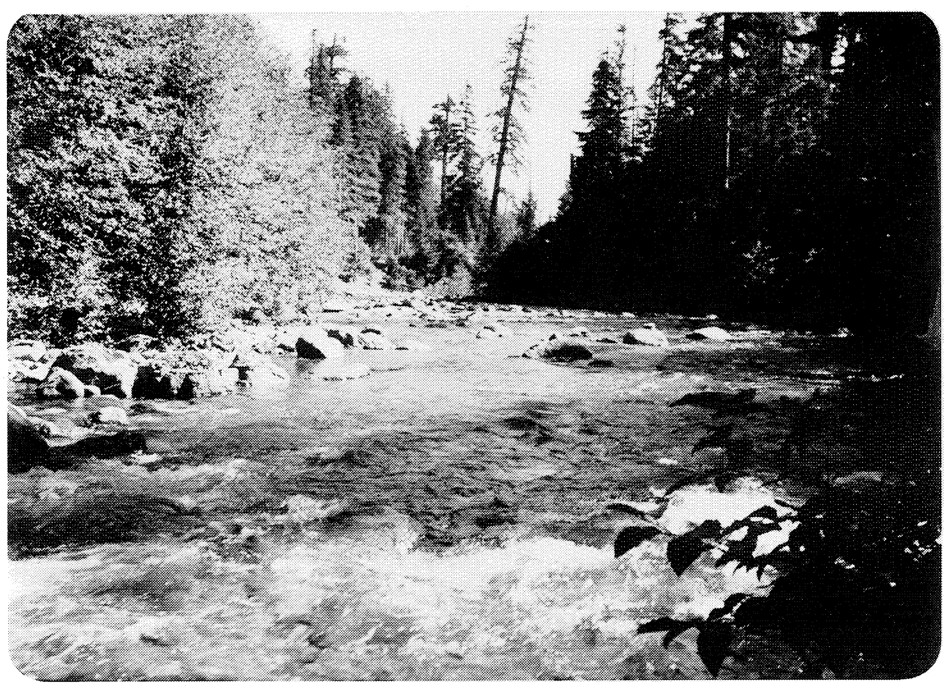


13. Reach II below Idsardi Creek. This glide habitat would have fish distribution restricted to the periphery.



14. Reach II near Unnamed Creek. Note generally larger substrate compared to Reach I.

15. One of the few log jams present in Reach II. Confined nature of the stream would not allow diversion around such a jam as would be the case in Reach I.



16. Upper Reach II. Despite abundant instream cover fish were not found in this habitat; only some peripheral areas were colonized.

17. Reach II - note mixture of habitat as pool/glide/riffle. Reach I did not have this variation in habitat as most was glide.

18. Reach III. Large bedrock and boulders formed many pools and areas of hydraulic cover.

19. Side channel in Reach IV. The upper Elk River floodplain had numerous side channels such as this, in which yearling cutthroat and Dolly Varden were abundant.

20. Another side channel in Reach IV.

21. An example of Reach IV habitat. Note the appearance of stability as moss was present on some boulders and overhead canopy was more noticeable.

APPENDIX II Population estimate results.

SITE NO.: 1
DATE: Sept. 21, 1978
AREA SAMPLED: 87m^2
WATER TEMPERATURE:
CATCH PROBABILITY: 0.4

LOCATION: Tlools Creek

LENGTH: 20.3m
DISCHARGE: 1.26m^3/s (45cfs)
SLOPE: 1.0%

SPECIES	AGE GROUP	n CAPTURED	AVERAGE FORK LENGTH	ESTIMATED POP. SIZE	$\widehat{NO.}/m$	$\widehat{NO.}/m^2$	AVG.WT. AT AVG. F.L.	EST. BIOMASS	$\hat{B}/m$	$\hat{B}/m^2$
Rainbow	0+	21	48.5	52.5	2.59	0.60	1.55	81.38	4.01	0.94
	1+	4	94.3	10.0	0.49	0.12	11.39	113.90	5.61	1.31
	2+	1	138.0	2.5	0.12	0.03	35.74	89.85	4.43	1.03
Dolly Varden	0+	19	59.5	47.5	2.34	0.55	2.09	99.28	4.89	1.14
	1+	1	100.0	2.5	0.12	0.03	9.90	24.75	1.22	0.28
ΣFry		40		100.0	4.93	1.15		180.66	8.90	2.08
ΣSalmonids		46		115.0	5.66	1.33		409.16	20.15	4.70

