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ASSESSMENT OF STREAM CARRYING CAPACITY RELATIVE
TO STEELHEAD ENHANCEMENT OPPORTUNITIES IN
THE DEADMAN RIVER

by

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ABSTRACT

The Deadman River, a known Thompson River summer steelhead spawning tributary, was studied by the Fish Habitat Improvement Section in late August, 1979. The major objective was to identify potential steelhead enhancement opportunities in the Deadman River and Criss Creek. The study was conducted by late summer fish habitat and carrying capacity analysis.

The salmonid population was composed primarily of rainbow trout juveniles, up to saturation levels, with lesser numbers of chinook and coho salmon. Late summer standing crop, growth rate and juvenile migration data indicate that smolt yield directly from the Deadman River and Criss Creek was not sufficient to produce enough smolts for the observed adult escapement. The steelhead juvenile life history pattern suggests that smolts are produced by a number of routes, including directly in the Deadman River and Criss Creek, and by rearing in the mainstem Thompson River as a result of Deadman River outmigrants. The majority of smolts appear to be produced as a result of yearling outmigrants.

Fish habitat was found in the Deadman River to be limited in quality by substrate compaction in large substrate areas, and in small substrate areas by riparian land use activities. Limiting factors in steelhead smolt production were in the overwintering habitat and parr habitat areas. A recommended enhancement strategy to maximize the number of yearling migrants to the Thompson River is suggested. Overwintering and summer parr habitat improvement methods and increased habitat protection measures are recommended.

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1.0 INTRODUCTION

The Deadman River has been identified as a major spawning stream of the Thompson River summer run steelhead. Radio tagging studies by McGregor (in prep.) have shown that adult steelhead move into the Deadman River to spawn in late April/early May from overwintering sites in the Thompson River. In 1979 an estimated 300 to 400 steelhead were observed in the stream.

In late August, 1979 the Fish Habitat Improvement Section of the B. C. Fish and Wildlife Branch, at the request of the regional fisheries biologist, conducted a biophysical assessment of the Deadman River and a tributary, Criss Creek. The purpose of the study was to identify potential fisheries (steelhead) enhancement opportunities in the stream. The study was conducted through late summer carrying capacity analysis, involving habitat and fish population assessment. Included in this report are discussions on fish habitat within the Deadman River watershed, associations between fish and fish habitat, life history of Deadman River steelhead, and opportunities for enhancement of the stock. The project was completed under the Salmonid Enhancement Program.

2.0 THE STUDY AREA

The Deadman River flows into the Thompson River roughly 4km downstream from the outlet of Kamloops Lake (Fig. 1). The stream has a mainstem length of approximately 90km and a drainage area of 1,450km². The watershed varies from a forested upland plateau forming the headwaters to near desert conditions in the Thompson Valley near the mouth. The stream lies within the interior dry belt of south central B. C. characterized by hot dry summers and cold dry winters. Most precipitation occurs in the upland plateau during the winter as snow. The major feature of the discharge regime is spring freshet, followed by low summer and winter flows.

This study was focussed on the area open to anadromous salmonids, covering the lowest 42km of the Deadman River below Snohoosh

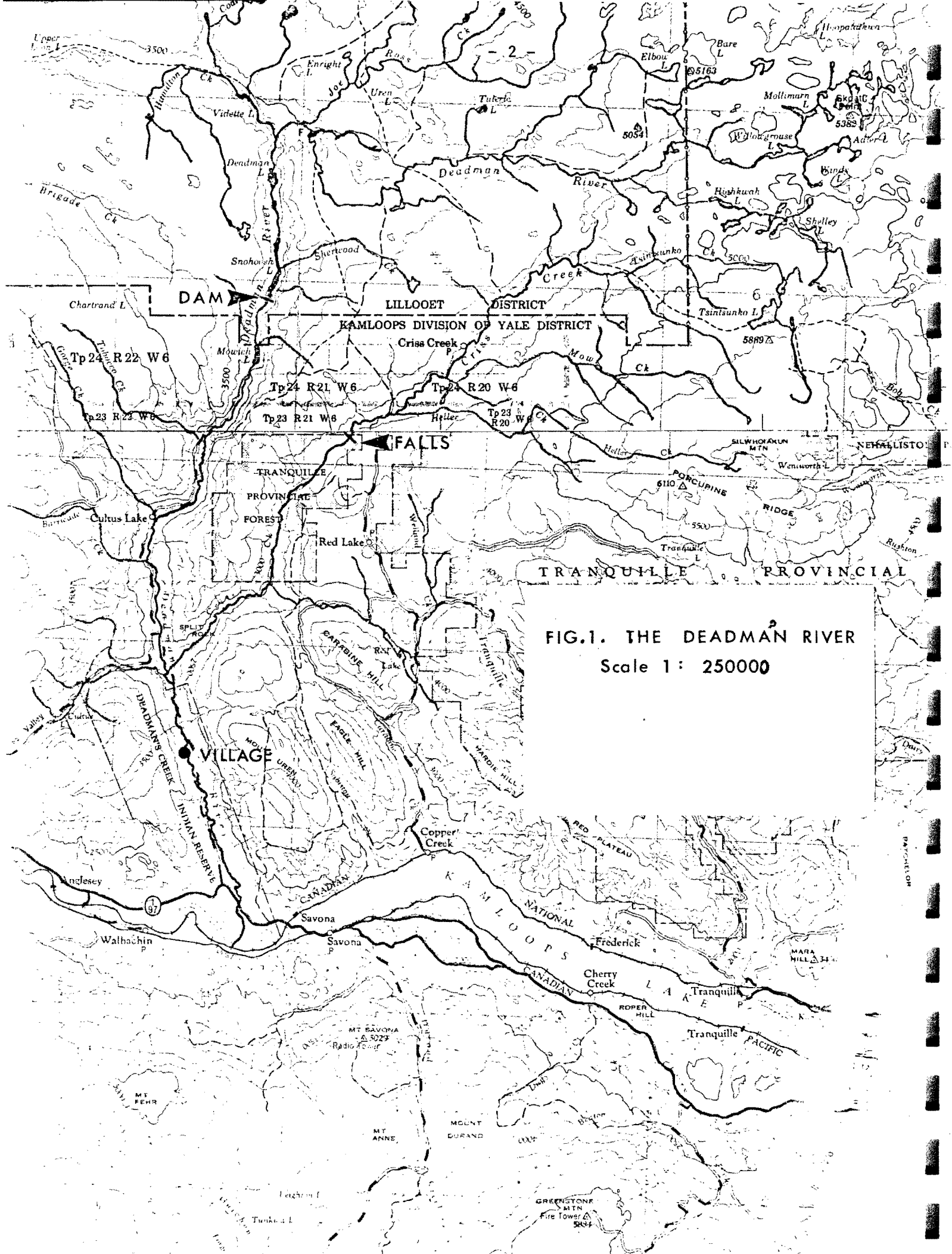


FIG. 1. THE DEADMAN RIVER
Scale 1 : 250000

Lake and 17km of the major tributary, Criss Creek. The Deadman River below Mowich Lake ranges in discharge from $30\text{m}^3/\text{s}$ (1100cfs) during freshet to $0.1\text{m}^3/\text{s}$ (3cfs) during low flow periods in the fall and winter. The main land use along the stream is agriculture, primarily cattle ranching and forage crop cultivation (hay, alfalfa). Agricultural activities are concentrated from 5km below Mowich Lake to above the Deadman's Creek Indian Reservation (19km), with sporadic developments through the reserve. A small village is located 12km from the mouth. Owing to the arid nature of the area irrigation demand on the stream is high. In 1976 the Deadman Creek Improvement District constructed a dam at the outlet of Snohoosh Lake to ensure adequate storage for summer irrigation purposes.

The only major tributary to the Deadman River is Criss Creek. This stream has a drainage area of 500km^2 and a discharge range from near zero in late summer to a maximum of $45\text{m}^3/\text{s}$ (1600cfs) during freshet. The lowest 1km of Criss Creek flows through agricultural land, while the remaining 16km of potentially anadromous stream is undeveloped. Agricultural development is present in the headwater plateau.

3.0 METHODS

The Deadman River, from the Thompson River to Mowich Lake, and Criss Creek were studied August 22 through 29, 1979. The procedure involved habitat assessment throughout the stream and fish population estimates at selected sites. Results were then applied to represent the whole stream.

Habitat assessment was conducted by the "habitat unit" sampling technique developed by the Fish Habitat Improvement Section in 1979 (DeLeeuw, in prep.; Tredger, 1980). This technique involved sampling units of habitat (pools, glides and riffles) throughout the stream on a reach basis. Units were sampled in sets of 6 or 12 in a continuous fashion, with up to 3 or 4 sets per reach. Assessment of habitat units quantified 21 parameters representing stream channel hydrology, substrate, cover and water quality. Habitat data was analyzed by computer

and results are reported as total and percentage area by reach of pools, glides and riffles, and average values and percentages of measured parameters in each. An outline of habitat unit parameters is given in Appendix I.

Fish population estimates were conducted by the removal method following standard Section procedures of site isolation (stop nets) and electrofishing (Wightman, 1979). A total of 12 population estimates were completed in the Deadman River and 2 in Criss Creek. Results were then related to habitat parameters collected by the habitat unit procedure at each study site. Relationships between population variables and habitat parameters were obtained by direct graphical analysis and linear regression techniques. These relationships were used in describing habitat utilization by salmonids in the Deadman River, and in extrapolating the data to estimate standing crop.

4.0 RESULTS

4.1 Water Quality and Discharge

Water Chemistry

Water chemistry data forwarded by the Water Investigations Branch indicated good water quality in the Deadman River system over the past 10 years (Table 1).

TABLE 1 Deadman River water quality data, 10 year summary 1970 to 1980, taken from Water Investigations Branch files.

	DEADMAN AT MOUTH	DEADMAN ABOVE CRISS CREEK	CRISS CREEK AT MOUTH
pH (relative units)	8.2 (7.3-9.25)	8.2 (7.5-9.1)	8.06 (7.4-8.8)
specific conductance (uohm/cm)	258.7 (89-400)	289.4 (50-425)	176.8 (47-418)
dissolved oxygen (mg/l)	11.03 (8.9-14.4)	10.3 (6.5-13.6)	11.07 (9.2-14.2)
nitrate N (mg/l)	.038 (.02-.16)	.06 (.02-.19)	.034 (.02-.08)
total phosphate (mg/l)	.013 (.004-.181)	.018 (.006-.429)	.013 (.004-.127)

The wide range in many of these parameters is related to variations in discharge, mainly low winter flows and spring freshet. Conductivity and nutrient levels were moderately high, suggesting a productive environment. Dissolved oxygen concentration was always within acceptable limits. Water quality analysis conducted by Starr (1979) found the stream generally suitable for salmonid rearing.

Water temperature

A Ryan thermograph was installed in the middle portion of the Deadman River (Reach 7, 26km) for the period July 29 to August 22, 1979. Maximum temperature recorded at this location was 18°C. More detailed temperature investigations were conducted by Starr (1979) in which continuous temperature records were kept for 3 sites over a year-and-a-half (July, 1977 to December, 1978). This study found the area subjected to highest stream temperature was that below the Indian village (Reaches 1 and 2, 0-12km). High summer temperatures ranging up to 24°C were recorded at the lowest thermograph site (Reach 1, 3km), however⁹ average temperature seldom exceeded 20°C. Mean weekly high temperatures over 22°C were recorded for 3 weeks in August, 1977. The almost complete lack of stream canopy cover below the village was a major factor in causing high water temperature, as was the occurrence of daily high air temperatures in excess of 40°C in the summer months.

Although the temperatures recorded may not be lethal to salmonids, they are capable of causing severe stress and perhaps an avoidance reaction. Bell (cited in Reiser and Bjornn, 1979) indicated that cold water fish cease growth at temperatures above 20.3°C because of increased metabolic activity. Reiser and Bjornn (1979) have found that density of steelhead fry were higher in channels with lower temperatures. The presence of high stream temperature in the lower stream area may therefore detract from its utility as a rearing area for salmonids.

Discharge

The discharge regime of both Deadman River and Criss Creek is characterized by high flows during spring freshet, with low flows occurring through the fall and winter months (Appendix II). As a result, high irrigation demand causes a conflict between fisheries and agricultural activities.

A detailed analysis of the hydrology, discharge regime and water budget was completed by Hamilton (1974). This study conducted a detailed analysis of water licences and irrigation demands relative to supply prior to construction of the Snohoosh Lake dam. In the above study a longitudinal profile of discharge in the Deadman River below Snohoosh Lake indicated a significant variation in discharge between sites. Discharge measurements taken during this study indicated variable discharge as well (Table 2), ranging from 0.5 to 0.6m³/s in the lower 26.5km, with a minimum of 0.30m³/s (10.7cfs) in an area 30 to 32km from the mouth.

TABLE 2 Longitudinal variation in mean discharge of the Deadman River, August 22 to 29, 1979.

REACH	STREAM AREA (km)	DISCHARGE	
		m ³ /s	cfs
1	0 - 6.6	0.58	20.7
4	16.3 - 21.5	0.56	20.0
5	21.5 - 23.9	0.60	21.4
6	23.9 - 25.9	0.51	18.2
7	25.9 - 26.5	0.60	21.4
8	26.5 - 30.2	0.40	14.3
9	30.2 - 32.2	0.30	10.7
10	32.2 - 36.1	0.50	17.9

Much of the flow disappears as groundwater roughly at Tobacco Creek, and fully reappears near Gorge Creek. Prior to dam construction this 5.7km section was apparently intermittently dry in the late summer to winter low flow period (Hamilton, 1974). With the dam in place adequate discharge is prolonged through the irrigation period, however once irrigation demand is finished water release from the dam is stopped, and this portion of the stream again becomes dry. McGregor (pers. comm.) has indicated the zone of dryness extends downstream to roughly 28.7km (Docksteads), covering a distance of roughly 2.5km.

During this study Criss Creek was dry over the lowest 1.0km, however throughout the remainder of the stream sampled discharge was roughly $0.10\text{m}^3/\text{s}$ (3.5cfs). The dry section corresponded with the Deadman River historic flood plain, allowing the entire flow to disappear as groundwater. An unscreened irrigation diversion located upstream of the Criss Creek road bridge (1.5km) was removing about half of the flow.

4.2 Fish Habitat in the Deadman River and Criss Creek

4.2.1 Physical habitat analysis

The Deadman River, up to Mowich Lake (roughly 37km) was divided into 11 reaches (Fig. 2) based on air-photo analysis and ground reconnaissance. Criss Creek was divided into 3 reaches over the 17km accessible length. A summary of general reach characteristics outlining the basic habitat types, riparian land use and stream channel alterations is given in Table 3. A detailed analysis of fish habitat based on habitat unit sampling is included in Appendix III as physical data summary tables for each reach. The data in Appendix III represents overall mean values of the habitat unit sampling in each reach. A series of representative photographs is included in Appendix IV.

Deadman River

Only 8 of 11 reaches in the mainstem Deadman River were studied by the habitat unit procedure. Reaches 2, 3 and 11 were excluded because

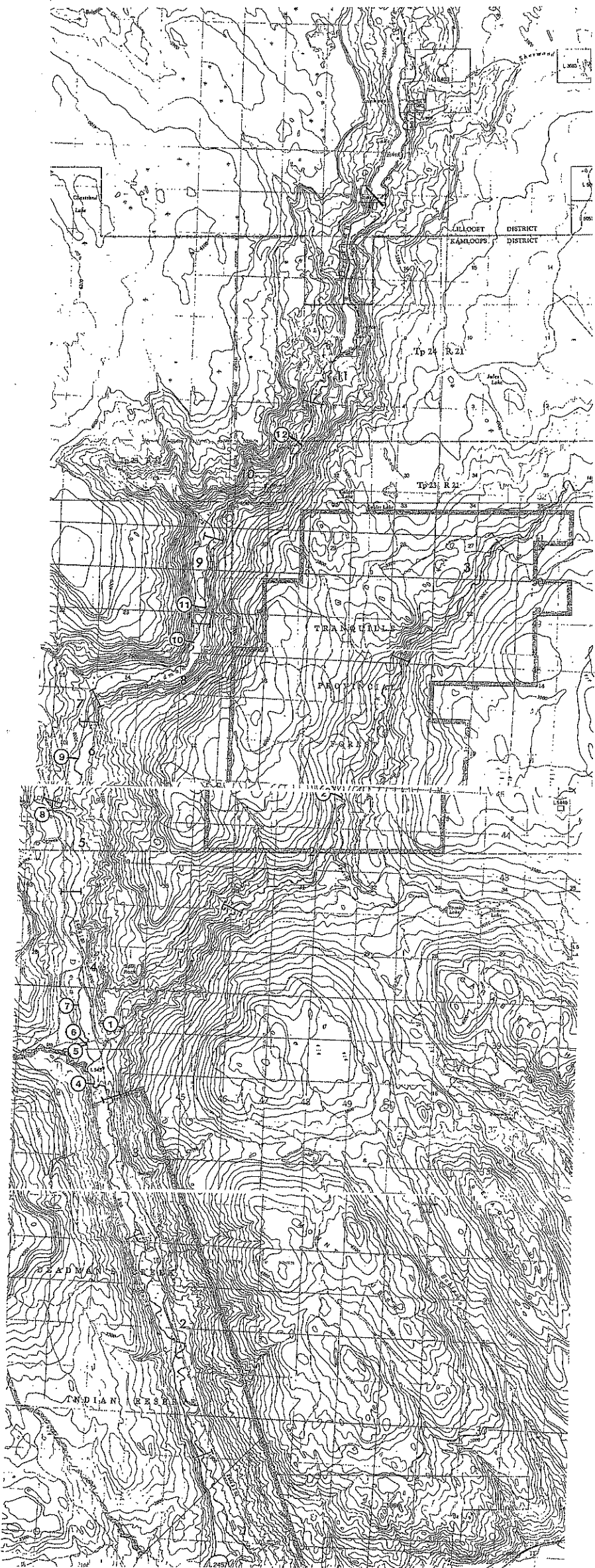


TABLE 3 Summary of general reach characteristics of the Deadman River and Criss Creek, August 22 to 29, 1979.

REACH	LENGTH (km)	GRADIENT ^a (%)	MAJOR SUBSTRATES ^b	SUBSTRATE QUALITY	HABITAT TYPE	% POOL	% RIFFLE	% GLIDE	RIPIARIAN LAND USE/AMOUNT ^c	STREAM ALTERATIONS ^c	COMMENTS
DEADMAN RIVER											
1	6.65	1.5	C, B, Lg	compacted, overlain with fines	1	9.6	58.4	32.0	Indian Reserve, very little activity	none	"desert" environment no canopy cover
2	6.18	0.7	Lg, C, B	n/a	1	-	-	-	Indian Reserve; some agricultural use; small village	none	increasing but sparse canopy cover
3	3.48	1.0	Lg, Sg, F	n/a	2	-	-	-	Indian Reserve; moderate agricultural use	occasional bank armouring (car bodies)	riparian vegetation increased
4	5.23	1.0	Lg, Sg, F	some compaction	2	10.4	42.4	47.2	Private: high agricultural use, forage crop production	channelization, debris removal, bank armouring (rip-rap) and devegetation	reach 3 and 4 were simi- lar, only separated because of I. R.
5	2.38	0.6	Lg, C, F	generally compacted	1	5.2	42.3	54.2	Range land with some cultivation at lower end	none	relatively steep- sided (entrenched) canyon area
6	1.98	0.5	F, Sg, Lg	large amount of fines	2	16.5	26.0	57.5	some cultivation with much of area cleared	minor debris and beaverdam removal	much area in early stage of development
7	0.55	1.1	C, Lg, B	covered with fines & algae, compacted	1	0	33.3	66.7	some forage crop cultivation	none	little encroachment on stream
8	3.72	0.7	Sg, Lg, F	covered with thin layer of fines	2	20.6	28.3	51.1	high use for forage crop cultivation	debris and riparian vegetation removal, and bank armouring (rip-rap)	Circle W to Docksteaders
9	1.98	0.5	Lg, Sg, F	slight compaction	2	15.7	42.2	42.1	high use for forage crop cultivation	extensive channelization, debris removal, and loss of riparian vegetation	channel has been re-located in some areas
10	3.96	1.5	Lg, Sg, B	moderate to high compaction	1	5.6	56.8	37.6	little agricultural activity	road rip-rapping	
11	1.34	5.7	C, B, Lg	n/a	1	-	-	-	none	none	confined, high gradient section to Mowich Lake
CRISS CREEK											
1	4.8	3.8	B, C, Lg	good	1	31.1	52.0	16.9	none	none	untouched beyond 1km
2	7.4	2.1	C, Lg, B	good	1	2.7	45.3	52.0	logging	none	
3	9.0	3.0	C, Lg, B	slight compaction	1	28.9	35.4	35.7	logging with some agricultural use above anadromous portion	none	anadromous length = 4.5km to falls

^a from map and air-photo analysis

^b F = fines, Sg = small gravel, Lg = large gravel, C = cobbles, B = boulders

^c observations and air-photo analysis

of access problems. In these unsampled reaches general data on habitat type, including gradient, substrate type and width was obtained by air-photo analysis and spot observations. Other parameters such as habitat areas, depth and cover were estimated on the basis of similarities to adjacent reaches.

The Deadman River downstream of Mowich Lake was basically a single channel with alternating relatively high gradient, confined sections and relatively low gradient meandering sections. Because of the relative homogeneity observed in mean width and depth between reaches throughout the stream, major differences in habitat type of reaches were largely due to major differences in gradient and substrate size. For ease of analysis and interpretation, reaches within the Deadman River were grouped as to general habitat type based on gradient and substrate characteristics. Type 1 habitat was defined as having relatively high gradient and large (cobble, boulder, large gravel) substrate. Type 2 habitat was that with relatively shallow gradient and small (fines, small gravel) substrate. Type 1 habitat was typical of Reaches 1, 2, 5, 7, 10 and 11, while type 2 reaches included 3, 4, 6, 8 and 9. Grouping of reaches in this manner was not intended to suggest that reaches of similar habitat type had identical habitat, only that they were similar in terms of cobble/boulder environment versus sand/gravel environments. There were large differences between reaches of similar type based on exact gradient and substrate, instream debris, canopy cover, riparian land use, etc. These are outlined in Table 3.

In terms of habitat quality within the general habitat types there were differences between reaches. In type 2 reaches major variations appeared to be the result of riparian land use and stream encroachments. Much habitat, particularly in Reaches 4, 8 and 9, had been altered by debris removal, channelization and bank armouring. In terms of general fish habitat, this has resulted in the loss of canopy and riparian cover, stable instream cover elements and bank undercuts. In other type 2 reaches, for example Reach 6, general fish habitat was of higher quality because of limited land use.

Land use had little effect on type 1 reaches because of the entrenched and generally steep nature of riparian areas. As a general comment, the quality of this larger substrate habitat type was not consistently good throughout the Deadman River. In most of the reaches sampled, the cobble/boulder material was covered with a layer of fines, and a large proportion of the substrate was "cemented" into the stream bed. Speculation as to the reasons for this substrate compaction point to the general abundance of fines throughout the stream, and the lack of a fall freshet.

Criss Creek

Criss Creek was accessible to anadromous fish for approximately 17km, to a falls located roughly 4.5km into Reach 3. The entire stream was a relatively high gradient cobble, boulder, large gravel (Type 1) system. Reaches 1 and 3 were more precipitous than Reach 2, resulting in somewhat larger substrate and greater pool percentage than the middle reach. Most of the stream was inaccessible, with no land use activities in riparian areas. Quality of the type 1 habitat was generally good (not compacted with fines).

4.3 Fish Populations of the Deadman River and Criss Creek

4.3.1 Species presence and population estimates

Fish species present in the Deadman River below Mowich Lake include rainbow trout (both steelhead and Thompson River/Kamloops Lake stock), brook trout, chinook salmon, coho salmon, longnose dace and sucker spp. Estimates of fish population size conducted at 12 sites in the Deadman and 2 sites in Criss Creek are summarized in Tables 4 and 5, with more complete data in Appendix V and VI.

TABLE 4 Summary of fish biomass density (g/m²) estimates in sample sites of the Deadman River and Criss Creek, August 22 to 29, 1979.

SITE NO.	RAINBOW TROUT					BROOK TROUT	CHINOOK	COHO	SALMONID TOTAL	COARSEFISH
	0+	1+	2+	3+	TOTAL					
DEADMAN RIVER										
1	0	0.15	0	0	0.15	0	0.58	0.22	0.95	0.93
2	0	0.42	0	0	0.42	0	0.17	0	0.59	0.27
3	0.10	1.07	0.67	0	1.84	0	0.30	0	2.14	0.15
4	4.37	1.39	0.39	0	6.15	0	0.12	0.04	6.31	0.54
5	3.67	0.11	0	0	3.78	0	0.04	0	3.82	0
6	2.68	4.50	2.07	0	9.25	0	4.82	0.17	14.24	0
7	3.89	2.13	0	0	6.02	0	0	0	6.02	0.39
8	2.06	1.73	0	0	3.79	0.04	0.22	0.13	4.20	0
9	1.52	2.20	1.20	0	4.92	0	0.51	0.59	6.02	0.10
10	0.99	1.75	1.19	0	3.93	0.25	0.72	0	4.90	0
11	3.06	0	0	0	3.06	0	0	0	3.06	0
12	1.85	0.59	0	0	2.44	0	0	0	2.44	1.85
CRISS CREEK										
1	1.28	7.32	1.82	0	10.42	0	0.11	0	10.53	0
2	1.84	3.23	1.96	0.77	7.80	0	0	0	7.80	0

TABLE 5 Summary of fish density (no./m²) estimates in sample sites of the Deadman River and Criss Creek, August 22 to 29, 1979.

SITE NO.	RAINBOW TROUT					BROOK TROUT	CHINOOK	COHO	SALMONID TOTAL	COARSEFISH
	0+	1+	2+	3+	TOTAL					
DEADMAN RIVER										
1	0	0.01	0	0	0.01	0	0.20	0.08	0.29	0.15
2	0	0.03	0	0	0.03	0	0.04	0	0.07	0.21
3	0.04	0.05	0.02	0	0.11	0	0.09	0	0.20	0.07
4	2.45	0.13	0.01	0	2.59	0	0.03	0.01	2.63	0.07
5	2.71	0.01	0	0	2.72	0	0.01	0	2.73	0
6	1.77	0.36	0.04	0	2.17	0	1.37	0.06	3.60	0
7	1.83	0.15	0	0	1.98	0	0	0	1.98	0.04
8	1.60	0.17	0	0	1.77	0.02	0.05	0.03	1.87	0
9	1.26	0.14	0.03	0	1.43	0	0.10	0.14	1.67	0.01
10	0.76	0.09	0.03	0	0.88	0.03	0.06	0	0.97	0
11	2.89	0	0	0	2.89	0	0	0	2.89	0
12	1.00	0.03	0	0	1.03	0	0	0	1.03	0.49
CRISS CREEK										
1	0.89	0.74	0.06	0	1.69	0	0.03	0	1.72	0
2	2.00	0.46	0.08	0.02	2.56	0	0	0	2.56	0

In the Deadman River total salmonid density ranged from 0.7 to 3.60 fish/m², while biomass density ranged from 0.59 to 14.24g/m². The most abundant fish in all but 1 site were rainbow trout juveniles, with a range from 0.01 to 2.89 fish/m² and 0.15 to 9.25g/m². Rainbow fry were very abundant throughout the upper 9 sites (4 through 12) with a range of 0.76 to 2.89 fish/m² and 0.99 to 3.89g/m². The lowest 3 sites had very low fry numbers and biomass relative to upper sites.

Chinook salmon were present through most of the stream in densities ranging up to 1.37 fish/m² and 4.82g/m². The majority of sites had less than 0.10 fish/m² and less than 1g/m². Coho salmon were found in 5 of 12 sites in low numbers, ranging up to 0.14 fish/m² and 0.59g/m². Brook trout were found only in 2 sites. Coarsefish were found throughout the Deadman River in 7 of 12 sites. Suckers were found only in the lowest site, while longnose dace were present over the whole area sampled in certain habitats.

The fish population in Criss Creek was again predominantly rainbow trout juveniles, ranging from 1.69 to 2.56 fish/m² and 7.80 to 10.42g/m². Chinook were present at the lowest site only, and in very small numbers. Coho and brook trout were not found in Criss Creek, nor were coarsefish of any kind.

4.3.2 Fish distribution and habitat saturation

Analysis of adult escapement, spawning distribution and population estimate results can add insight into recruitment levels and potential habitat saturation by each species. Preferred rearing areas in terms of reaches can also be identified. Saturation in the context of this analysis means the habitat is completely filled, or at carrying capacity. In a saturated environment therefore the fish population is a reflection on habitat (physical and biological environment) rather than recruitment levels.

Chinook

Starr (1979) estimated 1978 chinook escapement at 271, with an egg deposition of approximately 300,000. Redds were sparsely and evenly distributed throughout the stream, with high use occurring in Reaches 5 - 8 and the lower part of 9 up to the intermittently dry area (Docksteads, 30km). Systematic minnow trapping by Starr (1979) indicated that preferred rearing areas for chinook were the 4km upstream of the Indian village (Reach 3) and the 5km upstream of the Deadman River/Criss Creek confluence (Reach 4).

The above escapement is not expected to saturate the stream with chinook fry, however certain locations may be near saturation. Population estimates support this contention, as within the area of known spawning chinook fry density was generally less than 0.10 fish/m². One site may have received adequate recruitment, with chinook fry density of 1.37 fish/m² (4.82g/m²).

Coho

Estimated 1978 coho escapement was 80 (Starr, 1979), which represents only a small percentage of the historical maximum of 1600. Population estimates found maximum coho density of 0.14 fish/m², far below expected maximum levels.

Rainbow/Steelhead

McGregor (pers. comm.) estimated the 1979 steelhead escapement to the Deadman River at 300 to 400. In addition, a large number of residents (Thompson River/Kamloops Lake) spawn in the Deadman. No figures on the number of residents is available, however it is conceivable that three times the number of steelhead, or 900 to 1,200 residents, could use

the stream.¹ Using these figures, and estimated steelhead fecundity of 13,000 (McGregor, 1979) and 4,000 for residents, potential egg deposition was approximately 4.4 million (3.8-5.0), composed of roughly 50% resident and 50% steelhead fry.

Adult steelhead were tracked by McGregor (in prep.) right to the Mowich Lake outlet area. Other concentrations were noted in Reaches 8 and 9, while suspected redd sites were observed in Reach 4. Population estimates throughout the stream suggest that all areas in Reaches 4 through 11 were saturated with rainbow fry. Variation in fry density in this area was primarily related to habitat type. The fry population in Reach 1 was very small, due perhaps to low recruitment or poor habitat quality (particularly temperature problems). No sampling was conducted in Reaches 2 or 3, however suspected similarities in temperature regime, habitat type and recruitment levels suggest that Reach 3 may contain saturated habitat as in Reach 4, while Reach 2 may tend more towards the low fry population of Reach 1.

In terms of rainbow parr, saturated conditions were thought to persist throughout the stream, with the exception of Reaches 1 and 2, and possibly Reaches 10 and 11. High temperatures are thought to limit the rearing quality of Reaches 1 and 2. Reaches 10 and 11 may be underutilized by parr because of poor overwinter survival due to low winter flows, and since these reaches are located at the top of the stream, lack of yearling recruitment from downstream migrations.

¹ If we assume the juvenile population was 50% steelhead and 50% resident, and "smolt" to adult resident survival equals three times smolt to escaping steelhead survival, this estimate appears realistic.

eg. Steelhead		Residents (4 and 5 yr spawners)
.08	"smolt" to adult survival	.24
3:1	catch:escapement	3:1
.02	net survival	.06

Criss Creek

With the exception of a very small number of chinook in the lowest sample site, rainbow trout were the only species present in Criss Creek (including coarsefish). Steelhead have apparently not been documented in this stream, however the presence of a large mesh gill net in the lower canyon area indicates that large fish were present at some time of the year. Whether the juvenile trout in Criss Creek are of resident or anadromous stock, density of fry and yearlings was very high throughout.

4.3.3 Age and growth

A summary of mean fork length of age groups of the three major salmonid species sampled in the Deadman River and Criss Creek is given in Table 6.

TABLE 6 Mean fork lengths of age-groups of salmonids in the Deadman River and Criss Creek, August 22 to 29, 1980.

SPECIES	AGE-GROUP	n	MEAN F.L. (mm)	RANGE (mm)
DEADMAN RIVER				
Rainbow	0+	1320	48.1	30 - 79
	1+	73	104.6	76 - 145
	2+	9	153.0	137 - 174
Chinook	0+	112	69.8	53 - 107
Coho	0+	22	66.1	52 - 77
CRISS CREEK				
Rainbow	0+	117	43.8	27 - 59
	1+	49	88.5	71 - 124
	2+	6	133.2	125 - 142
	3+	1	150.0	-

Age determination was conducted by length frequency analysis and scale interpretation. These data are included in Appendix VII. The data presented in Table 6 are mean values, site specific variations do occur, particularly between samples taken in lower and upper river areas (eg. rainbow fry at site 11 averaged 44mm, while at site 7 the average was 56mm).

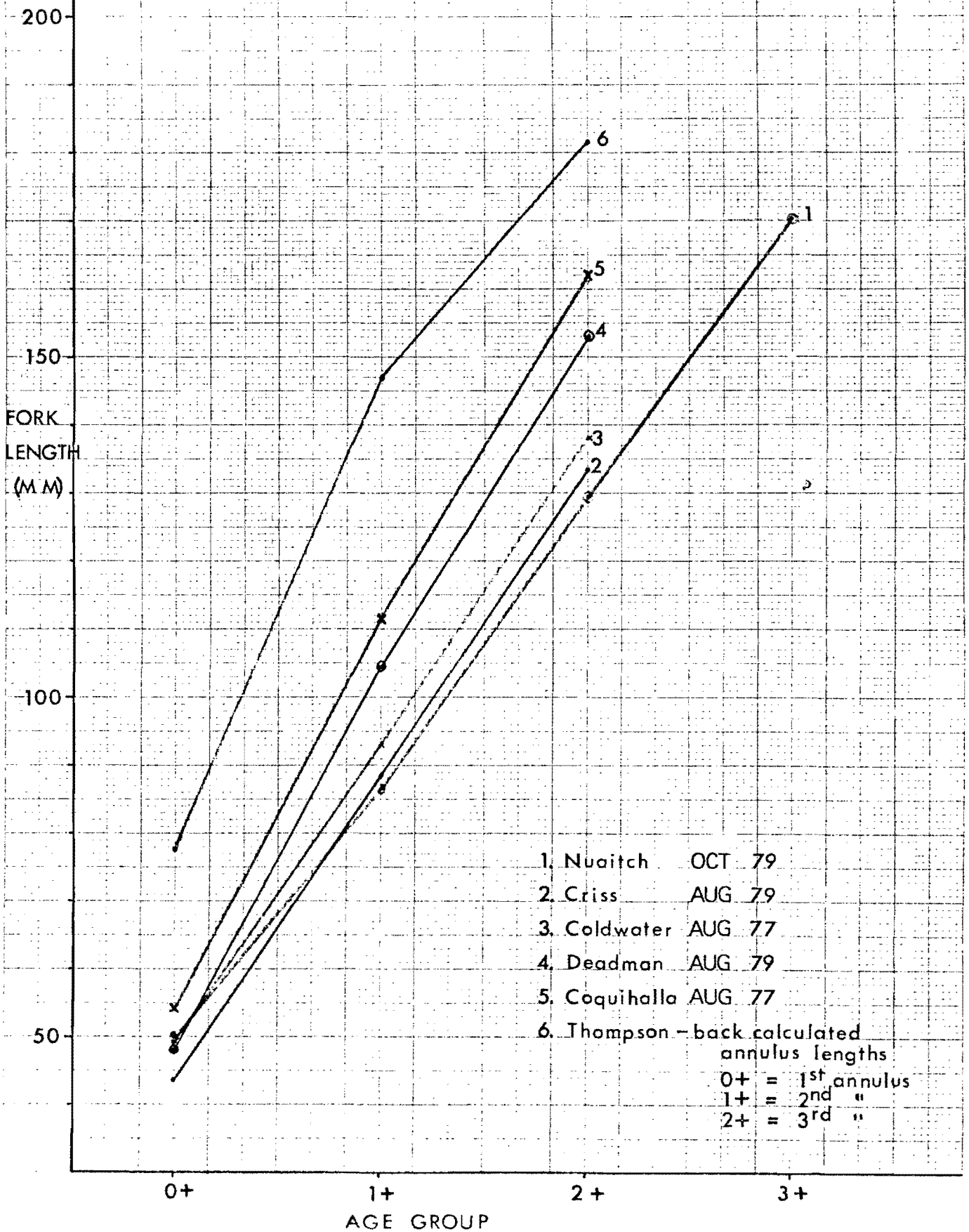
A graphical comparison of Deadman River and Criss Creek growth rates (length at age) with those of other local systems is shown on Figure 3. These data indicate the Deadman River as having a relatively good growth rate. Criss Creek had comparatively slow growth. Mean back-calculated annulus lengths from Thompson River adult steelhead (data from McGregor, in prep. reported in Wightman, 1980) are reported much greater than late August sampling in any of the streams. The sampled values do not correspond to annulus formation, as in the Deadman River roughly one-and-one-half months of the growth period remained.

4.3.4 Fish population and habitat associations

Analyses of fish populations and habitat parameters were conducted to identify relationships between species and age-groups of salmonids and habitat within the Deadman River. The analyses were carried out by relating fish population estimate results to habitat parameters collected at each sample site. Assumptions necessary to permit such an approach require that habitat be saturated with recruits, implying that fish populations were a reflection of habitat rather than recruitment levels. This assumption has been satisfied, at least for rainbow trout, in much of the Deadman River (section 4.3.2).

Habitat within each sample site was quantified by the habitat unit sampling procedure. Results are presented in Appendix VIII. Fish population estimates were then related to habitat at each site by direct graphical analysis and linear regression techniques where applicable. From the many parameters collected, three were chosen for analysis, mean depth, mean velocity and percent total cover. Total cover was a combination of instream log cover, instream boulder cover, instream

FIG. 3. Comparison of juvenile rainbow trout growth (length at age) in the Deadman River and Criss Creek with other B.C. systems.



vegetation, overstream vegetation and cutbanks. In some cases substrate and gradient were applied by designating the site as type 1 (boulder/cobble) or type 2 (fines/gravel) habitat.