SITE NO.: 2
DATE: Sept. 19, 1978
AREA SAMPLED: $90 m^2$
WATER TEMPERATURE: $6.8^{o}C$
CATCH PROBABILITY: 0.5

LOCATION: Filberg Creek at Highway bridge

LENGTH 15.5m
DISCHARGE: $0.42\text{-}.056 km^3/s$ (15-20cfs)
SLOPE: 4.0%

SPECIES	AGE GROUP	n CAPTURED	AVERAGE FORK LENGTH	ESTIMATED POP. SIZE	$\widehat{NO.}/m$	$\widehat{NO.}/m^2$	AVG.WT. AT AVG. F.L.	EST. BIOMASS	$\widehat{B}/m$	$\widehat{B}/m^2$
Rainbow	0+	1	44	2	0.13	0.02	1.16	2.32	0.15	0.03
	1+	0								
Dolly Varden	0+	0								
	1+	1	145	2	0.13	0.02	30.18	60.36	3.89	0.67
Sculpins		3								
Σ Fry		1		2	0.13	0.02		2.32	0.15	0.03
Σ Salmonids		2		4	0.26	0.04		62.68	4.04	0.70

SITE NO.: 3

LOCATION: Side Channel of mainstem Elk River approximately 450-500m upstream of Filberg Creek.

DATE: Sept. 20, 2978
AREA SAMPLED: 282m^2
WATER TEMPERATURE: 10.3^oC
CATCH PROBABILITY: 0.72

LENGTH: 41.5m
DISCHARGE: .028m^3/s (1cfs)
SLOPE: 0.3%

SPECIES	AGE GROUP	C_1	C_2	AVERAGE FORK LENGTH	ESTIMATED POP. SIZE	$\widehat{NO.}/m$	$\widehat{NO.}/m^2$	AVG.WT. AT AVG. F.L.	EST. BIOMASS	$\widehat{B}/m$	$\widehat{B}/m^2$
Rainbow	0+	36	11	47.0	51.8	1.25	0.18	1.41	73.04	1.76	0.26
	1+	0	0								
Dolly Varden	0+	3	0	62.0	4.2	0.10	0.01	2.36	9.91	0.24	0.04
	1+	0	0								
Σ Fry		39	11		56.0	1.35	0.19		82.95	2.00	0.30
Σ Salmonids		39	11		56.0	1.35	0.19		82.95	2.00	0.30

confidence limits: var. $= (C_1{}^2\ C_2{}^2\ (C_1 + C_2))/(C_1 - C_2)^4$

$= (39^2\ 11^2\ (39 + 11))/(39 - 11)^4 = 14.97$

S.E. $= \sqrt{\text{var.}} = \sqrt{14.97} = 3.87$

$\hat{N} = 56 \pm t_{(.05,\ 1DF)}\text{S.E.} = 56 \pm 7.7$

$\widehat{\text{pop.}} = 48.3$ n 63.7

SITE NO. 4

DATE: Sept. 19, 1978
AREA SAMPLED: 290m^2
WATER TEMPERATURE:
CATCH PROBABILITY: 0.7

LOCATION: Side channel of mainstem Elk River roughly 800m upstream of Filberg Creek

LENGTH: 52.5
DISCHARGE: 0.042m^3/s(1.5cfs)
SLOPE: 0.4%

SPECIES	AGE GROUP	n CAPTURED	AVERAGE FORK LENGTH	ESTIMATED POP. SIZE	$\hat{NO.}/m$	$\hat{NO.}/m^2$	AVG.WT. AT AVG. F.L.	EST. BIOMASS	$\hat{B}/m$	$\hat{B}/m^2$
Rainbow	0+ 1+	46	44.3	65.7	1.25	0.23	1.18	77.54	1.48	0.27
Dolly Varden	0+ 1+	4	54.8	5.7	0.11	0.02	1.63	9.29	0.18	0.03
Σ Fry		50		71.4	1.36	0.25		86.83	1.66	0.30
Σ Salmonids		50		71.4	1.36	0.25		86.83	1.66	0.30