Rainbow trout fry

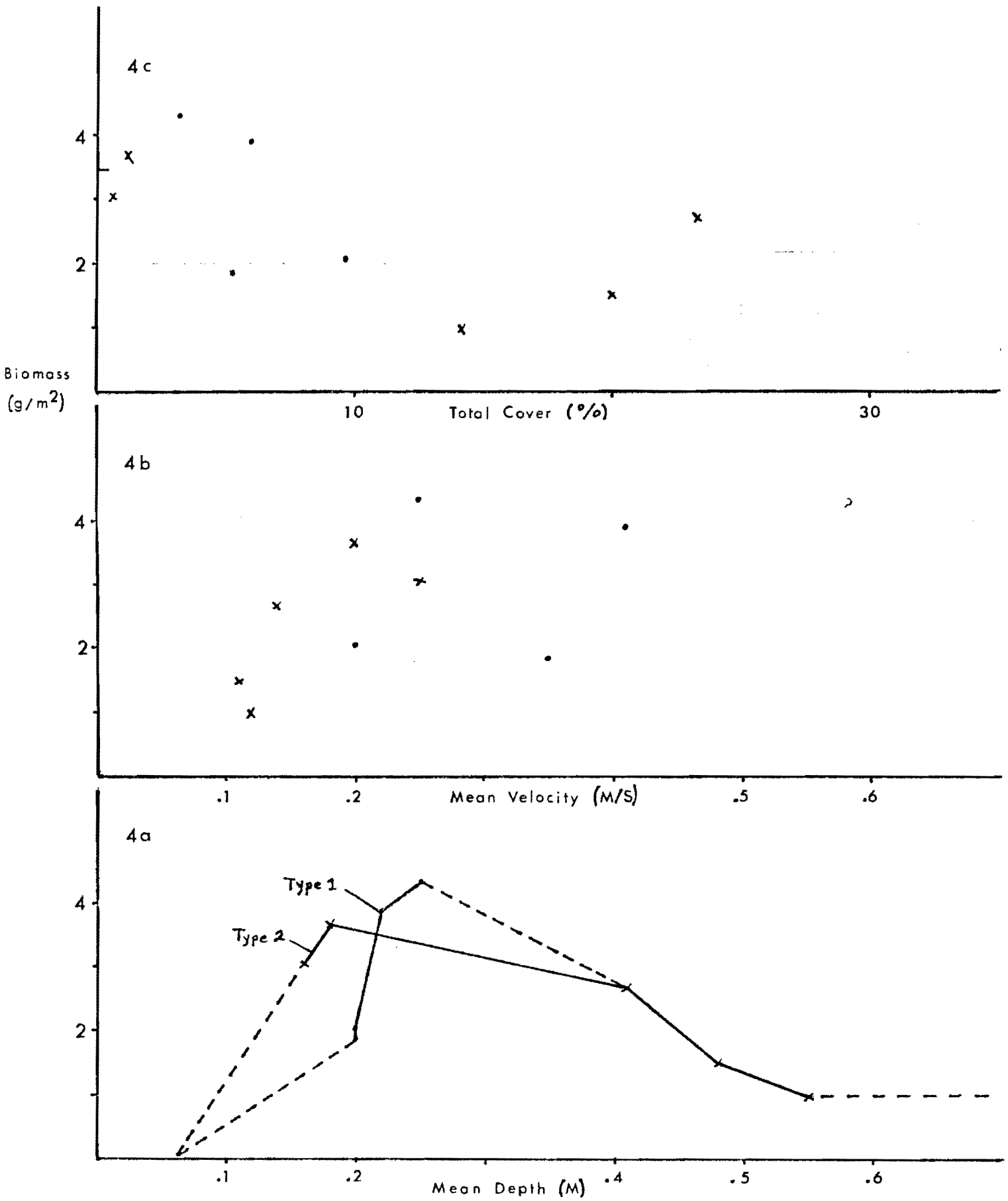
As indicated in section 4.3.2, the upper 9 sample sites were saturated with rainbow fry when sampled in late August, 1979. Observations and captures of fry indicated very high numbers were present in all habitat types sampled. In type 2 habitats, glides and pool tail-outs generally carried the highest fry density, however fry were also abundant in riffles and pools. In type 1 habitat fry were more abundant in edge habitat, particularly in those locations with a large amount of cobble material along the edge.

Data from these 9 saturated sites was plotted on graphs relating fry biomass density to mean depth, mean velocity and percent total cover (Figure 4a, b, c). Depth/biomass and velocity/biomass curves produced normal or "bell" type relationships, indicating an optimum range of depth and velocity exists, with maximum fry biomass occurring at medium depths and velocities. Fast, shallow habitat was not used by fry, while in deep, low velocity habitat only edge areas were available for fry, perhaps as a result of competition with other species and age-groups. This type of relationship of fry with depth and velocity has been observed in other studies (eg. Nuaitch Creek; Tredger, 1980) and resembles those outlined by the probability of use theory (Bovee and Cochnauer, 1977). The total cover curve produced no significant relationship, however a slight negative trend was suggested, again implying the possibility of competition effects.

In terms of habitat types, maximum fry biomass density was found in type 1 habitats. This was perhaps due to the larger substrate creating more living spaces. The fact that high densities of fry were present in areas of small substrate, lacking in cover qualities, suggests very high recruitment and saturation of less preferred areas.

Because of the obvious non-linear relationships observed, multiple regression analysis useful in identifying the combined effects

FIG. 4. Rainbow fry biomass-habitat parameter relationships



of variables were not effective. Because of the relative clarity of the mean depth/fry biomass curve, this relationship was used in later standing crop calculations.

Rainbow parr

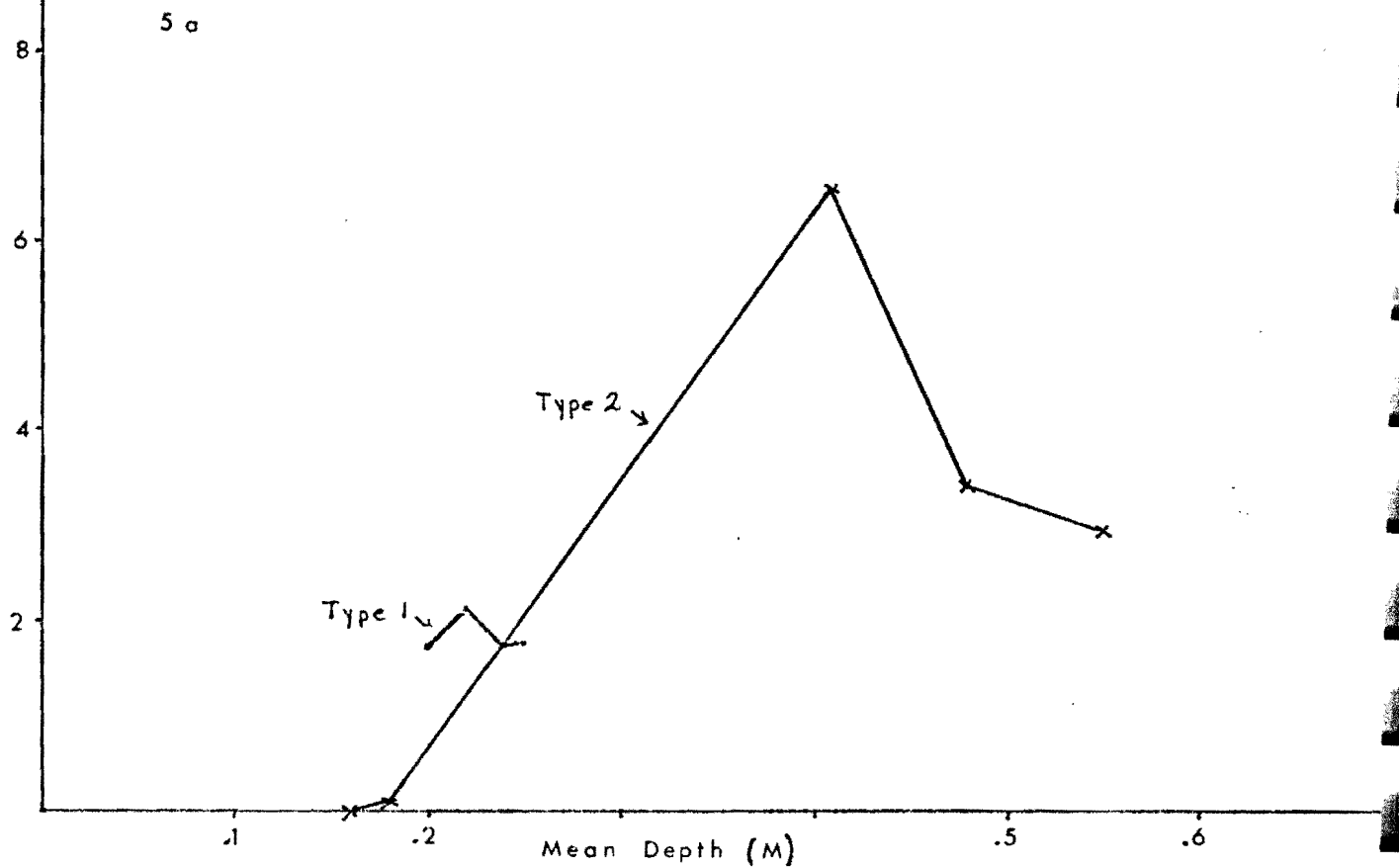
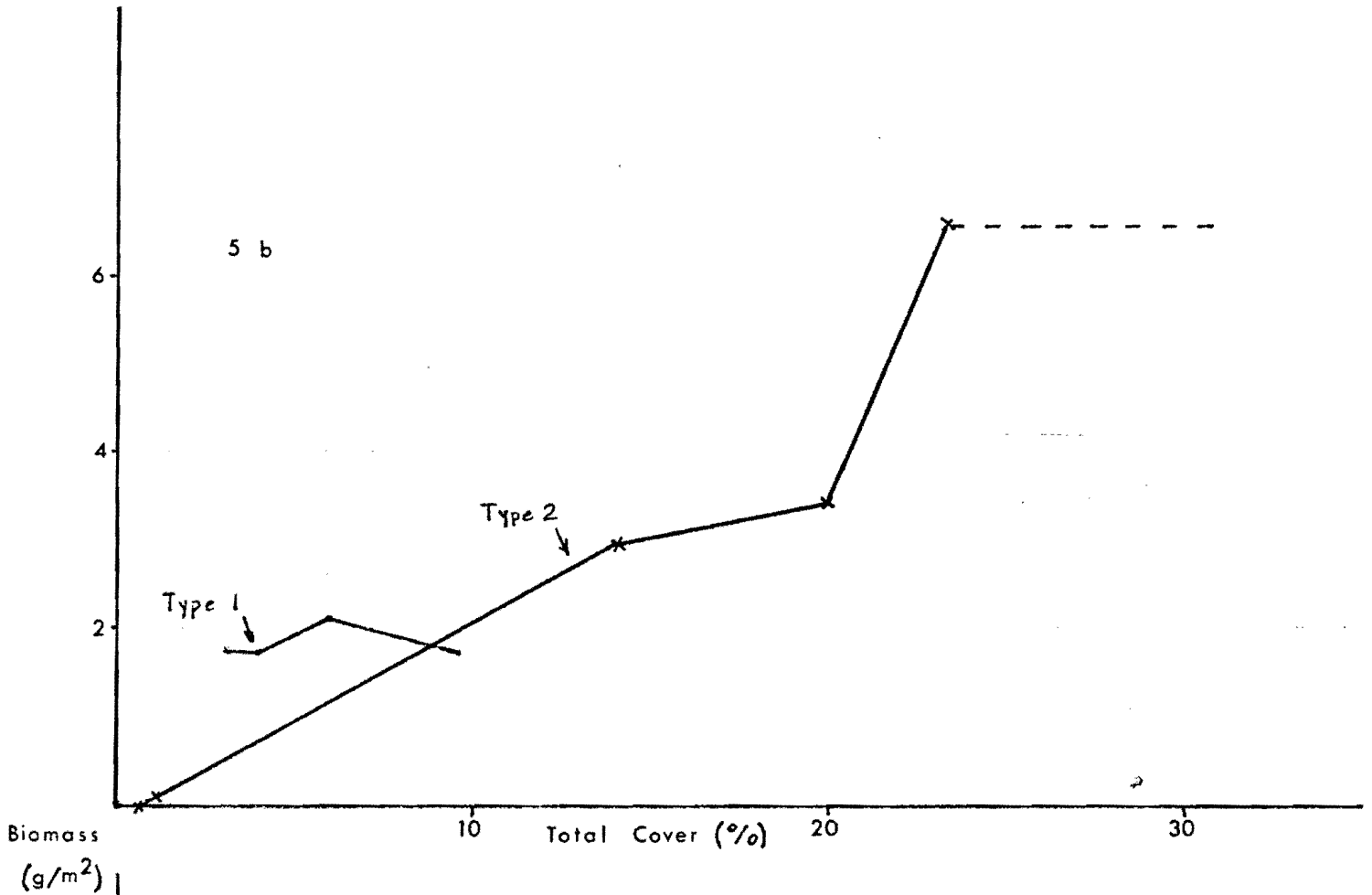
Rainbow parr were generally found in a variety of habitats, always in association with cover. Highest densities commonly occurred in type 2 habitats as a function of high depth and high percent total cover. Type 1 habitat, with boulder cover, often had moderately high biomass density, but not to the extreme found in type 2 habitat. Over a total reach however (including pools, riffles and glides) the biomass density of parr in type 1 habitat appeared more sustained (or uniform) as compared to local abundance in type 2 habitat.

The relationships of depth and percent total cover are outlined in Figure 5(a, b). Mean depth of sample sites showed basically a positive relationship with parr biomass density, however as depths increased beyond a certain point the relationship appeared to become negative. Total cover revealed a definite positive effect on parr biomass, with greatest density corresponding to maximum percent total cover. The apparent negative effect of depth on parr biomass illustrates the need for multiple comparison procedures, as certainly no one habitat parameter exclusively controls the fish population. In the case of depth, there appeared to be a certain point or critical level beyond which other parameters, in this case percent total cover, controlled density.

In type 1 habitat the variability in parr biomass density of saturated habitats was relatively small (1.73 to 2.13g/m²). The effects of mean depth and percent total cover therefore did not appear significant within the range sampled. This may be due to apparent similarities in inherent cover (cobble substrate) not detected in this analysis. The potential extremes of type 1 habitat, represented by deep pools and shallow, coverless riffles, are just as well analyzed as type 2 habitat.

A large variation in parr biomass density was detected in type 2 habitat, from 0 to 6.57g/m². The extremes of this type of habitat were represented by shallow riffles with no cover and deep pools with

FIG.5. Rainbow parr biomass - habitat parameter relationships



high percent total cover. The strongest influence on parr biomass density was cover, and beyond a certain depth may represent the only significant parameter.

Chinook and coho

Chinook and coho were only abundant in deeper, low velocity areas with cover. Figure 6(a,b,c) relates chinook and coho biomass density to depth, velocity and percent total cover in the sample sites. As these 2 species were not generally present at saturation levels, variability in density may be related more to local recruitment levels than to habitat. As was the case with rainbow parr, the most meaningful relationship in terms of chinook and coho biomass density was with percent total cover. Maximum density of $4.99\text{g}/\text{m}^2$ was found in the site with the greatest percent cover. Despite low recruitment levels a positive relationship was established with cover.

Criss Creek

Since only two population estimates were conducted in Criss Creek relationships of habitat parameters and fish populations cannot be made. Experience in another small stream in the Thompson system, Nuaitch Creek (Tredger, 1980) suggests that similar relationships are observed in these smaller systems. Depth and velocity were the most effective habitat parameters in predicting standing crop. Cover was relatively constant in these streams due to the cobbled substrate.

4.4 Standing Crop Estimates

Standing crop estimates for the Deadman River and Criss Creek are summarized in Table 7, with a detailed analysis included in Appendix IX.

FIG. 6. Chinook and coho biomass-habitat parameter relationships

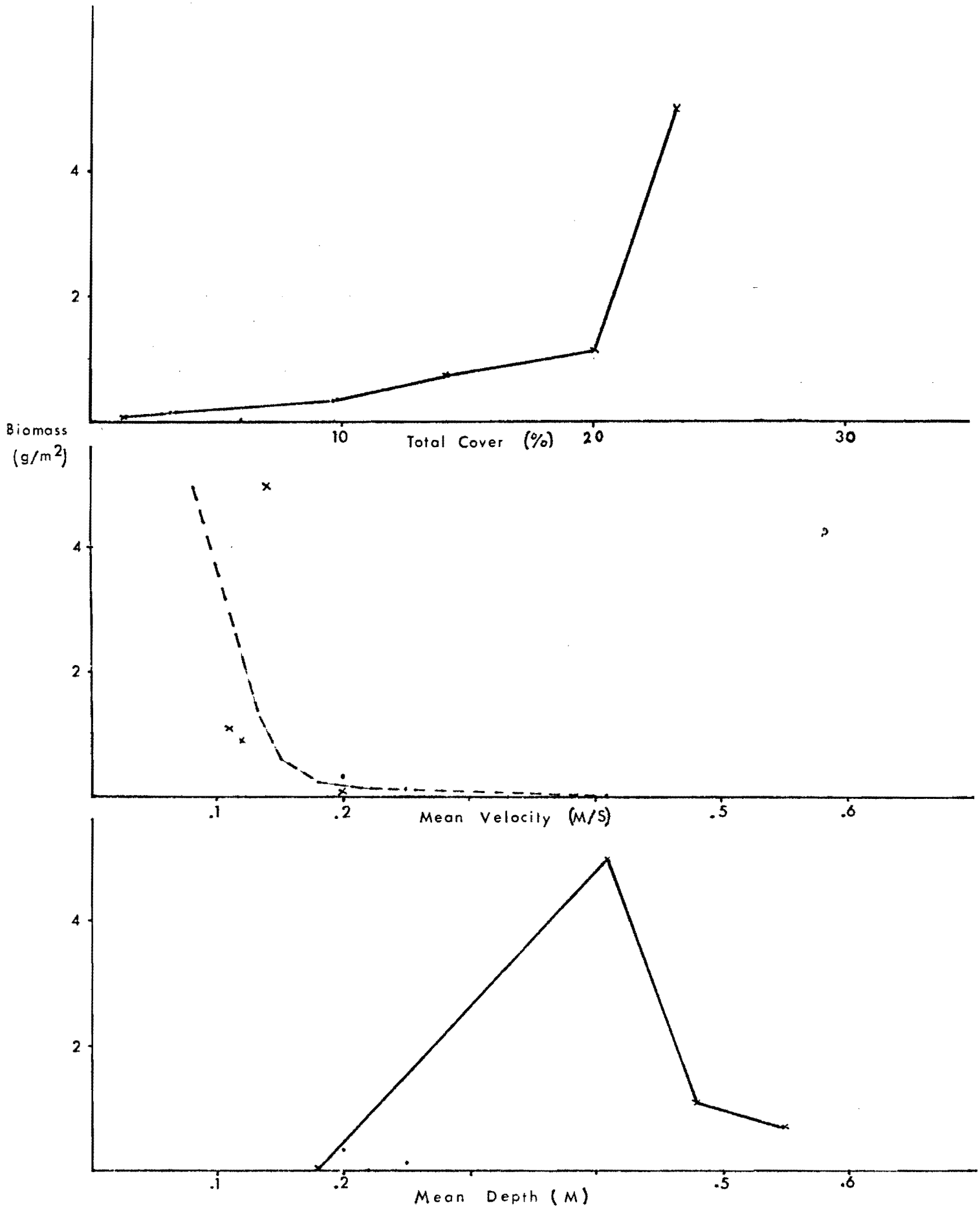


TABLE 7 Summary of standing crop estimates of salmonids in the Deadman River and Criss Creek, August 22 to 29, 1979.

SPECIES/AGE-GROUP	DEADMAN RIVER		CRISS CREEK	
	BIOMASS (g)	NUMBER	BIOMASS (g)	NUMBER
rainbow fry/0+	504,930	400,000	134,670	100,000
rainbow parr/1+	254,000	19,480	278,840	35,290
/2+	84,700	2,070	164,020	6,090
/3+	-	-	34,530	900
chinook/0+	42,700	11,400	-	-
coho/0+	7,700	2,200	-	-

These estimates were based on the fish and habitat association relationships, reach habitat parameter analysis and suspected recruitment levels. Accuracy of these estimates has not been determined, however they are considered reasonably accurate. In past studies of this type, extrapolations were based on quantified habitat parameters and relationships of fish populations to those parameters, suggesting a greater level of accuracy.

A further indication of accuracy was derived from the chinook salmon standing crop estimates. Starr (1979) estimated the 1978 brood chinook population (1979 fry) at approximately 16,200 July fish, based on estimated egg deposition and the best 90-day survival estimate. A further month's mortality and known chinook pre-smolt outmigrations (Starr, 1979) would bring the estimated number at the end of August very close to the 11,400 estimated by this study. At the outset the chinook/coho estimates were considered the least likely to be accurate, due to under-saturated conditions in much of the stream.

In the Deadman River and Criss Creek, the population of juvenile rainbow trout was composed both of steelhead and of non-anadromous stocks (Thompson/Kamloops Lake residents). As the proportion

of steelhead or residents in the population is not known, an arbitrary designation of 50% steelhead - 50% resident was made.

5.0 SUMMARY OF RESULTS

1. Fish habitat in the Deadman River below Mowich Lake was composed of alternating higher gradient, large substrate areas (type 1 habitat) and lower gradient, smaller substrate areas (type 2 habitat). The quality of type 1 habitat was less than optimum because of temperature problems in the lower areas (Reaches 1 and 2) and substrate compaction throughout the stream. Type 2 habitat quality was largely dependent on the degree of riparian land use and stream encroachments.

Habitat in the 17km of Criss Creek was generally a high quality type 1 environment.

2. Population estimates at 12 sites in the Deadman River found juvenile rainbow trout density ranging from 0.01 to 2.89 fish/m² (0.15 to 9.25g/m²). Rainbow fry ranged from 0 to 2.89 fish/m² (0 to 4.37g/m²) and were present to saturation levels in all areas above the reserve up to Mowich Lake. Rainbow parr ranged from 0.01 to 0.40 fish/m² (0.15 to 6.57g/m²), with suspected saturation occurring in all but the lower and upper areas (Reaches 1, 10 and 11). Chinook salmon were present in densities up to 1.37 fish/m² (4.82g/m²), with most sites having less than 0.10 fish/m². Coho salmon were found in 5 of 12 sites with densities up to 0.14 fish/m² (0.59g/m²). Neither salmon species was present at saturation levels.

The fish population of Criss Creek was almost entirely juvenile rainbow trout, with densities of 1.69 and 2.56 fish/m² (7.80 and 10.42g/m²). Coarsefish were not present in Criss Creek.

3. Analysis of length at age data indicate that juvenile rainbow in the Deadman River had relatively good growth compared to other local systems, however when compared to back-calculated lengths of Thompson River steelhead had relatively poor growth. Length at age in Criss Creek was much less than in the Deadman River.
4. Saturation levels of juvenile rainbow suggest that population size was a reflection of habitat quality (not recruitment levels) at most sites. Relationships between habitat parameters and fish populations were produced for rainbow fry, parr and chinook

and coho. Rainbow fry were best related to depth criteria, while rainbow parr and chinook and coho were most significantly related to total cover.

5. Standing crop calculations revealed a juvenile rainbow population of roughly 400,000 fry, 19,500 yearlings and 2,000 two-year-olds in the Deadman River in late August. Roughly 11,400 chinook and 2,200 coho were present. In Criss Creek roughly 100,000 rainbow fry were present, with roughly 35,000 yearlings, 6,000 two-year-olds and 900 three-year-olds. It was assumed that 50% of the juvenile rainbow population was of anadromous stock.

6.0 DISCUSSION

6.1 Life History of Deadman River Steelhead

It was not the intent of this study to draw conclusions regarding the life history patterns of Deadman River steelhead, however a knowledge of life history is essential in developing recommendations for stock enhancement. In view of this, a discussion of life history is included based on results of this study, regional office data, and the findings of Starr (1979).

6.1.1 Juvenile rainbow migrations

Starr (1979) documented large scale migrations of juvenile chinook salmon and rainbow trout out of the Deadman River into the Thompson River in 2 years of counting fence operation. Juvenile rainbow migrations are summarized in Table 8.

TABLE 8 Juvenile rainbow trout downstream migration in the Deadman River, 1977 and 1978 (data summarized from Starr, 1979).

WEEK TRAPPING PERIOD	0+			1+		
	n	\bar{n}/day	max. n./ day	n	\bar{n}/day	max. n./ day
Summer 1977: July 22 to October 22	52,826	636	3,383	9,480	114	570
Spring 1978: March 17-23 and April 5-26 ^a	0	0	0	3,343	157 ^a	374
Summer 1978: July 13 to September 19	59,609	877	7,673	16,140	237	772

^a 157 yearlings/day average for the period April 5 - 26.

These data show a large number of fry outmigrating through the summer and early fall in both 1977 and 1978, beginning in early August (Starr, 1979). Yearling outmigrations, reported for the summer of 1977 and spring and summer of 1978, were apparently continuous through spring, summer and into fall (P. Starr, pers. comm.), therefore the reported number of migrants does not represent the total outmigration. The total number of yearling migrants, accounting for the May - June period, could approach 30,000 fish, at least in 1978. These data suggest that fry and yearling outmigrations occur each year, with variable magnitude.

The question of whether these outmigrating fish were steelhead or resident stock, or both remains. In 1977 and 1978 yearling migrants were marked with coded wire tags (8,074 in 1977, 18,780 in 1978; Starr, 1979). To date a total of 6 of these fish have been recovered in the ocean through the commercial salmon fishery as steelhead (Wightman, 1980). This indicates that at least a portion of the yearling outmigrants from the Deadman River were steelhead progeny.

6.1.2 Age, growth and smolt size

Juvenile rainbow present in the Deadman River and Criss Creek appeared on the average to be much smaller than fish returning as Thompson River adult steelhead. Back calculated lengths at smolt

and annulus formation collected from Thompson River adult steelhead by McGregor, (Wightman, 1980) when compared to length at age data collected by this study (Table 9), show Thompson fish to be much larger than the Deadman River or Criss Creek fish sampled.

TABLE 9 Back calculated lengths at annulus formation of Thompson River adult steelhead compared to length at age of Deadman River and Criss Creek juvenile trout sampled in late August, 1979.

ANNULUS	THOMPSON RIVER ¹				AGE (August 1979)	DEADMAN R.		CRISS CREEK mean
	1976-7		1977-8			mean	S.D.	
	mean	S.D.	mean	S.D.				
1	79.6	15.8	76.8	12.0	0+	48.1	-	43.8
2	151.1	35.3	145.1	25.1	1+	104.6	14.7	88.5
3	193.6	35.6	169.7	33.8	2+	153.0	-	133.2
smolts	172.2	32.9	154.9	24.0				

¹ Data collected by McGregor (in prep.) reported by Wightman (1980).

The average Deadman rainbow fry was 28 to 31mm smaller than the mean size of Thompson fish at the first annulus, while Criss Creek fry were 32 to 35mm smaller. The largest discrepancy occurred at the yearling stage, with Deadman fish being 40 to 45mm smaller and Criss Creek fish being 55 to 62mm smaller than the average second annulus of Thompson steelhead. This difference is likely exaggerated because of the time differential between the sampling period of this study (late August) and the end of the growth season (mid-October). It is unlikely however that these differences could be made up in 6 weeks.

Another factor affecting the length at age of Deadman River and Criss Creek rainbow was the juvenile outmigrations. Data collected by Starr (1979) indicates that particularly yearlings were on the average larger than the fish left in the stream. The mean size of yearling outmigrants through the summer period ranged from 106mm to 120mm in 1977, and 114mm to 127mm in 1978 (Appendix X), compared to the average of

104.6mm in the Deadman River and 88.5 in Criss Creek. It is noteworthy that the size of yearling migrants did not appear to increase throughout the summer.

In terms of age at smolt formation, the majority of Deadman River fish would reach average smolt size late in their second year of growth, thus forming 3 year smolts. Only a very small proportion of yearlings would reach average smolt size of 2 year smolts, even if an extra 20mm were added to the mean size in lieu of the shorter growth period when sampled.¹ In Criss Creek, virtually no fish would be of average smolt size at age 2, while the majority would be 3. and 4. smolts. This of course assumes that steelhead form smolts directly in these streams.

6.1.3 Required smolt yield and population dynamics

In order to produce an adult return to the Deadman River of 300 to 400 steelhead, a smolt yield of roughly 11,000 to 25,000 is required (Table 10), depending on the catch to escapement values used.

TABLE 10 Estimated smolt yield required to produce the observed adult escapement in the Deadman River, 1979.

ADULT ESCAPEMENT	C:E	n ADULTS	SMOLT TO ADULT (%)	n SMOLTS
300	2:1	900	8	11,250
	4:1	1,500	8	18,750
400	2:1	1,200	8	15,000
	4:1	2,000	8	25,000

¹ from Zar (1974) pg. 75:

$$Z = \frac{x_1 - \bar{x}}{S.D.} = \frac{145.1 - 125}{14.7} = 1.37$$

$$P (Z > 1.37) = .0853$$

∴ 8.5% of yearlings would be greater than the average size at second annulus formation of Thompson River adult steelhead, assuming an additional 20mm growth.

The question now is to determine where these smolts come from; were they produced directly in Deadman River and Criss Creek, or were they the result of fry and yearling outmigrants to the Thompson River.

The population (standing crop) of yearling rainbow trout in the Deadman River was estimated at 19,500. An estimated 8.5% of these fish would potentially be larger than the mean size at second annulus formation of Thompson River smolts, suggesting that 17% would be of potential smolt size, or 3,300 fish. Assuming a 70% overwinter survival and 50% steelhead/resident split, then roughly 1,200 smolts may be produced as 2 year smolts. Similarly, 2+ fish in the Deadman may produce 700 three year smolts. A summary of potential smolt production in the Deadman/Criss/Thompson system is given in Table 11.

TABLE 11 Derivation of smolt yield estimates from the Deadman-Criss-Thompson system.

	n	n POTENTIAL SMOLT SIZE		n SMOLTS ^a	AGE
1. Deadman River					
1+	19,500	3,300	(17%)	1,160	2.
2+	2,070	2,070	(100%)	725	3.
2. Criss Creek					
1+	35,290	0	(0%)	-	
2+	6,090	4,800	(80%)	1,680	3.
3+	900	900	(100%)	315	4.
3. Fry migrants					
0+	50,000	0	0		
1+ @ 25%	12,500	12,500	(100%)	4,375	2.
4. Yearling migrants					
1+	10,000	10,000	(100%)	3,500	2.
1+	30,000	30,000	(100%)	10,500	2.

^a 70% survival from 1+ to smolt; 50% steelhead/resident split.

These estimates indicate that the majority of smolts must be produced as a result of fry and particularly yearling migrations from the Deadman River system. The combined potential smolt output from the Deadman River/Criss Creek system was estimated at under 4,000, not sufficient to produce an adult return of 300 to 400 fish. The total smolt output from all sources was an estimated 18,750, more in line with the required smolt yield.

6.1.4 Summary of juvenile steelhead life history

The juvenile steelhead life history in the Deadman River system is thought to be comprised of a number of patterns. After spawning in the Deadman River (or Criss Creek) and initial rearing in the natal stream, a number of potential routes are available for smolt production. These include production directly from the Deadman River and Criss Creek, and production in the mainstem Thompson River as a result of Deadman River outmigrants. The available information suggests that the majority of smolts are produced in the mainstem Thompson as a result of rainbow fry and yearling outmigrants. The major portion of smolt yield originates from yearling migrants, with the potential to produce over 10,000 smolts. Although larger numbers of fry outmigrate on a yearly basis their contribution to smolt yield is expected to be somewhat less ($\approx 4,400$) due to poorer survival rates. Other components contributing to smolt production, including direct production in the Deadman River and Criss Creek, are thought to be limited because of low yearling numbers and their relatively small size (length at age).

6.2 Enhancement Strategy

The suspected life history pattern of Deadman River steelhead suggests that enhancement should aim at the production of large yearlings, which would emigrate from the stream into the Thompson as pre-smolts. As yearlings these fish should be of sufficient size to assure good survival to smolt formation in the larger, more stable Thompson River. In terms of instream enhancement, the most efficient method to fulfill the above

aims is to increase or improve the habitat components which are most successful in providing habitat for fish through critical or limiting periods.

6.2.1 Limiting factors

Standing crop calculations estimated a very small number of yearlings in the Deadman River relative to fry numbers. Survival in the stream from 0+ to 1+ was only 5% (400,000 fry, 19,500 yearlings), and even adding the yearling outmigration to the total (30,000 yearlings maximum) a survival rate of only 12% was observed. This low survival suggests that the abundance of yearlings in the Deadman River was limited, possibly by summer parr habitat or overwinter habitat, or both. If the enhancement strategy was to maximize smolt yield by production of yearling migrants, as suggested by the life history pattern, then overwinter survival was the most critical limiting phase in smolt production.

In Criss Creek survival between age-groups appeared much better (35% 0+ to 1+). The major limiting factor in smolt production in this stream appeared to be the very slow growth rate of rainbow juveniles, particularly at the yearling stage. The implied enhancement strategy for Criss Creek suggests that juveniles should be encouraged to emigrate as early as possible.

6.2.2 Overwintering habitat quality

The type of habitat utilized by steelhead in summer and winter depends on availability. In some stream types stable debris provides cover in the main production areas while in other stream types, where large boulders are frequent in runs and riffles, most of the production occurs in boulder habitat (Facchin and Slaney, 1977). These cover associations become more important as winter habitat, where steelhead juveniles move into substrates or log jams as freezing occurs. In a stream such as the Deadman River, summer and winter habitat (parr habitat) was available in two forms represented by type 1 and type 2

habitat. Type 1 habitat, the larger (boulder, cobble) substrate environment, generally affords overwinter habitat in association with interstitial spaces in the substrate in which fish (particularly fry) can hide. In the Deadman River this large substrate habitat was not considered to consistently provide high quality overwintering habitat such as that found in high gradient coastal systems. Much of the substrate was compacted with finer substrate materials, indicating that the spaces between many boulders and cobbles were filled up. This was thought to reduce the overwinter carrying capacity of much of the type 1 habitat (Bjornn et al, 1977).

Parr and overwintering habitat in type 2 environments was associated primarily with stable debris, undercut banks and log jams. In the winter, this type of cover material in association with deeper pools may provide the only overwinter habitat, due to low flow and freezing conditions. As with late summer parr habitat, more debris and cover materials present should create a higher overwinter carrying capacity.

6.3 Steelhead Enhancement Opportunities

Several opportunities for steelhead enhancement through habitat improvement measures exist, aimed at minimizing the effects of potential limiting factors. These factors in the Deadman River are thought to be overwintering habitat, affecting fry to yearling survival, and parr habitat, affecting summer carrying capacity. Results of this study have identified the prime overwintering and parr habitat as being deep pool areas with abundant cover. The most efficient cover types in terms of maximum biomass density were instream log cover and undercut banks. Habitat improvement should therefore be directed at increasing the amount and quality of this type of environment.

Precise areas which require treatment will not be identified at this time, other than by general reach areas, as there was great variability in habitat quality within reaches. There were several areas, most notably in Reaches 4, 8 and 9, which have undergone severe channel modification and debris removal, and form the most obvious areas of need for habitat improvements (Figs. 7,8). Some areas in Reach 6 may also



FIGURE 7 Contrasting habitat quality in the Deadman River. The top photograph shows altered habitat, lacking in riparian vegetation and deep, complex areas. The bottom photograph shows a relatively natural pool with good habitat quality. Total salmonid biomass density at the bottom site was $14.25\text{g}/\text{m}^2$.



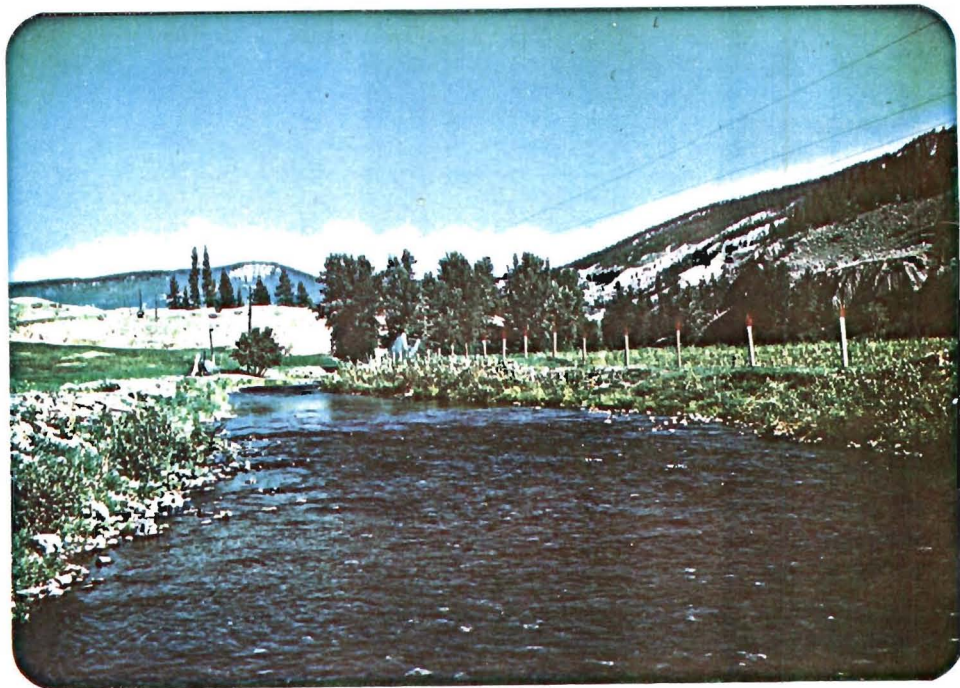


FIGURE 8 Two examples of altered habitat in the Deadman River (Reach 4). Complete removal of instream debris and riparian vegetation have severely reduced summer parr habitat and overwinter carrying capacity.



require treatment, however much less so because of the relatively early stage of land development.