SITE NO.: 5
DATE:
AREA SAMPLED: $36.5m^2$
WATER TEMPERATURE: 7^oC
CATCH PROBABILITY: 0.7

LOCATION: Cervus Creek

LENGTH: 25m
DISCHARGE:
SLOPE: 0.8%

SPECIES	AGE GROUP	n CAPTURED	AVERAGE FORK LENGTH	ESTIMATED POP. SIZE	$\widehat{NO.}/m$	$\widehat{NO.}/m^2$	AVG.WT. AT AVG. F.L.	EST. BIOMASS	$\hat{B}/m$	$\hat{B}/m^2$
Rainbow	0+	11	52.5	15.7	0.63	0.43	1.96	30.77	1.23	0.84
	1+	0								
Dolly Varden	0+	5	45.6	7.1	0.28	0.19	1.00	7.10	0.28	0.19
	1+	1	100.0	1.4	0.06	0.04	9.90	13.86	0.55	0.38
Σ Fry		16		22.8	0.91	0.62		37.88	1.51	1.03
Σ Salmonids		1		24.2	0.97	0.66		51.74	2.06	1.41

SITE NO.: 6

LOCATION: Side channel of mainstem Elk River 300m upstream of Cervus Creek

DATE: Sept. 23, 1978

AREA SAMPLED: 180m^2

WATER TEMPERATURE:

CATCH PROBABILITY:

LENGTH: 60m

DISCHARGE:

SLOPE:

SPECIES	AGE GROUP	n CAPTURED	AVERAGE FORK LENGTH	ESTIMATED POP. SIZE	$\hat{NO.}/m$	$\hat{NO.}/m^2$	AVG.WT. AT AVG. F.L.	EST. BIOMASS	$\hat{B}/m$	$\hat{B}/m^2$
Rainbow	0+	6	40							

This was a sample only - no population estimate.

SITE NO.: 7

LOCATION: Side channel to mainstem Elk River 300m upstream of Cervus Creek

DATE: Sept. 23, 1978
AREA SAMPLED: 345m^2
WATER TEMPERATURE: 9.5^{o}C
CATCH PROBABILITY: 0.6

LENGTH: 83m
DISCHARGE: 0.10^3/s (3.5cfs)
SLOPE: 0.8%

SPECIES	AGE GROUP	n CAPTURED	AVERAGE FORK LENGTH	ESTIMATED POP. SIZE	$\widehat{NO.}/m$	$\widehat{NO.}/m^2$	AVG.WT. AT AVG. F.L.	EST. BIOMASS	$\hat{B}/m$	$\hat{B}/m^2$
Rainbow	0+	118	43.9	196.7	2.37	0.57	1.15	226.20	2.73	0.66
	1+	0								
Dolly Varden	0+	9	58.2	15.0	0.18	0.04	1.95	29.25	0.35	0.08
	1+	1	103.0	1.7	0.02	0.01	10.82	18.39	0.22	0.05
Σ Fry		127		211.7	2.55	0.61		255.45	3.08	0.74
Σ Salmonids		128		213.4	2.57	0.61		273.84	3.30	0.79

SITE NO.: 8

LOCATION: Edge of mainstem Elk River 300m upstream of Cervus Creek

DATE: Sept. 23, 1978
AREA SAMPLED: $171 m^2$
WATER TEMPERATURE:
CATCH PROBABILITY: 0.5

LENGTH: 57m
DISCHARGE:
SLOPE: 0.9%

SPECIES	AGE GROUP	n CAPTURED	AVERAGE FORK LENGTH	ESTIMATED POP. SIZE	$\widehat{NO.}/m$	$\widehat{NO.}/m^2$	AVG.WT. AT AVG. F.L.	EST. BIOMASS	$\hat{B}/m$	$\hat{B}/m^2$
Rainbow	0+	8	38.9	16	0.28	0.09	0.80	12.80	0.22	0.07