The specific treatments required at each location must be determined on a site specific basis. At this time two general treatment types are envisioned for the Deadman River, involving cover introductions and pool creation.

6.3.1 Cover introductions

In those areas which have undergone debris removal without significant losses in abundance of deep pool areas, cover introductions are recommended. Because of the observed dependence of rainbow parr (and chinook and coho salmon) on log cover in pool areas, the potential for large increases in late summer carrying capacity exists. Since this type of habitat represents the prime overwintering area in the stream, overwinter survival should also be enhanced. This type of improvement work is envisioned for large areas within Reaches 4 and 8, and can be extended to any pool area within the stream (type 1 or type 2 habitat) which lacks cover.

Specific techniques of debris placement must be determined at each treatment site. Bank associated placements are recommended, as materials may be secured by cable to existing standing trees along the stream bank, anchored to the stream bottom or banks by some other means (eg. pilings). This type of log cover introduction has been done by the Fish Habitat Improvement section in a small stream (Colquitz Creek; maximum discharge = $8.5\text{m}^3/\text{s}$ or 300cfs), in which root masses were cabled to cedar pilings embedded in the stream bottom. These have proven very durable in this small stream. Log cover has been introduced in the Keogh River study, in which log bundles (approximately 2m long) were attached to boulder groupings by eyebolts and short cables (Ward and Slaney, in prep.). The amount of log cover envisioned for the Deadman River, in order to have a significant impact, is much greater than either of these previous attempts.

Introduction of large boulders as cover components has not been recommended for large areas of the Deadman River. In type 1 habitat, particularly glides and riffles, any increase in total cover (log or boulder) may not significantly increase the biomass density of rainbow parr. The sampled biomass density was relatively constant, between 1.73 and $2.13\text{g}/\text{m}^2$ (mean = $1.85\text{g}/\text{m}^2$), regardless of habitat parameters, within the available range. In type 2 habitat, boulders alone would not provide adequate overwinter habitat. There are some areas, transition zones between type 1 and type 2 habitat with primarily large gravel substrates, which may benefit from boulder introductions. Biomass density increases will be observed in summer parr habitat, with an expected maximum density (per habitat unit) reaching near $2\text{g parr}/\text{m}^2$ (rainbow).

6.3.2 Pool creation

Many areas of the Deadman River have been channelized, resulting in loss of most deep pool areas as well as cover. These areas, most obvious in Reach 9 and parts of 8 and 4, require pool creation measures as well as debris introductions to create the preferred complex habitat. The large variability in rainbow parr biomass density in type 2 habitat (0 to 6.25g/m²) between complex pools and barren glide/riffle environments common in these areas suggests great latitude for increase.

In some type 2 areas, those with small substrate (sand, gravel), pool scouring may occur as a result of bank associated debris introductions. In areas with larger substrates (large gravel, cobble) boulder introductions may be necessary to create sufficient scouring. Boulder groupings have proven effective in creating small pools in the Keogh River study (Ward and Slaney, in prep.). In the Deadman River, unless a large amount of log cover is included, increases in overwinter survival may not occur.

Flow augmentation in the Deadman River has been treated in this report as an improbability, because of water use conflicts (Hamilton, 1974) and the fact that no improvement in low winter flows has been realized since the Snohoosh dam was put into operation. The impact of low flow on overwintering survival may be substantial, particularly in the 2.5km section (Reach 9 area) which apparently runs dry in late fall and winter. Throughout much of this area riparian land use has removed debris and by channelization has reduced the number of deeper pool areas. Pool creation and debris introduction in this area may restore some of the overwinter carrying capacity by producing deeper areas to or below the water table, which may retain water through the winter. The presence of standing water in existing pool areas in winter should be verified.

6.3.3 Criss Creek

In Criss Creek, a potential enhancement technique might be to alter the flow characteristics of the lower 1.5km during critical low summer flow periods to allow downstream migrant rainbow fry and yearlings access to the Deadman and Thompson Rivers. Under current conditions the stream runs dry in the lowest 1.5km in late summer, thus trapping any downstreaming fish in Criss Creek, or in the unscreened irrigation diversion. This situation should be improved, either by increasing flow to this lower reach (reducing irrigation demands) which appears unlikely, or by providing alternative access to the Deadman River (modified

irrigation ditch). Before any action is taken in this regard it must be determined:

- (a) to what extent adult steelhead/residents use Criss Creek.
- (b) what magnitude of fry and yearling migrations occur in Criss Creek.
- and (c) what is the time period of juvenile migrations.

The duration of juvenile migrations should be expected to occur continuously throughout the summer, as experienced in the Deadman River (Starr, 1979). Other small streams, particularly in the Nicola system, may be studied in the near future, and results could be empirically applied to Criss Creek.

6.4 Further Considerations and Cautions

6.4.1 Habitat protection and agricultural activities

Fisheries enhancement and habitat protection must follow similar goals; the creation or preservation of a complex, natural stream channel. In the Deadman River encroachments of agricultural developments are present in various stages. Where development has not yet proceeded beyond initial stages (eg. Reach 6), adequate stream protection measures should be adhered to (eg. cattle control, streamside fencing, streamside leave strips; Gram, 1979). Where encroachments have taken place, the effects are not irreversible and reclamation is possible if proper protection is given soon.

Many of the potential land use - fisheries conflicts along the Deadman River, concerning both fish habitat and farm land losses, may have been caused by the lack of stream protection. Fish habitat losses resulting from channelization, streamside vegetation removal and debris removal, etc. are fairly obvious to the fisheries worker. Farm land losses resulting from these same activities; increased erosion through higher velocities (debris removal, upstream channelization) and reduced bank resistance (vegetation removal, cattle activity), may not be so obvious to the land owner. A case can be made for stream protection to satisfy both fish and land use parties.

Alternative methods for stream channel stabilization do exist which are more beneficial as fish habitat than others. For example, rip-rap in many of the type 2 reaches will do little for fish habitat, particularly overwintering habitat. As an alternative, cabled logs to secure bank areas (trees) may provide bank protection similar to rip-rap, and provide suitable fish habitat as well. Karanka and Kellerhals (in prep.) have recommended this type of approach in another Fish Habitat Improvement section project (Elk River, Vancouver Island) not to permanently stop erosion but to slow it down until natural bank resistance (through revegetation) returns.

6.4.2 Precautions

- (i) Attempts to sell instream improvements, particularly log debris introductions, to riparian land owners may not meet with much success. In all likelihood the majority of the local farming community have specific concerns relating to stream processes, such as flooding and land losses to erosion, which they have traditionally dealt with by debris removal, channelization and rip-rapping. Suggestions to reverse the process may not be easily accepted amid fears of re-starting the flooding and erosion problems. There is good reason to oversize "channelizations" in the future so fish habitat can be created through complexing with instream inclusions (eg. rip-rap, stable log debris).
- (ii) The approaches to habitat improvement outlined in this report have not been proven, therefore potential instream works should proceed in a trial and error fashion. The habitat improvements may prove ineffective in producing the expected results in terms of hydraulic or biomass expression. The structures may be found not durable enough and are washed away during spring freshet. In both of these cases small failures are easier to "take" than large ones. On the other hand small successes can be duplicated fairly readily.

Potentially the most serious reason for proceeding with caution is the potential for instream works to cause undesirable effects on adjacent lands. The Branch would be held liable for any negative impacts.

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REFERENCES

- Bjornn, T. C., M. A. Brusven, M. P. Molnar, J. H. Milligan, R. A. Klamt, E. Chacho and C. Schaye. 1977. Transport of granitic sediments in streams and its effects on insects and fish. University of Idaho, College of Forestry, Wildlife and Range Sciences, Bulletin No. 17. 43 pp.
- Bovee, K. D. and T. Cochnauer. 1977. Development and evaluation of weighted criteria, probability-of-use curves for instream flow assessments: fisheries. Instream flow information paper no. 3. Cooperative Instream Flow Service Group U. S. Fish and Wildlife Service, Fort Collins, Colorado. 49 pp.
- DeLeeuw, A. D. 1980. in prep. Small Stream Enhancement Possibilities for Sea-Run Cutthroat Trout in the Lower Mainland and Sechelt Areas. B. C. Fish and Wildlife Branch, Fish Habitat Improvement, Victoria, B. C.
- Facchin, A. and P. A. Slaney. 1977. Management implications of substrate utilization during summer by juvenile steelhead trout (Salmo gairdneri) in the South Alouette River. Fisheries Technical Circular No. 32. B. C. Fish and Wildlife Branch. 19 pp.
- Gram, G. D. 1979. Farm and Stream. Water use, farm management and the protection of the aquatic environment. B. C. Federation of Agriculture. 38 pp.
- Hamilton, R. E. 1974. Water requirements for the fisheries resource of the Deadman River. Fisheries and Marine Service, Habitat Protection Unit, Southern Operations Branch.
- McGregor, I. in prep. B. C. Fish and Wildlife Branch, Kamloops, B. C.
- _____ 1979. A preliminary assessment of Nicola River steelhead stocks with reference to enhancement opportunities. B. C. Fish and Wildlife Branch, Kamloops, B. C. 26 pp.
- Reiser, D. W. and T. C. Bjornn. 1979. Influence of forest and rangeland management on anadromous fish habitat in Western North America. 1. Habitat requirements of anadromous salmonids. USDA Forest Service General Technical Report PNW-96. 54 pp.
- Starr, P. 1979. Deadman River: Biological assessment of the salmonid population, July, 1977 to January, 1979. Preliminary draft. Canada Department of Fisheries and Oceans.

- Tredger, C. D. 1980. Carrying capacity and theoretical steelhead smolt yield from Nuaitch Creek, Nicola River system. Unpubl. Manus., B. C. Fish and Wildlife Branch. 46 pp.
- Ward, B. R. and P. A. Slaney, in prep. Evaluation of instream enhancement structures for the production of juvenile steelhead trout and coho salmon in the Keogh River: progress 1977 and 1978. Fisheries Technical Circular, B. C. Fish and Wildlife Branch.
- Wightman, J. C. 1980. File note re: telecon with Ian McGregor 26/3/80. B. C. Fish and Wildlife Branch. File no. 0140-3 Nicola River.

APPENDIX I Habitat parameters collected by the habitat unit sampling method.

1. Stream and code.
2. Reach no. and gradient code.
3. Reach length (km)
4. Habitat class (falls, ditch, slough, pool, riffle, glide)
5. Length (m)
6. Wetted width (m)
7. Channel width (m)
8. Area (m^2)
9. \bar{x} Depth (m)
10. Velocity (m/s)
11. Instream log cover (m^2) x Depth (m)
12. Instream boulder cover (m^2)
13. Instream vegetation (m^2)
14. Overstream vegetation (m^2)
15. Cutbanks (m^2)
16. Turbidity (m)
17. Gradient (%)
18. Fines (%) 0 - 0.1cm
19. Small gravel (%) 0.1 - 4cm
20. Large gravel (%) 4 - 10cm
21. Cobbles (%) 10 - 30cm
22. Boulders (%) >30cm
23. Bedrock (%)
24. Compaction (yes=1, no=0)
25. Temperature ($^{\circ}C$)

APPENDIX II Summary of discharge records in the Deadman River and Criss Creek.

CRISS CREEK NEAR SAVONA - STATION NO. 08LFC07

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

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	MEAN	YEAR
1912	---	---	---	---	---	---	84.2	29.7	---	---	---	---	---	1912
1913	---	---	---	---	260	167	168	32.2	11.6	30.8	---	---	---	1913
1914	---	---	---	102	328	145	26.6	9.9	10.7	15.5	15.5	---	---	1914
1915	---	---	---	89.2	274	299	242	100	11.6	---	---	---	---	1915
1916	---	---	---	71.2	266	328	126	25.0	5.3	5.7	---	---	---	1916
1917	---	---	---	---	370	373	68.6	2.9	0.81	---	---	---	---	1917
1918	---	---	---	72.5	352	181	4.6	1.4	1.3	---	---	---	---	1918
1919	---	---	---	---	189	111	10.0	1.8	0.34	---	---	---	---	1919
1920	---	---	---	3.8	136	195	23.3	4.3	29.1	---	---	---	---	1920
1921	---	---	---	13.4	320	171	8.7	1.0	2.6	---	---	---	---	1921
1962	4.7	6.0	5.7	115	440	245	70.8	16.4	23.5	29.4	23.2	14.2	83.3	1962
1963	9.1	4.4	9.9	107	352	144	61.1	12.0	9.6	5.9	7.2	5.0	61.1	1963
1964	6.2	5.1	4.8	16.1	117	384	40.3	3.0	32.0	26.4	10.2	5.3	53.9	1964
1965	9.4	12.7	6.4	63.9	186	130	18.4	28.2	26.4	20.7	21.3	11.7	44.7	1965
1966	8.7	8.5	11.8	53.7	371	167	73.9	27.0	5.5	9.2	8.8	10.4	61.6	1966
1967	10.1	8.9	8.8	13.2	315	273	14.9	2.0	1.6	2.4	7.4	6.0	55.4	1967
1968	6.4	6.6	22.9	12.4	319	327	35.1	9.7	14.2	15.8	14.4	9.9	66.2	1968
1969	6.7	8.5	12.5	132	503	177	272	12.4	29.9	44.0	45.2	25.9	107	1969
1970	14.3	13.0	14.7	21.0	228	145	9.1	0.47	1.5	5.0	5.0	5.8	38.7	1970
1971	8.1	11.2	8.6	44.4	415	436	52.6	0.34	0.31	2.0	4.8	4.3	82.5	1971
1972	4.9	5.4	11.2	19.9	571	463	37.1	4.1	3.1	4.5	6.3	4.1	94.7	1972
1973	4.8	8.1	9.8	5.6	331	89.6	9.9	0.50	0	2.0	4.6	5.2	39.7	1973
1974	4.5	2.9	4.7	12.0	155	364	33.5	5.2	1.6	2.5	4.7	4.8	49.5	1974
1975	3.9	3.8	5.0	8.2	321	510	75.0	7.6	6.5	12.0	15.5	10.8	81.6	1975
1976	9.4	7.4	7.1	30.5	375	198	42.4	76.5	51.0	16.5	13.3	12.9	70.3	1976
MEAN	7.4	7.5	9.6	48.0	314	251	64.3	16.5	11.7	13.9	13.0	9.1	66.1	MEAN

LOCATION - LAT 50 53 04 N
LONG 120 57 54 W
DRAINAGE AREA 159 SQ MILES
REGULATED

CRISS CREEK NEAR SAVONA - STATION NO. 08LFC07

ANNUAL EXTREMES OF DISCHARGE IN CFS AND ANNUAL TOTAL DISCHARGE IN AC-FT FOR THE PERIOD OF RECORD

YEAR	MAXIMUM INSTANTANEOUS DISCHARGE	MAXIMUM DAILY DISCHARGE	MINIMUM DAILY DISCHARGE	TOTAL DISCHARGE	YEAR
1912	---	---	---	---	1912
1913	---	444 CFS ON MAY 10	---	---	1913
1914	---	533 CFS ON MAY 5	---	---	1914
1915	---	1470 CFS ON JUN 27	---	---	1915
1916	---	730 CFS ON JUN 4	---	---	1916
1917	---	620 CFS ON MAY 29	---	---	1917
1918	---	450 CFS ON MAY 8	---	---	1918
1919	---	340 CFS ON MAY 23	---	---	1919
1920	---	339 CFS ON JUN 8	---	---	1920
1921	---	660 CFS ON MAY 24	---	---	1921
1962	---	1300 CFS ON MAY 29	2.0 CFS ON FEB 20	60400 AC-FT	1962
1963	---	651 CFS ON MAY 28	3.0 CFS ON SEP 29	44200 AC-FT	1963
1964	---	678 CFS ON JUN 12	2.1 CFS ON AUG 24	39200 AC-FT	1964
1965	---	574 CFS ON JUN 1	4.6 CFS ON MAR 24	32300 AC-FT	1965
1966	---	642 CFS ON MAY 9	3.2 CFS ON SEP 9	45000 AC-FT	1966
1967	---	790 CFS ON MAY 23	0.48 CFS ON OCT 8	40000 AC-FT	1967
1968	---	650 CFS ON MAY 21	3.8 CFS ON AUG 11	48100 AC-FT	1968
1969	---	1670 CFS ON JUL 6	4.6 CFS ON AUG 31	77200 AC-FT	1969
1970	---	720 CFS ON MAY 26	0 CFS ON AUG 18	28000 AC-FT	1970
1971	---	1610 CFS ON JUN 9	0 CFS ON AUG 17	59600 AC-FT	1971
1972	---	1120 CFS ON MAY 24	0.80 CFS ON AUG 24	68700 AC-FT	1972
1973	---	1010 CFS ON MAY 24	0 CFS ON AUG 15	28800 AC-FT	1973
1974	---	684 CFS ON JUN 13	0.75 CFS ON SEP 21	35900 AC-FT	1974
1975	---	1300 CFS ON MAY 31	2.0 CFS ON MAR 6	59000 AC-FT	1975
1976	760 CFS AT 0600 PST ON MAY 11 *	650 CFS ON MAY 11	5.4 CFS ON MAR 4	51100 AC-FT	1976
				47900 AC-FT	MEAN

* - EXTREME RECORDED FOR THE PERIOD OF RECORD

DEADMAN RIVER ABOVE CRESS CREEK - STATION NO. 08LF027
MONTHLY AND ANNUAL MEAN DISCHARGES IN CUBIC FEET PER SECOND FOR THE PERIOD OF RECORD

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	MEAN	YR
1913	---	---	---	---	267	89.5	92.1	31.5	10.3	10.8	---	---	---	1913
1914	---	---	---	154	365	96.7	54.3	54.0	25.2	9.1	11.1	---	---	1914
1915	---	---	---	14.3	45.9	94.1	197	63.4	24.8	---	---	---	---	1915
1916	---	---	---	84.6	273	225	148	63.8	64.2	23.8	---	---	---	1916
1917	---	---	---	10.8	465	292	96.6	56.5	37.2	---	---	---	---	1917
1918	---	---	---	28.8	214	96.7	39.7	47.0	33.1	---	---	---	---	1918
1919	---	---	---	---	10.0	19.0	37.7	33.7	19.7	---	---	---	---	1919
1920	---	---	---	5.8	33.5	72.6	45.0	46.3	31.1	---	---	---	---	1920
1921	---	---	---	9.0	95.1	69.0	30.5	32.2	32.2	---	---	---	---	1921
1962	4.8	6.7	9.1	111	362	275	121	47.6	31.4	27.7	30.7	27.9	88.3	1962
1963	29.0	21.2	20.8	105	255	106	48.2	16.7	12.4	12.3	11.0	8.7	53.3	1963
1964	10.5	15.3	16.9	19.8	173	265	90.5	21.4	23.8	26.0	20.3	12.9	58.0	1964
1965	15.9	14.1	15.6	53.3	251	119	22.6	16.3	14.0	10.4	13.7	12.5	46.7	1965
1966	13.8	14.6	20.4	98.0	229	116	86.1	66.2	17.9	14.2	11.7	14.4	58.8	1966
1967	17.1	23.7	22.1	26.8	452	172	32.7	11.1	15.9	4.1	4.7	4.7	66.1	1967
1968	5.0	5.1	7.8	9.0	279	203	44.5	16.1	14.8	14.8	15.8	15.3	52.8	1968
1969	16.4	18.3	13.8	112	439	47.8	313	47.5	39.4	60.3	66.0	52.7	103	1969
1970	32.2	30.9	27.2	52.1	173	91.2	17.2	6.7	3.6	4.2	5.4	4.1	37.3	1970
1971	4.5	5.8	8.0	30.2	371	309	97.2	19.2	8.5	6.8	6.3	5.8	73.1	1971
1972	5.4	8.8	22.5	50.2	522	224	98.4	25.3	14.8	11.9	10.6	9.1	84.1	1972
1973	8.1	9.6	12.0	19.8	168	87.4	18.3	11.8	7.2	6.4	6.6	5.6	30.2	1973
1974	5.6	5.5	8.9	17.1	284	192	34.6	16.6	13.9	10.3	8.5	7.6	50.6	1974
1975	7.6	6.2	6.8	10.1	289	254	81.9	14.5	10.8	10.4	11.3	9.9	59.7	1975
1976	8.9	9.9	12.2	24.8	300	97.8	56.3	123	91.2	32.1	18.7	37.4	68.1	1976
MEAN	11.7	13.0	14.9	47.6	262	151	79.3	37.0	24.9	16.4	15.8	15.2	52.0	MEAN

LOCATION - LAT 50 53 53 N DRAINAGE AREA 333 SQ MILES
LONG 120 58 28 W REGULATED

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DEADMAN RIVER ABOVE CRESS CREEK - STATION NO. 08LF027
ANNUAL EXTREMES OF DISCHARGE IN CFS AND ANNUAL TOTAL DISCHARGE IN AC-FT FOR THE PERIOD OF RECORD

YEAR	MAXIMUM INSTANTANEOUS DISCHARGE	MAXIMUM DAILY DISCHARGE	MINIMUM DAILY DISCHARGE	TOTAL DISCHARGE	YR
1913	---	481 CFS ON MAY 14	---	---	1913
1914	---	563 CFS ON MAY 6	---	---	1914
1915	---	739 CFS ON JUL 2	1.0 CFS ON MAR 22	---	1915
1916	---	390 CFS ON MAY 8	---	---	1916
1917	---	1100 CFS ON MAY 19	---	---	1917
1918	---	290 CFS ON MAY 8	---	---	1918
1919	---	60.0 CFS ON JUL 25	0 CFS ON APR 13 *	---	1919
1920	---	97.0 CFS ON MAY 29	5.0 CFS ON APR 1	---	1920
1921	---	253 CFS ON MAY 25	5.0 CFS ON APR 7	---	1921
1962	---	733 CFS ON MAY 28	3.0 CFS ON JAN 1	64000 AC-FT	1962
1963	---	322 CFS ON MAY 4	8.1 CFS ON NOV 28	38600 AC-FT	1963
1964	---	335 CFS ON JUN 21	8.5 CFS ON JAN 1	42100 AC-FT	1964
1965	---	365 CFS ON MAY 2	9.0 CFS ON OCT 9	33800 AC-FT	1965
1966	---	362 CFS ON MAY 12	6.4 CFS ON NOV 30	42600 AC-FT	1966
1967	---	678 CFS ON MAY 21	2.8 CFS ON DEC 17	47900 AC-FT	1967
1968	---	527 CFS ON MAY 27	3.2 CFS ON JAN 29	38300 AC-FT	1968
1969	---	1090 CFS ON JUL 9	9.5 CFS ON MAR 9	74800 AC-FT	1969
1970	---	242 CFS ON MAY 12	3.0 CFS ON OCT 2	27000 AC-FT	1970
1971	---	409 CFS ON MAY 8	3.6 CFS ON JAN 15	52900 AC-FT	1971
1972	---	934 CFS ON MAY 25	4.5 CFS ON JAN 26	61100 AC-FT	1972
1973	---	208 CFS ON MAY 30	4.8 CFS ON DEC 31	21900 AC-FT	1973
1974	---	364 CFS ON MAY 11	4.0 CFS ON JAN 10	36600 AC-FT	1974
1975	---	539 CFS ON MAY 17	5.2 CFS ON JAN 14	43200 AC-FT	1975
1976	---	634 CFS ON MAY 12	7.8 CFS ON MAR 4	49500 AC-FT	1976

* - EXTREME RECORDED FOR THE PERIOD OF RECORD

45000 AC-FT

APPENDIX III Reach habitat summary data for the Deadman River and Criss Creek.

REACH NO.	TOTAL LENGTH (km)	COMMENTS
Deadman River		
1	6.65	2.5km above Hwy 1
2	6.18	above Indian village
3	3.48	top of reservation
4	5.23	above Allen's ranch
5	2.38	Barricade Creek
6	1.98	0.5km below Gorge Creek
7	0.55	lower end of Circle W
8	3.72	above Docksteaders
9	1.98	below Tobacco Creek
10	3.96	last road access before Mowich Lake
11	1.34	Mowich Lake
Criss Creek		
1	4.80	
2	7.40	
3	9.00	falls located at approx. 4.5km

SUMMARY OF PHYSICAL RESULTS

RIVER NAME: DEADMAN REACH 1 CODE: 300-0-0-1-A

	POOL		RIFFLE		GLIDE		DITCH		SLOUGH		FALLS	
	VALUE	%	VALUE	%	VALUE	%	VALUE	%	VALUE	%	VALUE	%
AVERAGE LENGTH	213.0	31.9	64.5	53.0	22.4	15.1	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE WETTED WIDTH	7.5	61.5	8.7	60.9	7.6	56.9	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE CHANNEL WIDTH	13.0	0.0	14.6	0.0	13.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE DEPTH	0.4	0.0	0.2	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE AREA	216.0	9.6	239.2	58.4	159.9	32.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL NUMBER IN REACH	9.9	0.0	54.7	0.0	44.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL AREA IN REACH	5256.0	9.6	31973.0	58.4	17514.0	32.0	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE AREA LOG DEBRIS COVER	0.6	0.0	0.1	0.2	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE AREA BOULDER COVER	1.8	2.8	6.4	2.9	3.1	2.3	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE AREA INSTREAM VEG. COVER	0.3	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE AREA OVERSTREAM VEG. COVER	2.5	4.8	0.3	0.2	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE AREA CUTBANKS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE AREA TOTAL COVER	5.2	7.7	6.8	3.3	3.3	2.5	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE PERCENT FINES	10.0	10.0	1.8	1.8	6.7	6.7	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE PERCENT SMALL GRAVEL	15.0	15.0	8.2	8.2	15.0	15.0	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE PERCENT LARGE GRAVEL	25.0	25.0	24.1	24.1	24.4	24.4	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE PERCENT CURBLES	27.5	27.5	32.7	32.7	33.3	33.3	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE PERCENT Boulders	22.5	22.5	32.7	32.7	20.6	20.6	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE PERCENT BEDROCK	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

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SUMMARY OF PHYSICAL RESULTS

RIVER NAME: DEADMAN REACH 4 CODE: 0300-0-0-4-3
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	POOL		RIFFLE		GLIDE		DITCH		SLOUGH		FALLS	
	VALUE	%	VALUE	%	VALUE	%	VALUE	%	VALUE	%	VALUE	%
AVERAGE LENGTH	13.7	10.8	15.7	41.2	21.5	48.0	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE WETTED WIDTH	6.5	57.7	8.1	73.7	7.2	65.9	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE CHANNEL WIDTH	12.0	0.0	11.3	0.0	11.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE DEPTH	0.8	0.0	0.2	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE AREA	104.7	10.4	127.8	42.4	167.1	47.2	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL NUMBER IN REACH	41.2	0.0	137.2	0.0	116.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL AREA IN REACH	4307.5	10.4	17526.8	42.4	19487.2	47.2	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE AREA LOG DEBRIS COVER	20.3	4.2	0.5	2.1	1.2	1.2	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE AREA BOULDER COVER	0.2	0.1	1.5	1.1	0.4	0.2	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE AREA INSTREAM VEG. COVER	0.1	0.6	0.1	0.2	0.7	1.3	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE AREA OVERSTREAM VEG. COVER	1.3	2.1	0.3	0.3	1.2	2.1	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE AREA CUTBANKS	0.7	2.8	0.0	0.0	0.5	0.7	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE AREA TOTAL COVER	22.6	9.7	2.5	3.7	4.1	5.4	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE PERCENT FINES	58.3	58.3	5.3	5.3	27.9	27.9	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE PERCENT SMALL GRAVEL	14.2	14.2	27.0	27.0	25.3	25.3	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE PERCENT LARGE GRAVEL	17.5	17.5	46.5	46.5	35.9	35.9	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE PERCENT CURBLES	9.2	9.2	16.3	16.3	9.1	9.1	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE PERCENT BOULDERS	0.8	0.8	5.0	5.0	1.8	1.8	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE PERCENT BEDROCK	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

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SUMMARY OF PHYSICAL RESULTS

RIVER NAME: DEADMAN REACH 5 CODE: 0300-0-0-5-3

	POOL		RIFFLE		GLIDE		DITCH		SLOUGH		FALLS	
	VALUE	%	VALUE	%	VALUE	%	VALUE	%	VALUE	%	VALUE	%
AVERAGE LENGTH	8.0	4.7	24.4	43.2	33.1	52.1	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE WETTED WIDTH	7.7	55.8	6.9	66.5	7.1	58.7	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE CHANNEL WIDTH	16.0	0.0	19.4	0.0	22.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE DEPTH	1.1	0.0	0.2	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE AREA	66.3	5.2	178.3	42.3	248.4	52.4	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL NUMBER IN REACH	14.0	0.0	42.1	0.0	37.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL AREA IN REACH	930.5	5.2	7502.4	42.3	9290.9	52.4	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE AREA LOG DEBRIS COVER	20.7	21.2	3.1	3.9	3.4	1.5	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE AREA BOULDER COVER	0.0	0.0	5.1	1.9	2.9	1.2	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE AREA INSTREAM VEG. COVER	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE AREA OVERSTREAM VEG. COVER	0.2	1.4	0.7	0.5	3.6	1.5	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE AREA CUTBANKS	0.2	1.4	0.1	0.0	1.3	0.5	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE AREA TOTAL COVER	21.0	24.0	9.0	6.3	11.2	4.7	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE PERCENT FINES	66.7	66.7	3.3	3.3	27.5	27.5	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE PERCENT SMALL GRAVEL	15.0	15.0	15.6	15.6	19.4	19.4	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE PERCENT LARGE GRAVEL	13.3	13.3	35.0	35.0	26.3	26.3	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE PERCENT COBBLES	5.0	5.0	32.2	32.2	20.6	20.6	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE PERCENT BOULDERS	0.0	0.0	13.9	13.9	6.3	6.3	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE PERCENT BEDROCK	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

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SUMMARY OF PHYSICAL RESULTS

RIVER NAME: DEADMAN

REACH 6 CODE: 0300-0-0-6-3

	POOL		RIFFLE		GLIDE		DITCH		SLOUGH		FALLS	
	VALUE	%	VALUE	%	VALUE	%	VALUE	%	VALUE	%	VALUE	%
AVERAGE LENGTH	10.8	18.3	9.4	26.4	17.9	55.3	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE WETTED WIDTH	6.2	48.8	7.2	58.5	7.0	59.0	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE CHANNEL WIDTH	14.0	0.0	12.4	0.0	13.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE DEPTH	0.5	0.0	0.2	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE AREA	66.7	16.5	62.8	26.0	126.5	57.5	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL NUMBER IN REACH	33.4	0.0	55.6	0.0	61.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL AREA IN REACH	2224.7	16.5	3492.8	26.0	7739.2	57.5	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE AREA LOG DEBRIS COVER	9.7	6.4	1.4	7.4	3.0	3.1	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE AREA BOULDER COVER	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE AREA INSTREAM VEG. COVER	0.2	0.5	0.1	0.5	0.5	1.1	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE AREA OVERSTREAM VEG. COVER	1.2	2.0	1.1	3.4	1.6	4.3	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE AREA CUTBANKS	1.3	1.7	0.3	1.6	0.4	0.5	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE AREA TOTAL COVER	12.2	10.6	3.0	13.1	5.5	8.9	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE PERCENT FINES	65.0	65.0	8.5	8.5	49.5	49.5	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE PERCENT SMALL GRAVEL	21.7	21.7	30.5	30.5	23.6	23.6	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE PERCENT LARGE GRAVEL	13.3	13.3	46.0	46.0	21.4	21.4	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE PERCENT CORBLES	0.0	0.0	13.5	13.5	5.5	5.5	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE PERCENT BULDERS	0.0	0.0	1.5	1.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE PERCENT BEDROCK	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

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SUMMARY OF PHYSICAL RESULTS

RIVER NAME: DEADMAN REACH 7 CODE: 0300-0-0-7-A

	POOL		RIFFLE		GLIDE		DITCH		SLOUGH		FALLS	
	VALUE	%	VALUE	%	VALUE	%	VALUE	%	VALUE	%	VALUE	%
AVERAGE LENGTH	0.0	0.0	5.3	30.2	12.3	69.8	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE WETTED WIDTH	0.0	0.0	8.0	77.6	7.0	71.4	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE CHANNEL WIDTH	0.0	0.0	10.3	0.0	10.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE DEPTH	0.0	0.0	0.2	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE AREA	0.0	0.0	43.3	33.3	86.7	66.7	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL NUMBER IN REACH	0.0	0.0	31.1	0.0	31.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL AREA IN REACH	0.0	0.0	1349.1	33.3	2698.1	66.7	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE AREA LOG DEBRIS COVER	0.0	0.0	0.3	5.3	2.5	2.6	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE AREA BOULDER COVER	0.0	0.0	2.8	5.2	1.7	2.2	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE AREA INSTREAM VEG. COVER	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE AREA OVERSTREAM VEG. COVER	0.0	0.0	1.7	2.6	1.0	1.2	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE AREA CUTBANKS	0.0	0.0	0.0	0.0	1.7	2.6	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE AREA TOTAL COVER	0.0	0.0	4.8	13.1	6.8	8.7	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE PERCENT FINES	0.0	0.0	5.0	5.0	11.7	11.7	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE PERCENT SMALL GRAVEL	0.0	0.0	5.0	5.0	6.7	6.7	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE PERCENT LARGE GRAVEL	0.0	0.0	36.7	36.7	25.0	25.0	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE PERCENT CUBBLES	0.0	0.0	40.0	40.0	35.0	35.0	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE PERCENT BOULDERS	0.0	0.0	13.3	13.3	21.7	21.7	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE PERCENT BEDROCK	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

SUMMARY OF PHYSICAL RESULTS

RIVER NAME: DEADMAN

REACH 8

CODE: 0300-0-0-8-3

	POOL		RIFFLE		GLIDE		DITCH		SLOUGH		FALLS	
	VALUE	%	VALUE	%	VALUE	%	VALUE	%	VALUE	%	VALUE	%
AVERAGE LENGTH	15.7	20.5	13.3	29.0	25.7	50.4	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE WETTED WIDTH	5.8	60.3	6.3	68.8	5.9	69.6	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE CHANNEL WIDTH	10.1	0.0	9.4	0.0	8.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE DEPTH	0.7	0.0	0.2	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE AREA	94.2	20.6	77.5	28.3	155.4	51.1	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL NUMBER IN REACH	48.7	0.0	81.2	0.0	73.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL AREA IN REACH	4589.1	20.6	6293.1	28.3	11363.1	51.1	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE AREA LOG DEBRIS COVER	6.3	2.4	0.3	2.6	2.1	2.0	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE AREA BOULDER COVER	0.3	0.2	0.4	0.6	0.7	0.3	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE AREA INSTREAM VEG. COVER	0.0	0.0	0.1	0.1	0.4	0.2	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE AREA OVERTREAM VEG. COVER	2.3	3.4	0.0	0.0	1.8	2.3	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE AREA CUTBANKS	3.8	4.6	0.0	0.0	0.7	0.7	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE AREA TOTAL COVER	12.7	10.6	0.8	3.4	5.7	5.6	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE PERCENT FINES	44.2	44.2	4.5	4.5	22.8	22.8	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE PERCENT SMALL GRAVEL	34.2	34.2	66.5	66.5	48.3	48.3	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE PERCENT LARGE GRAVEL	17.5	17.5	28.0	28.0	27.2	27.2	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE PERCENT CURBLES	2.5	2.5	0.5	0.5	1.1	1.1	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE PERCENT BOULDERS	1.7	1.7	0.5	0.5	0.6	0.6	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE PERCENT BEDROCK	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

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SUMMARY OF PHYSICAL RESULTS

RIVER NAME: DEADMAN

REACH 9

CODE: 0300-0-0-9-3

	POOL		RIFFL		GLIDE		DITCH		SLOUGH		FALLS	
	VALUE	%	VALUE	%	VALUE	%	VALUE	%	VALUE	%	VALUE	%
AVERAGE LENGTH	13.8	21.3	14.4	44.5	18.5	34.2	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE WETTED WIDTH	4.6	42.7	7.3	47.5	7.5	59.4	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE CHANNEL WIDTH	12.0	0.0	15.6	0.0	13.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE DEPTH	0.4	0.0	0.1	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE AREA	65.1	15.7	87.6	42.2	145.7	42.1	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL NUMBER IN REACH	30.5	0.0	61.0	0.0	36.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL AREA IN REACH	1986.1	15.7	5348.1	42.2	5335.9	42.1	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE AREA LOG DEBRIS COVER	0.5	0.1	0.3	0.5	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE AREA BOULDER COVER	0.6	0.6	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE AREA INSTREAM VEG. COVER	0.4	0.5	0.0	0.0	0.3	0.2	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE AREA OVERSTREAM VEG. COVER	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE AREA CUTBANKS	0.1	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE AREA TOTAL COVER	1.6	1.7	0.3	0.6	0.4	0.3	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE PERCENT FINES	19.0	19.0	0.5	0.5	5.0	5.0	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE PERCENT SMALL GRAVEL	43.0	43.0	42.0	42.0	40.8	40.8	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE PERCENT LARGE GRAVEL	31.0	31.0	51.5	51.5	51.7	51.7	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE PERCENT CURBLES	2.0	2.0	6.0	6.0	2.5	2.5	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE PERCENT BOULDERS	5.0	5.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE PERCENT BEDROCK	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