SITE NO.: 9
DATE: Oct. 31, 1978
AREA SAMPLED: 123m^2
WATER TEMPERATURE: 6^oC
CATCH PROBABILITY: 0.75

LOCATION: Unnamed tributary below highway bridge

LENGTH: 28m
DISCHARGE:
SLOPE: 1.5%

SPECIES	AGE GROUP	n CAPTURED	AVERAGE FORK LENGTH	ESTIMATED POP. SIZE	$\widehat{NO.}/m$	$\widehat{NO.}/m^2$	AVG.WT. AT AVG. F.L.	EST. BIOMASS	$\widehat{B}/m$	$\widehat{B}/m^2$
Rainbow	0+	2	56.5	2.7	0.10	0.02	2.45	6.62	0.24	0.05
	1+	0								
Cutthroat	0+	11	50.5	14.7	0.53	0.12	1.64	24.11	0.86	0.20
	1+	2	101.5	2.7	0.10	0.02	13.28	35.86	1.28	0.29
Dolly Varden	0+	20	48.5	26.7	0.95	0.22	1.13	30.17	1.08	0.25
	1+	8	105.3	10.7	0.38	0.09	11.56	123.69	4.42	1.01
	2+[a]	3	162.0	4.0			42.09	168.36		
	3+[a]	4	255.5	5.3			165.12	875.14		
Σ Fry		33		44.1	1.58	0.36		60.90	2.18	0.50
Σ Salmonids		43[a]		57.5	2.06	0.47		220.45	7.88	1.80

a 2+ and 3+ Dolly Varden were spawning adults, probably from Upper Campbell Lake, so were not included in biomass estimates.

SITE NO.: 10
DATE:
AREA SAMPLED: $234 m^2$
WATER TEMPERATURE: $9^{o}C$
CATCH PROBABILITY: 0.7

LOCATION: Mainstem Elk River 200 m below Gold River Highway bridge
LENGTH: 29.5m
DISCHARGE:
SLOPE: 1.1%

SPECIES	AGE GROUP	n CAPTURED	AVERAGE FORK LENGTH	ESTIMATED POP. SIZE	$\widehat{NO.}/m$	$\widehat{NO.}/m^2$	AVG.WT. AT AVG. F.L.	EST. BIOMASS	$\widehat{B}/m$	$\widehat{B}/m^2$
Rainbow	0+	15	41.5	21.4	0.73	0.09	0.97	20.80	0.71	0.09

SITE NO.: 11
DATE: Sept. 19, 1978
AREA SAMPLED: $98m^2$
WATER TEMPERATURE:
CATCH PROBABILITY: 0.5

LOCATION: Mainstem Elk River 80m below Elk River Timber bridge crossing
LENGTH: 28m
DISCHARGE:
SLOPE: 1%

SPECIES	AGE GROUP	n CAPTURED	AVERAGE FORK LENGTH	ESTIMATED POP. SIZE	$\widehat{NO.}/m$	$\widehat{NO.}/m^2$	AVG.WT. AT AVG. F.L.	EST. BIOMASS	$\widehat{B}/m$	$\widehat{B}/m^2$
Rainbow	0+	11	53.09	22	0.79	0.22	2.04	44.88	1.60	0.46
	1+	0								
Dolly Varden	0+	1	52.0	2	0.07	0.02	1.39	2.78	0.10	0.03
	1+	1	100.0	2	0.07	0.02	9.90	19.80	0.71	0.20
Σ Fry		12		24	0.86	0.24		47.66	1.70	0.49
Σ Salmonids		13		2	0.93	0.26		67.46	2.41	0.69

SITE NO.: 12
DATE: Sept. 19, 1978
AREA SAMPLED: 166m^2
WATER TEMPERATURE:
CATCH PROBABILITY: 0.65

LOCATION: Mainstem Elk River 100m below Drum Creek confluence
LENGTH: 24m
DISCHARGE:
SLOPE: 2.8%

SPECIES	AGE GROUP	n CAPTURED	AVERAGE FORK LENGTH	ESTIMATED POP. SIZE	$\widehat{NO.}/m$	$\widehat{NO.}/m^2$	AVG.WT. AT AVG. F.L.	EST. BIOMASS	$\widehat{B}/m$	$\widehat{B}/m^2$
Rainbow	0+	51	48.73	78.5	3.27	0.47	1.57	123.20	5.14	0.74
	1+	0	-	-	-	-	-	-		
Dolly Varden	0+	3	48.0	4.6	0.19	0.03	1.09	5.01	0.21	0.03
	1+	1	117.0	1.5	0.06	0.01	15.86	23.79	0.99	0.14
Σ Fry		54		83.1	3.43	0.50		128.21	5.35	0.77
Σ Salmonids		55		84.6	3.49	0.51		152.0	6.34	0.91