SUMMARY OF PHYSICAL RESULTS

RIVER NAME: DEADMAN REACH 10 CODE: 0300-0-0-0-4

	POOL		RIFFLE		GLIDE		DITCH		SLOUGH		FALLS	
	VALUE	%	VALUE	%	VALUE	%	VALUE	%	VALUE	%	VALUE	%
AVERAGE LENGTH	16.0	7.3	27.2	59.3	19.4	33.4	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE WETTED WIDTH	5.3	69.6	6.8	79.9	6.6	77.5	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE CHANNEL WIDTH	7.6	0.0	8.4	0.0	8.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE DEPTH	0.7	0.0	0.2	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE AREA	79.5	5.6	169.7	56.8	142.4	37.6	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL NUMBER IN REACH	18.2	0.0	86.3	0.0	68.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL AREA IN REACH	1444.1	5.6	14641.1	56.8	9697.9	37.6	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE AREA LOG DEBRIS COVER	1.0	0.4	1.6	1.2	1.4	0.9	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE AREA BOULDER COVER	2.9	4.2	6.0	4.3	1.8	2.0	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE AREA INSTREAM VEG. COVER	0.0	0.0	0.2	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE AREA OVERSTREAM VEG. COVER	1.0	2.2	2.3	1.8	1.0	0.8	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE AREA CUTRANKS	0.9	1.5	0.1	0.1	0.2	0.3	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE AREA TOTAL COVER	5.8	8.4	10.2	7.6	4.6	4.1	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE PERCENT FINES	13.8	13.8	2.9	2.9	7.0	7.0	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE PERCENT SMALL GRAVEL	16.3	16.3	13.4	13.4	14.3	14.3	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE PERCENT LARGE GRAVEL	25.0	25.0	32.6	32.6	36.7	36.7	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE PERCENT CURBLES	30.0	30.0	30.0	30.0	30.7	30.7	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE PERCENT BOULDERS	13.8	13.8	21.1	21.1	11.3	11.3	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE PERCENT BEDROCK	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

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SUMMARY OF PHYSICAL RESULTS

RIVER NAME: CRISS CREEK REACH 1 CODE: 0300-1-0-1-4

	POOL		RIFFLE		GLIDE		DITCH		SLOUGH		FALLS	
	VALUE	%	VALUE	%	VALUE	%	VALUE	%	VALUE	%	VALUE	%
AVERAGE LENGTH	5.8	14.1	10.5	64.4	8.8	21.5	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE WETTED WIDTH	5.5	57.8	3.0	33.7	3.1	37.0	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE CHANNEL WIDTH	9.5	0.0	9.0	0.0	8.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE DEPTH	0.3	0.0	0.1	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE AREA	52.5	31.1	35.1	52.0	28.5	16.9	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL NUMBER IN REACH	117.8	0.0	294.5	0.0	117.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL AREA IN REACH	6184.0	31.1	10336.2	52.0	3357.1	16.9	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE AREA LOG DEBRIS COVER	0.1	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE AREA BOULDER COVER	1.5	2.9	3.4	11.2	2.6	9.8	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE AREA INSTREAM VEG. COVER	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE AREA OVERSTREAM VEG. COVER	0.5	0.8	0.7	8.4	1.0	6.1	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE AREA CUTBANKS	0.1	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE AREA TOTAL COVER	2.1	4.0	4.2	19.7	3.6	16.0	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE PERCENT FINES	2.5	2.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE PERCENT SMALL GRAVEL	10.0	10.0	4.0	4.0	5.0	5.0	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE PERCENT LARGE GRAVEL	22.5	22.5	10.0	10.0	10.0	10.0	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE PERCENT COBBLES	37.5	37.5	37.0	37.0	37.5	37.5	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE PERCENT Boulders	27.5	27.5	49.0	49.0	47.5	47.5	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE PERCENT BEDROCK	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

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RECEIVED FROM
 DATE
 COUNTY
 DISTRICT

SUMMARY OF PHYSICAL RESULTS

RIVER NAME: CRISS CREEK REACH 2 CODE: 0300-1-0-2-4

	POOL		RIFFLE		GLIDE		DITCH		SLOUGH		FALLS	
	VALUE	%	VALUE	%	VALUE	%	VALUE	%	VALUE	%	VALUE	%
AVERAGE LENGTH	9.0	3.4	19.9	51.8	20.1	44.9	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE WETTED WIDTH	4.0	30.8	4.0	32.0	4.7	36.9	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE CHANNEL WIDTH	13.0	0.0	12.7	0.0	13.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE DEPTH	0.3	0.0	0.1	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE AREA	36.0	2.7	85.5	45.3	114.4	52.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL NUMBER IN REACH	27.6	0.0	192.9	0.0	165.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL AREA IN REACH	992.2	2.7	16486.7	45.3	18917.5	52.0	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE AREA LOG DEBRIS COVER	2.5	0.0	0.0	1.0	0.1	0.2	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE AREA BOULDER COVER	1.0	2.8	4.7	6.0	2.4	3.7	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE AREA INSTREAM VEG. COVER	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE AREA OVERSTREAM VEG. COVER	0.0	0.0	0.4	0.8	0.5	0.3	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE AREA CUTBANKS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE AREA TOTAL COVER	3.5	2.8	5.1	7.8	3.0	4.2	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE PERCENT FINES	15.0	15.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE PERCENT SMALL GRAVEL	5.0	5.0	4.3	4.3	5.8	5.8	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE PERCENT LARGE GRAVEL	25.0	25.0	29.3	29.3	32.5	32.5	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE PERCENT CURBLES	40.0	40.0	39.3	39.3	37.5	37.5	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE PERCENT BOULDERS	15.0	15.0	27.1	27.1	24.8	24.8	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE PERCENT BLDROCK	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

SUMMARY OF PHYSICAL RESULTS

RIVER NAME: CRISS CREEK

REACH 3

CODE: 0300-1-0-3-4

	POOL		RIFFLE		GLIDE		DITCH		SLOUGH		FALLS	
	VALUE	%	VALUE	%	VALUE	%	VALUE	%	VALUE	%	VALUE	%
AVERAGE LENGTH	31.5	25.9	15.8	39.1	21.3	35.0	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE WETTED WIDTH	7.3	65.0	5.6	56.2	6.8	69.0	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE CHANNEL WIDTH	11.0	0.0	10.0	0.0	9.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE DEPTH	0.3	0.0	0.1	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE AREA	234.5	28.9	95.7	35.4	145.0	35.7	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL NUMBER IN REACH	74.1	0.0	222.2	0.0	148.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL AREA IN REACH	17370.4	28.9	21259.2	35.4	21481.5	35.7	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE AREA LOG DEBRIS COVER	1.5	0.9	0.1	0.5	0.7	0.3	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE AREA BOULDER COVER	1.3	0.6	2.8	2.6	2.4	1.9	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE AREA INSTREAM VEG. COVER	1.8	1.1	0.7	1.4	1.6	1.1	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE AREA OVERSTREAM VEG. COVER	0.8	0.2	0.7	0.6	1.6	1.0	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE AREA CUTTHANKS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE AREA TOTAL COVER	5.3	2.8	4.2	5.1	6.3	4.5	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE PERCENT FINES	10.0	10.0	0.0	0.0	6.3	6.3	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE PERCENT SMALL GRAVEL	10.0	10.0	5.0	5.0	6.3	6.3	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE PERCENT LARGE GRAVEL	35.0	35.0	27.5	27.5	31.3	31.3	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE PERCENT COBBLES	35.0	35.0	35.0	35.0	33.8	33.8	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE PERCENT BOULDERS	10.0	10.0	32.5	32.5	22.5	22.5	0.0	0.0	0.0	0.0	0.0	0.0
AVERAGE PERCENT BEDROCK	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

APPENDIX IV Representative photographs of the Deadman River and
Criss Creek.



Deadman River - Reach 1 below Highway 1.



Population estimate site no. 3 in Reach 1. Biomass density of rainbow trout was $1.84\text{g}/\text{m}^2$ ($0+ = 0.10$, $1+/2+ = 1.74$).



Reach 1 above Highway no. 1.



Electrofishing site 7 in a boulder/cobble section. Rainbow biomass density was 6.02g/m^2 ($0+ = 3.89$, $1+ = 2.13$).



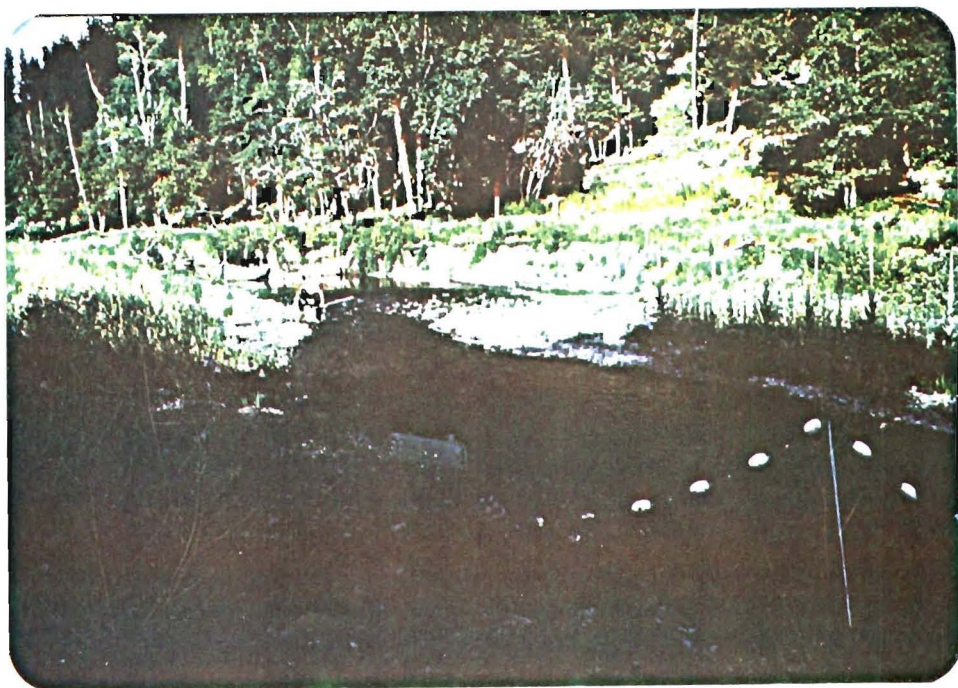
A portion of site no. 9 with deep, complex habitat. Rainbow biomass density was 4.92g/m^2 ($0+ = 1.52$, $1+/2+ = 3.40$).



Glide/riffle environment in Reach 6. Riparian land use was in early stages in this area relative to other reaches.



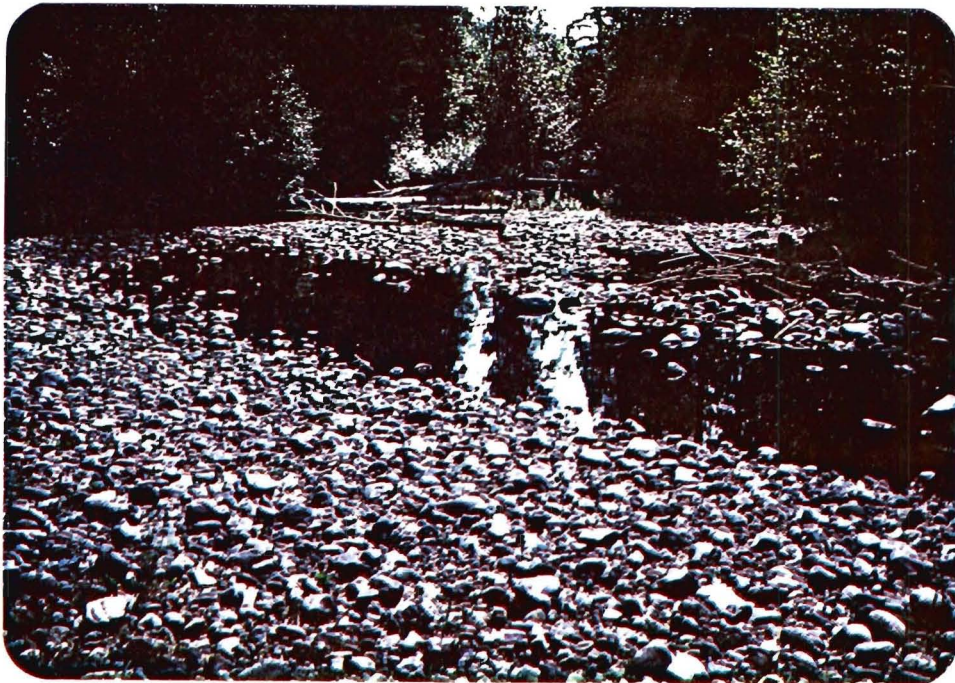
A large gravel/cobble section in Reach 7. Substrate throughout this type of environment was compacted.



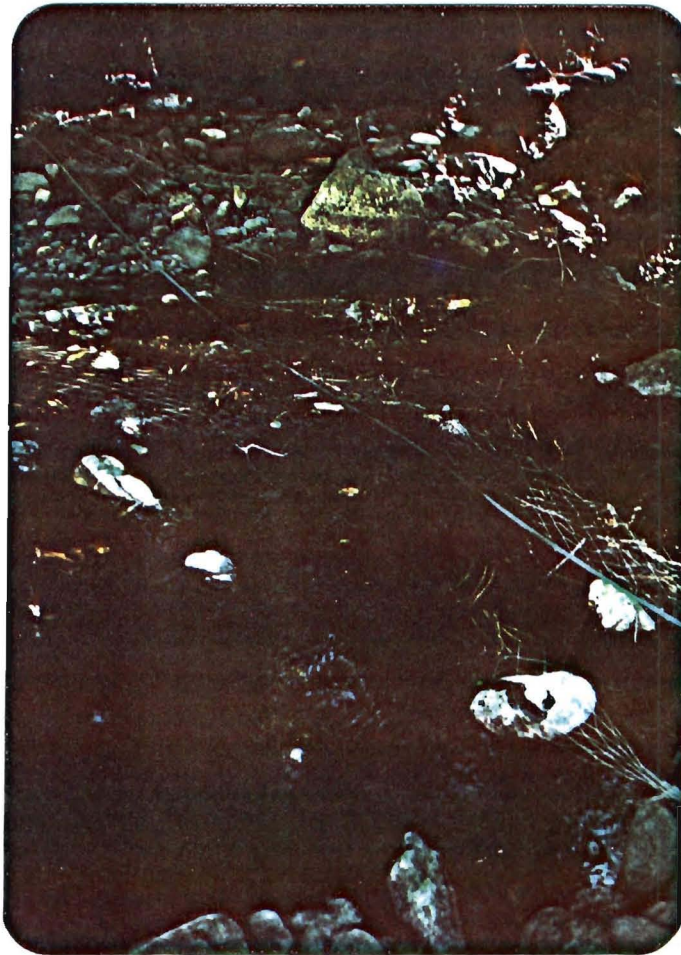
Site no. 11 in Reach 9. An estimated population of nearly 1,000 rainbow fry were present in this glide/riffle/glide section. Biomass density of 0+ = 3.06g/m^2 , 1+ = 0g/m^2 .



Criss Creek in Reach 1: moderately high gradient with large substrate.



Criss Creek in Reach 2: glide/pool/riffle habitat at low summer discharge.



Criss Creek - a large mesh gill net found in Reach 1 above the Criss Creek road bridge. This is evidence of the presence of large fish at some time of the year, perhaps steelhead.

APPENDIX V Fish population estimate results from the Deadman River
and Criss Creek, August 22 to 29, 1979.

DEADMAN RIVER

DATE Aug. 23/79

AREA 126m²

SITE # 1

SPECIES	AGE	f1-RANGE	f1	MEAN WEIGHT	C ₁	p̄	n̄	TOTAL BIOMASS	No./m ² DENSITY	BIOMASS DENSITY	No./LINEAR METER
Rb	+				0		0	0	0	0	0
Rb	1+		100	11.40	1	.6	1.67	19.00	0.01	0.15	0.09
Ch	+	52-70	64	2.93	15	.6	25.00	73.17	0.20	0.58	1.32
Coho	+	57-65	62	2.82	6	.6	10.00	28.18	0.08	0.22	0.53
ESalmonid							36.7	120.4	0.3	0.95	1.94
Suckers		25-124	85	8.63	8	.6	13.33	115.10	0.11	0.91	0.70
Dace	1+	35-40	38	0.54	3	.6	5.00	2.69	0.04	0.02	0.26

Rb K = 1.14 x 10⁻⁵
 Ch K = 1.10 x 10⁻⁵
 Coho K = 1.20 x 10⁻⁵
 Dace K = 9.7 x 10⁻⁶

Finescale Suckers: log W = -4.457 + 2.88 log SL
 where SL = .88FL (Carlander)

DEADMAN RIVER

DATE Aug. 23/79

AREA 113m²

SITE # 2

SPECIES	AGE	f1-RANGE	f1	MEAN WEIGHT	C ₁	p̄	n̄	TOTAL BIOMASS	No./m ² DENSITY	BIOMASS DENSITY	No./LINEAR METER
Rb	+				0		0	0	0	0	0
Rb	1+	106-110	108	14.38	2	.6	3.33	47.92	0.03	0.42	0.20
Ch	+	64-78	70	3.80	3	.6	5.00	19.02	0.04	0.17	0.30
ESalmonid							8.30	66.90	0.07	0.59	0.50
Dace	1+, 2+	36-98	56	2.49	6	.6	10.00	24.93	0.09	0.22	0.60
Suckers		24-35	28	0.35	9	.6	15.00	5.27	0.13	0.05	0.90

Rb K = 1.14 x 10⁻⁵
 Ch K = 1.10 x 10⁻⁵
 Dace K = 9.70 x 10⁻⁶

Finescale Sucker: log W = -4.457 + 2.88 log SL
 where SL = .88FL (Carlander)

DEADMAN RIVER

DATE Aug. 23/79AREA 141m²SITE # 3

SPECIES	AGE	f1-RANGE	$\bar{f1}$	MEAN WEIGHT	C_1	\bar{p}	\bar{n}	TOTAL BIOMASS	No./m ² DENSITY	BIOMASS DENSITY	No./LINEAR METER
Rb	+	52-64	57	2.18	4	.65	6.15	13.43	0.04	0.10	0.37
	1+	112-126	120	19.63	5	.65	7.69	150.98	0.05	1.07	0.46
	2+	138-140	139	30.62	2	.65	3.08	94.22	0.02	0.67	0.18
ERb							16.92	258.63	0.11	1.84	1.01
Ch	+	62-74	68	3.49	8	.65	12.31	42.99	0.09	0.30	0.74
ESalmonid							29.20	301.60	0.20	2.14	1.80
Dace		34-101	47	2.06	6	.60	10.00	20.55	0.07	0.15	0.60

Rb K = 1.14×10^{-5}
 Ch K = 1.10×10^{-5}
 Dace K = 9.70×10^{-6}

DEADMAN RIVER

DATE Aug. 23/79AREA 94.5m²SITE # 4

SPECIES	AGE	f1-RANGE	$\bar{f1}$	MEAN WEIGHT	C_1	\bar{p}	\bar{n}	TOTAL BIOMASS	No./m ² DENSITY	BIOMASS DENSITY	No./LINEAR METER
Rb	+	23-71	53	1.78	185	.8	231.25	412.69	2.45	4.37	22.02
Rb	1+	79-123	95	10.50	10	.8	12.50	131.21	0.13	1.39	1.19
Rb	2+		137	29.31	1	.8	1.25	36.64	0.01	0.39	0.12
							245.00	580.54	2.59	6.15	23.33
Ch	+	70-77	74	4.40	2	.8	2.50	10.99	0.03	0.12	0.24
Coho	+		64	3.15	1	.8	1.25	3.93	0.01	0.04	0.12
ESalmonid							248.80	595.50	2.63	6.31	23.70
Dace	2+, 3+	72-108	93	8.15	5	.8	6.25	50.91	0.07	0.54	0.60