SITE NO.: 13
DATE: Sept. 19, 1978
AREA SAMPLED: $148m^2$
WATER TEMPERATURE: 9.8^oC
CATCH PROBABILITY: 0.6

LOCATION: Drum Creek

LENGTH: 25m
DISCHARGE: $1.26m^3/s$ (45cfs)
SLOPE: 0.7%

SPECIES	AGE GROUP	n CAPTURED	AVERAGE FORK LENGTH	ESTIMATED POP. SIZE	$\widehat{NO.}/m$	$\widehat{NO.}/m^2$	AVG.WT. AT AVG. F.L.	EST. BIOMASS	$\hat{B}/m$	$\hat{B}/m^2$
RAINBOW	0+	17	43.2	28.3	1.13	0.19	1.10	31.13	1.25	0.21

SITE NO.: 14

DATE: Sept. 22, 1978

AREA SAMPLED:

WATER TEMPERATURE:

CATCH PROBABILITY:

LOCATION: Upper mainstem Elk River

LENGTH:

DISCHARGE:

SLOPE:

SPECIES	AGE GROUP	n CAPTURED	AVERAGE FORK LENGTH	ESTIMATED POP. SIZE	$\widehat{NO.}/m$	$\widehat{NO.}/m^2$	AVG.WT. AT AVG. F.L.	EST. BIOMASS	$\hat{B}/m$	$\hat{B}/m^2$
Dolly Varden	0+	4	56.3							
	1+	1	105.0							
Cutthroat	0+	0								
	1+	2	96.0							

Sample only - not a population estimate

SITE NO.: 15
DATE: Sept. 23, 1978
AREA SAMPLED: $50m^2$
WATER TEMPERATURE: $7^{o}C$
CATCH PROBABILITY: 0.5

LOCATION: Upper mainstem Elk River

LENGTH: 7m
DISCHARGE:
SLOPE:

SPECIES	AGE GROUP	n CAPTURED	AVERAGE FORK LENGTH	ESTIMATED POP. SIZE	$\widehat{NO.}/m$	$\widehat{NO.}/m^2$	AVG.WT. AT AVG. F.L.	EST. BIOMASS	$\hat{B}/m$	$\hat{B}/m^2$
Rainbow	0+	1	55.0	2	0.29	0.04	2.26	4.52	0.64	0.09
	1+									
Dolly Varden	0+	10	53.4	20	2.90	0.40	1.51	30.20	4.31	0.60
	1+									
Cutthroat	0+	1	50.0	2	0.29	0.04	1.59	3.18	0.45	0.06
	1+									
Σ Fry		12		24	3.48	0.48		37.90	5.40	0.75
Σ Salmonids		12								

SITE NO.: 16
DATE: Sept. 23, 1978
AREA SAMPLED: $65.5m^2$
WATER TEMPERATURE: 7^oC
CATCH PROBABILITY: 0.7

LOCATION: Upper mainstem Elk River

LENGTH: 13.5m
DISCHARGE: $0.25m^3/s$ (8cfs)
SLOPE:

SPECIES	AGE GROUP	n CAPTURED	AVERAGE FORK LENGTH	ESTIMATED POP. SIZE	$\widehat{NO.}/m$	$\widehat{NO.}/m^2$	AVG.WT. AT AVG. F.L.	EST. BIOMASS	$\widehat{B}/m$	$\widehat{B}/m^2$
Rainbow										
Dolly Varden	0+	4	49.5	5.7	0.42	0.09	1.20	6.84	0.51	0.10
	1+	2	94.5	2.9	0.21	0.05	8.35	24.22	1.79	0.37
Cutthroat	0+	2	48.5	2.9	0.21	0.05	1.45	4.21	0.31	0.06
	1+	4	85.8	5.7	0.42	0.09	8.01	45.66	3.38	0.70
Σ Fry		6		8.6	.63	0.14		11.05	0.82	0.16
Σ Salmonids		12		17.2	1.26	0.28		80.93	5.99	1.23

SITE NO.: 17
DATE: Sept. 23, 1978
AREA SAMPLED: 38.5m^2
WATER TEMPERATURE: 7^oC
CATCH PROBABILITY: 0.65

LOCATION: Side channel of the Upper Elk River

LENGTH: 13.5
DISCHARGE: 0.008m^3/s (0.3cfs)
SLOPE:

SPECIES	AGE GROUP	n CAPTURED	AVERAGE FORK LENGTH	ESTIMATED POP. SIZE	$\widehat{NO.}/m$	$\widehat{NO.}/m^2$	AVG.WT. AT AVG. F.L.	EST. BIOMASS	$\hat{B}/m$	$\hat{B}/m^2$
Rainbow		-								
Dolly Varden	0+	-								
	1+	4	85.0	6.2	0.46	0.16	6.08	37.70	2.79	0.98
Cutthroat	0+	9	49.8	13.8	1.02	0.36	1.57	21.67	1.61	0.56
	1+	7	94.9	10.8	0.80	0.28	10.84	117.01	8.67	3.04
Σ Fry		9		13.8	1.02	0.36		21.67	1.61	0.56
Σ Salmonids		20		30.8	2.28	0.80		176.38	13.07	4.58

SITE NO.: 18
DATE: Sept. 23, 1978
AREA SAMPL:ED: 52
WATER TEMPERATURE: 7.5°C
CATCH PROBABILITY: 0.4

LOCATION: Side channel of the Upper Elk River

LENGTH: 13.6
DISCHARGE:
SLOPE:

SPECIES	AGE GROUP	n CAPTURED	AVERAGE FORK LENGTH	ESTIMATED POP. SIZE	$\widehat{NO.}/m$	$\widehat{NO.}/m^2$	AVG.WT. AT AVG. F.L.	EST. BIOMASS	$\widehat{B}/m$	$\widehat{B}/m^2$
Rainbow										
Dolly Varden	0+									
	1+	2	114	5.0	0.37	0.10	14.67	73.35	5.39	1.41
Cutthroat	0+	1	43	2.5	0.18	0.05	1.01	3.51	0.26	0.07
	1+									
Σ Fry		1		2.5	0.18	0.05		3.51	0.26	0.07
Σ Salmonids		3		7.5	0.55	0.15		76.86	5.65	1.48

SITE NO.: 19
DATE: Sept. 23, 1978
AREA SAMPLED: $88 m^2$
WATER TEMPERATURE:
CATCH PROBABILITY: 0.5

LOCATION: Side Channel of the Upper Elk River

LENGTH: 23m
DISCHARGE:
SLOPE:

SPECIES	AGE GROUP	n CAPTURED	AVERAGE FORK LENGTH	ESTIMATED POP. SIZE	$\widehat{NO.}/m$	$\widehat{NO.}/m^2$	AVG.WT. AT AVG. F.L.	EST. BIOMASS	$\hat{B}/m$	$\hat{B}/m^2$
Rainbow		0								
Dolly Varden	0+	5	51.8	10	0.43	0.11	1.38	13.80	0.60	0.16
	1+	2	97.5	4	0.17	0.05	9.18	36.70	1.60	0.43
Cutthroat	0+	0								
	1+	2	101.5	4	0.17	0.05	13.28	53.12	2.30	0.60
Σ Fry		5		10	0.43	0.11		13.80	0.60	0.16
Σ Salmonids		9		18	0.77	0.21		103.62	4.51	1.18

APPENDIX III Standing crop estimates by species in the Elk River

Cutthroat trout population size in the Elk River, Strathcona Park, September-October 1978 based on population estimates

	HABITAT	AREA	REFERENCE	AGE GROUP	N/m^2	B/m^2	N_T	B_T(kg)
Reach I & II	Stable side channels and sloughs	$1,900m^2$	Site 9	0+	0.12	0.20	225	0.38
				1+	0.02	0.29	38	0.55
Unnamed Trib.		$3,000m^2$	Site 9	0+	0.12	0.20	360	0.60
				1+	0.02	0.29	60	0.87
Reach III	Mainstem	$6,000m^2$	Estimate from samples 14 and 16	0+	0.05	0.06	300	0.36
				1+	0.09	0.70	540	4.20
Reach IV	Mainstem pools	$14,000m^2$	Site 16	0+	0.05	0.06	700	0.80
				1+	0.09	0.70	1,260	9.80
	Mainstem riffles	$29,400m^2$	Site 15	0+	0.04	0.06	1,176	1.80
	Side channels	$4,500m^2$	Sites 17, 18 + 19	0+	0.18	0.21	815	0.95
				1+	0.11	1.21	500	5.48
	Total for Elk River System			0+			3,576	4.89
				1+			2,398	20.90

Dolly Varden char population size in the Elk River, Strathcona Park, September-October 1978 based on population estimates.

	HABITAT	AREA	REFERENCE	AGE GROUP	N/m^2	B/m^2	N_T	B_T
Tlools Creek		$36,000 m^2$	Site 1	0+	0.55	1.14	19,800	41.0
				1+	0.03	0.28	1,080	10.1
Filberg Creek		$3,000 m^2$	Site 1	0+	0.55	1.14	1,650	3.24
				1+	0.03	0.28	90	0.84
Cervus Creek	edge	$1,200 m^2$	Site 5	0+	0.19	0.19	228	0.23
				1+	0.04	0.38	48	0.46
Reach I	mainstem edge	$37,500 m^2$	Site 8	0+	-	-	-	-
Reach I	open side channels	$16,200 m^2$	Sites 3, 4, 6 + 7	0+	0.02	0.05	324	0.81
				1+	0.002	0.015	32	0.24
Reach I + II	stable side channels	$1,900 m^2$	Site 9	0+	0.22	0.25	413	0.47
				1+	0.09	1.01	169	2.06
Unnamed Trib.		$3,000 m^2$	Site 9	0+	0.22	0.25	660	0.75
				1+	0.09	1.01	270	3.03
Idsardi Creek		$1,000 m^2$	Site 2	1+	0.02	0.67	20	0.67
Reach II	mainstem edge - glide	$21,600 m^2$	Sites 10 + 11	0+	0.01	0.15	216	0.32
				1+	0.01	0.10	216	2.16
Reach II	mainstem edge - riffle	$44,800 m^2$	Site 12	0+	0.03	0.03	1,344	1.34
				1+	0.01	0.14	448	6.27
Reach III	mainstem	$6,000 m^2$	Estimated from samples 14 + 16	0+	0.09	0.10	540	0.60
				1+	0.05	0.37	300	2.20
Reach IV	mainstem pools	$14,000 m^2$	Site 16	0+	0.09	0.10	1,260	1.40
				1+	0.05	0.37	700	5.18
Reach IV	mainstem riffles	$29,400 m^2$	Site 15	0+	0.40	0.60	11,760	17.64
Reach IV	side channels	$4,500 m^2$	Sites 17, 18 + 19	0+	0.04	0.05	181	0.23
				1+	0.10	0.94	452	4.25
	Total for Elk River system			0+			38,396	68.0
				1+			3,825	37.5

Rainbow trout population size in the Elk River, Strathcona Park, September - October 1978 based on population estimates.

	HABITAT	AREA	REFERENCE	AGE GROUP	N/m^2	B/m^2	N_T	B_T
Tlools Creek		$36,000 m^2$	Site 1	0+	0.60	0.94	21,600	33.8
				1+	0.12	1.31	4,320	47.2
				2+	0.03	1.03	1,080	37.1
Filberg Creek		$3,000 m^2$	Site 1	0+	0.60	0.94	1,800	2.8
				1+	0.12	1.31	360	3.9
				2+	0.03	1.03	90	3.1
Cervus Creek	edge	$1,200 m^2$	Site 5	0+	0.43	0.84	516	1.0
Reach I	mainstem edge	$37,500 m^2$	Site 8	0+	0.09	0.07	3,375	2.6
Reach I	side channels	$16,200 m^2$	Sites 3, 4, 6 + 7	0+	0.33	0.40	5,346	6.5
Reach I + II	stable side channels	$1,900 m^2$	Site 9	0+	0.02	0.05	38	0.09
Unnamed Trib.		$3,000 m^2$	Site 9	0+	0.02	0.05	60	0.15
Idsardi Creek		$1,000 m^2$	Site 2	0+	0.02	0.03	20	0.3
Drum Creek	edge	$9,600 m^2$	Site 13	0+	0.19	0.21	1,824	2.0
Reach II	mainstem edge - glide	$21,600 m^2$	Sites 10 + 11	0+	0.15	0.28	3,240	6.0
	mainstem edge - riffle	$44,800 m^2$	Site 12	0+	0.47	0.74	21,056	33.2
Reach IV	mainstem edge - riffle	$29,400 m^2$	Site 15	0+	0.04	0.09	1,176	2.6
	Total for Elk River system			0+			60,051	92.6
				1+			4,680	51.1
				2+			1,170	40.2