Rb K = 1.14×10^{-5}
 Ch K = 1.10×10^{-5}
 Coho K = 1.20×10^{-5}
 Dace K = 9.70×10^{-6}

DEADMAN RIVER

DATE Aug. 27/79

AREA 95m²

SITE # 5

SPECIES	AGE	f1-RANGE	f1	MEAN WEIGHT	C ₁	p̄	n̄	TOTAL BIOMASS	No./m ² DENSITY	BIOMASS DENSITY	No./LINEAR METER
Rb	+	29-67	48	1.35	206	.8	257.50	348.68	2.71	3.67	15.24
Rb	1+		89	8.04	1	.8	1.25	10.05	0.01	0.11	0.07
							258.75	358.73	2.72	3.78	15.31
Ch	+		65	3.02	1	.8	1.25	3.78	0.01	0.04	0.07
ΣSalmonid							260.00	362.50	2.73	3.82	15.40

Rb K = 1.14×10^{-5}
 Ch K = 1.10×10^{-5}

DEADMAN RIVER

DATE Aug. 27/79

AREA 62m²

SITE # 6

SPECIES	AGE	f1-RANGE	f1	MEAN WEIGHT	C ₁	p̄	n̄	TOTAL BIOMASS	No./m ² DENSITY	BIOMASS DENSITY	No./LINEAR METER
Rb	+	38-62	50	1.51	88	.8	110.00	166.09	1.77	2.68	6.43
Rb	1+	76-129	102	12.40	18	.8	22.50	279.04	0.36	4.50	1.32
Rb	2+	163-167	165	51.23	2	.8	2.50	128.08	0.04	2.07	0.15
ΣRb							135.00	573.21	2.17	9.25	7.90
Ch	+	57-77	68	3.52	68	.8	85.00	298.93	1.37	4.82	4.97
Coho	+	52-66	61	2.81	3	.8	3.75	10.54	0.06	0.17	0.22
ΣSalmonid							223.80	882.70	3.60	14.24	13.10

Rb K = 1.14×10^{-5}
 Ch K = 1.10×10^{-5}
 Coho K = 1.20×10^{-5}

DEADMAN RIVER

DATE Aug. 27/79AREA 58m²SITE # 7

SPECIES	AGE	f1-RANGE	$\bar{f1}$	MEAN WEIGHT	C_1	\bar{p}	\bar{n}	TOTAL BIOMASS	No./m ² DENSITY	BIOMASS DENSITY	No./LINEAR METER
Rb	+	39-73	56	2.13	85	.8	106.25	225.66	1.83	3.89	11.30
Rb	1+	82-145	103	14.15	7	.8	8.75	123.81	0.15	2.13	0.93
Σ Rb							105.00	349.47	1.98	6.02	12.23
Σ Salmonid							105.0	349.50	1.98	6.02	12.20
Dace	3+	90-105	98	9.15	2	.8	2.50	22.88	0.04	0.39	0.27

Rb K = 1.14×10^{-5} Dace K = 9.70×10^{-6}

DEADMAN RIVER

DATE Aug. 28/79AREA 74m²SITE # 8

SPECIES	AGE	f1-RANGE	$\bar{f1}$	MEAN WEIGHT	C_1	\bar{p}	\bar{n}	TOTAL BIOMASS	No./m ² DENSITY	BIOMASS DENSITY	No./LINEAR METER
Rb	+	34-66	47	1.28	95	.8	118.75	152.46	1.60	2.06	7.61
Rb	1+	83-124	95	10.23	10	.8	12.50	127.84	0.17	1.73	0.80
Σ Rb							131.25	280.30	1.77	3.79	8.41
EBt	+		62	2.38	1	.8	1.25	2.98	0.02	0.04	0.08
Ch	+	70-75	73	4.29	3	.8	3.75	16.09	0.05	0.22	0.24
Coho	+	65-71	68	3.80	2	.8	2.50	9.49	0.03	0.13	0.16
Σ Salmonid							138.80	308.90	1.87	4.20	8.9

DEADMAN RIVER

DATE Aug. 25/79

AREA 238m²

SITE #9

SPECIES	AGE	f1-RANGE	$\bar{f1}$	MEAN WEIGHT	C ₁	\bar{p}	\bar{n}	TOTAL BIOMASS	No./m ² DENSITY	BIOMASS DENSITY	No./LINEAR METER
Rb	+	34-66	46	1.21	90	.3	300.00	361.83	1.26	1.52	12.00
Rb	1+	92-140	109	15.67	10	.3	33.33	522.45	0.14	2.20	1.33
Rb	2+	155-156	156	42.87	2	.3	6.67	285.77	0.03	1.20	0.27
ERb							340.00	1,170.05	1.43	4.92	13.60
Ch	+	72-82	78	5.22	7	.3	23.33	121.89	0.10	0.51	0.93
Coho	+	64-77	70	4.20	10	.3	33.33	139.98	0.14	0.59	1.33
ESalmonid							396.70	1,431.90	1.67	6.0	15.90
Dace	2+		89	6.84	1	.3	3.33	22.79	0.01	0.10	0.13

Rb K = 1.14×10^{-5}
 Ch K = 1.10×10^{-5}
 Coho K = 1.20×10^{-5}
 Dace K = 9.70×10^{-6}

DEADMAN RIVER

DATE Aug. 25/79

AREA 113.6m²

SITE #10

SPECIES	AGE	f1-RANGE	$\bar{f1}$	MEAN WEIGHT	C ₁	\bar{p}	\bar{n}	TOTAL BIOMASS	No./m ² DENSITY	BIOMASS DENSITY	No./LINEAR METER
Rb	+	38-62	48	1.31	43	.5	86.00	112.93	0.76	0.99	4.57
Rb	1+	100-139	119	19.93	7	.7	10.00	199.32	0.09	1.75	0.53
Rb	2+	145-174	160	47.40	2	.7	2.86	135.44	0.03	1.19	0.15
							98.86	447.69	.88	3.93	5.25
EBt	1+		100	10.00	2	.7	2.86	28.57	0.03	0.25	0.15
Ch	+ ?	92-107	101	11.41	5	.7	7.14	81.53	0.06	0.72	0.38
ESalmonid							108.90	557.80	0.97	4.90	5.80

Rb K = 1.14×10^{-5}
 EBt K = 1.00×10^{-5}
 Ch K = 1.10×10^{-5}

DEADMAN RIVER

DATE Aug. 24.79

AREA 302m²

SITE # 11

SPECIES	AGE	f1-RANGE	$\bar{f1}$	MEAN WEIGHT	C_1	\bar{p}	\bar{n}	TOTAL BIOMASS	No./m ² DENSITY	BIOMASS DENSITY	No./LINEAR METER
Rb	+	26-62	44	1.06	450	0.52*	872.84	925.16	2.89	3.06	22.04
ΣSalmonid							872.80	925.20	2.89	3.06	22.00

* probability calculated from two catches $\bar{p} = \frac{C_1 - C_2}{C_1} = 0.5156$

Rb K = 1.14×10^{-5}

DEADMAN RIVER

DATE Aug. 22/79

AREA 106m²

SITE # 12

SPECIES	AGE	f1-RANGE	$\bar{f1}$	MEAN WEIGHT	C_1	\bar{p}	\bar{n}	TOTAL BIOMASS	No./m ² DENSITY	BIOMASS DENSITY	No./LINEAR METER
Rb	+	35-70	53	1.85	74	.7	105.71	195.83	1.00	1.85	7.55
Rb	1+	115-132	124	21.78	2	.7	2.86	62.23	0.03	0.59	0.20
							108.57	258.06	1.03	2.44	7.75
ΣSalmonid							108.60	258.10	1.03	2.44	7.80
Dace	1+, 2+	44-87	73	3.81	36	.7	51.43	196.17	0.49	1.85	3.67

Rb K = 1.14×10^{-5}

Dace K = 9.70×10^{-6}

CRISS CREEK DATE Aug. 26/79 AREA 44.8m² SITE # 1

SPECIES	AGE	f1-RANGE	$\bar{f}1$	MEAN WEIGHT	C ₁	\bar{p}	\bar{n}	TOTAL BIOMASS	No./m ² DENSITY	BIOMASS DENSITY	No./LINEAR METER
Rb	+	33-59	49	1.43	28	.7	40.00	57.27	0.89	1.28	2.65
Rb	1+	74-124	93	9.92	26	*.786	33.08	328.10	0.74	7.32	2.19
Rb	2+	140-142	141	31.96	2	*.786	2.54	81.33	0.06	1.82	0.17
							75.62	466.70	1.69	10.42	5.01
Ch	+		67	3.31	1	.7	1.43	4.73	0.03	0.11	0.09
ΣSalmonid							77.00	471.40	1.72	10.53	5.10

* Calculated from 2 catch method.

Rb K = 1.14×10^{-5}
 Ch K = 1.10×10^{-5}

CRISS CREEK DATE Aug. 26/79 AREA 55.6m² SITE # 2

SPECIES	AGE	f1-RANGE	$\bar{f}1$	MEAN WEIGHT	C ₁	\bar{p}	\bar{n}	TOTAL BIOMASS	No./m ² DENSITY	BIOMASS DENSITY	No./LINEAR METER
Rb	+	27-54	42	0.92	89	.8	111.25	102.49	2.00	1.84	7.32
Rb	1+	71-98	84	7.03	23	.9	25.56	179.74	0.46	3.23	1.68
Rb	2+	125-132	129	24.50	4	.9	4.44	108.89	0.08	1.96	0.29
Rb	3+		150	38.48	1	.9	1.11	42.75	0.02	0.77	0.07
ERb							142.36	433.87	2.56	7.80	9.36
ΣSalmonid							142.40	433.90	2.60	7.80	9.40

APPENDIX VI Computation of juvenile rainbow trout condition factor based on length-weight data collected in the field.

$$\text{Condition factor (K)} = \frac{\text{weight(g)}}{\text{length(mm)}^3}$$

L(mm)	WT(g)	L(mm)	WT(g)	L(mm)	WT(g)	L(mm)	WT(g)
52	1.70	51	1.43	38	0.53	52	1.80
54	1.56	54	1.78	39	0.55	53	1.61
59	2.35	55	1.81	40	0.56	54	1.87
64	2.95	56	2.02	41	0.62	54	1.75
112	15.79	58	2.27	41	0.75	55	2.00
114	16.48	59	2.44	42	0.74	56	2.42
123	18.43	64	2.76	42	0.74	59	2.35
123	19.50	64	3.03	43	0.70	59	2.33
126	23.34	66	3.43	46	1.05	60	2.61
138	30.95	68	3.20	46	1.10	61	2.48
140	32.18	70	3.74	47	1.13	62	2.70
42	0.91	79	5.60	48	1.14	63	2.93
44	0.98	82	6.29	48	1.31	67	3.36
46	1.07	86	7.25	48	1.51	67	3.50
46	1.20	92	8.61	48	1.25	68	4.13
48	1.00	99	9.55	48	1.38	70	3.90
48	1.10	123	20.82	49	1.24	115	16.77
49	1.37	137	30.70	50	1.31	132	26.45
50	1.24	37	0.45	51	1.81		
50	1.30	38	0.52	51	1.63		

1. regression of weight on length³
 regression coefficient = K = 1.14 x 10⁻⁵

2. empirical formula for rainbow trout juveniles
 Weight(g) = 1.14 x 10⁻⁵ (length³)

APPENDIX VII(a) Summary of scale reading and circuli counts of juvenile rainbow trout in the Deadman River and Criss Creek, August 22 to 29, 1979.

AGE	FORK LENGTH	NUMBER OF CIRCULI TO		
		1st ANNULUS	2nd ANNULUS	TOTAL
1. DEADMAN RIVER				
0+	61			10
0+	69			8
0+	71			8
0+	79			18
0+	73			9
0+	61			8
mean				10.16
1+	123	10		23
1+	89	9		15
1+	86	9		22
1+	123	12		27
1+	112	13		26
1+	126	12		26
1+	123	14		25
1+	114	11		27
1+	100	9		21
1+	110	12		28
1+	106	11		22
1+	115	11		22
1+	145	16		25
1+	82	9		18
1+	82	10		18
1+	127	12		23
1+	101	10		22
1+	111	12		21
1+	140	14		27
1+	120	13		28
1+	110	12		26
1+	100	11		24
1+	130	16		25
1+	132	13		28
1+	115	14		30
mean		11.8		23.96
2+	137	9	20	31
2+	140	11	22	31
2+	138	11	28	36
2+	167	10	28	43
2+	155	13	28	36
2+	145	12	23	29
mean		11	24.83	34.33

SUMMARY FOR DEADMAN RIVER

AGE GROUP	n CIRCULI		
	1st ANNULUS	1st ANNULUS TO 2nd ANNULUS	PLUS GROWTH
0+	-	-	10.16
1+	11.8	-	12.16
2+	11.0	13.83	9.50

AGE	FORK LENGTH	NUMBER OF CIRCULI TO		
		1st ANNULUS	2nd ANNULUS	TOTAL

2. CRISS CREEK

1+	76	9		15	
1+	76	13		17	
1+	102	14		22	
1+	124	14		23	
1+	101	11		21	
1+	94	11		18	
1+	80	11		18	
1+	112	-		-	
1+	71	9		15	
mean		11.5		18.6	
2+	140	9	21	28	
2+	132	8	20	28	
mean		8.5	20.5	28	
3+	150	1st = 7	2nd = 16	3rd = 24	28

SUMMARY FOR CRISS CREEK

AGE GROUP	n CIRCULI		
	1st ANNULUS	1st ANNULUS TO 2nd ANNULUS	PLUS GROWTH
1+	11.5	-	7.1
2+	8.5	12.0	7.5

APPENDIX VII(b) Cumulative length frequency records for the Deadman
River and Criss Creek, August 22-29, 1979.

SYSTEM: DEADMAN RIVER

DATE: CUMULATIVE

SITE: COARSE FISH LENGTH: _____ m WIDTH: _____ in AREA: _____ m²

T₁: _____ seconds T₂: _____ seconds T_{WATER}: _____ °C

FILSE: _____ FREQUENCY: _____ VOLTAGE: _____ T_{AIR}: _____ °C

	LONGNOSED DACE	FINESCALE SUCKERS		LONGNOSED DACE	FINESCALE SUCKERS	
20			80			
1			1			1
2			2			2
3			3			3
4			4			4
5			5			5
6			6			6
7			7			7
8			8			8
9			9			9
30			90			0
1			1			1
2			2			2
3			3			3
4			4			4
5			5			5
6			6			6
7			7			7
8			8			8
9			9	3+		9
40			100			0
1			1			1
2			2			2
3			3			3
4			4			4
5			5			5
6			6			6
7			7			7
8			8			8
9			9			9
50			110			0
1			1			1
2			2			2
3			3			3
4			4			4
5			5			5
6			6			6
7			7			7
8			8			8
9			9			9
60			120			0
1			1			1
2			2			2
3			3			3
4			4			4
5			5			5
6			6			6
7			7			7
8			8			8
9			9			9
70			130			0
1			1			1
2	2+		2			2
3			3			3
4			4			4
5			5			5
6			6			6
7			7			7
8			8			8
9			9			9

APPENDIX VIII Habitat parameters sampled in the 12 Deadman River
population estimate sites.

APPENDIX IX Standing crop calculations

Estimates of standing crop were made by relating fish-habitat association relationships to reach habitat parameters, with consideration to suspected recruitment levels. The habitat-biomass density relationships derived in section 4.3.4 and used in standing crop calculations are summarized in Table 1.

TABLE 1 Summary of habitat-biomass density relationships used in standing crop estimates in the Deadman River and Criss Creek.

HYDRAULIC UNIT		TYPE 1	TYPE 2
<u>DEADMAN RIVER</u>			
rainbow fry	pool, riffle, glide	depth curve (Fig. A)	depth curve (Fig. A)
rainbow parr	pool	total cover curve (Fig. C)	total cover curve (Fig. C)
	riffle, glide	constant at 1.85g/m ²	total cover curve (Fig. C)
chinook/coho	pool, riffle, glide	total cover curve (Fig. B)	total cover curve (Fig. B)
<u>CRISS CREEK</u>			
rainbow fry and parr	all	mean sampled biomass density	

Appropriate habitat parameters were selected for each hydraulic unit of each reach (Table 2) and a value for biomass density of each age-group in each unit was derived from the above relationships. Where curves were used, direct graphical analysis was employed rather than regression analysis in order to satisfy the nonlinear functions (depth) and to minimize over or under estimates.

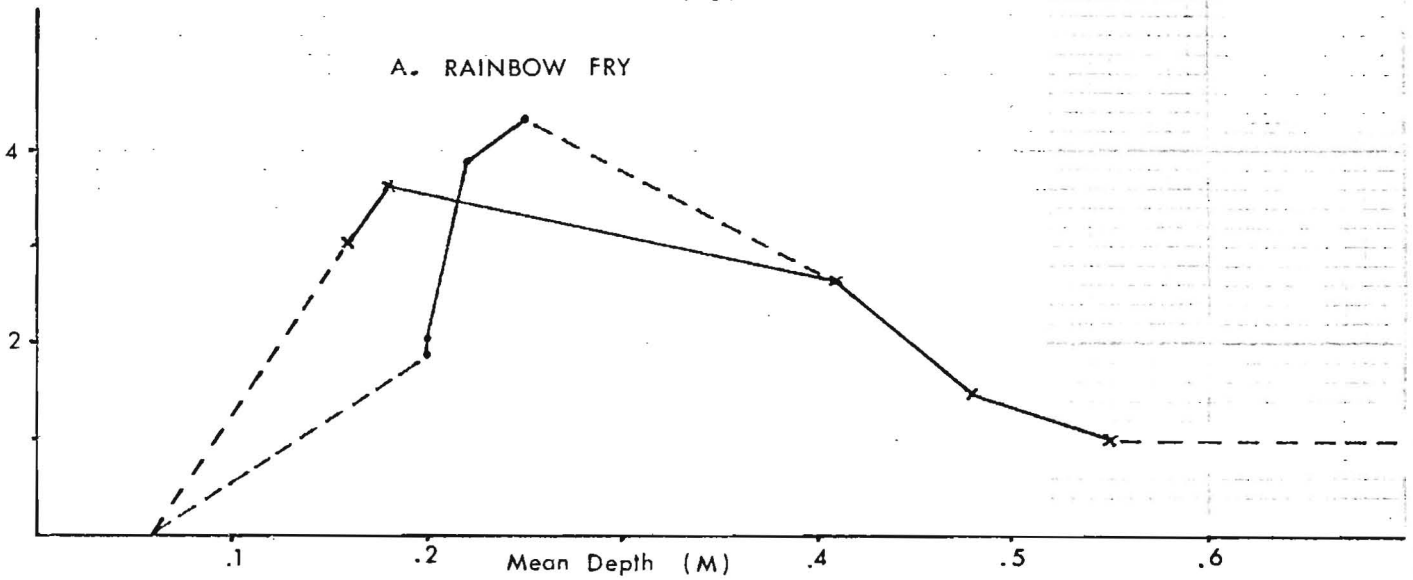
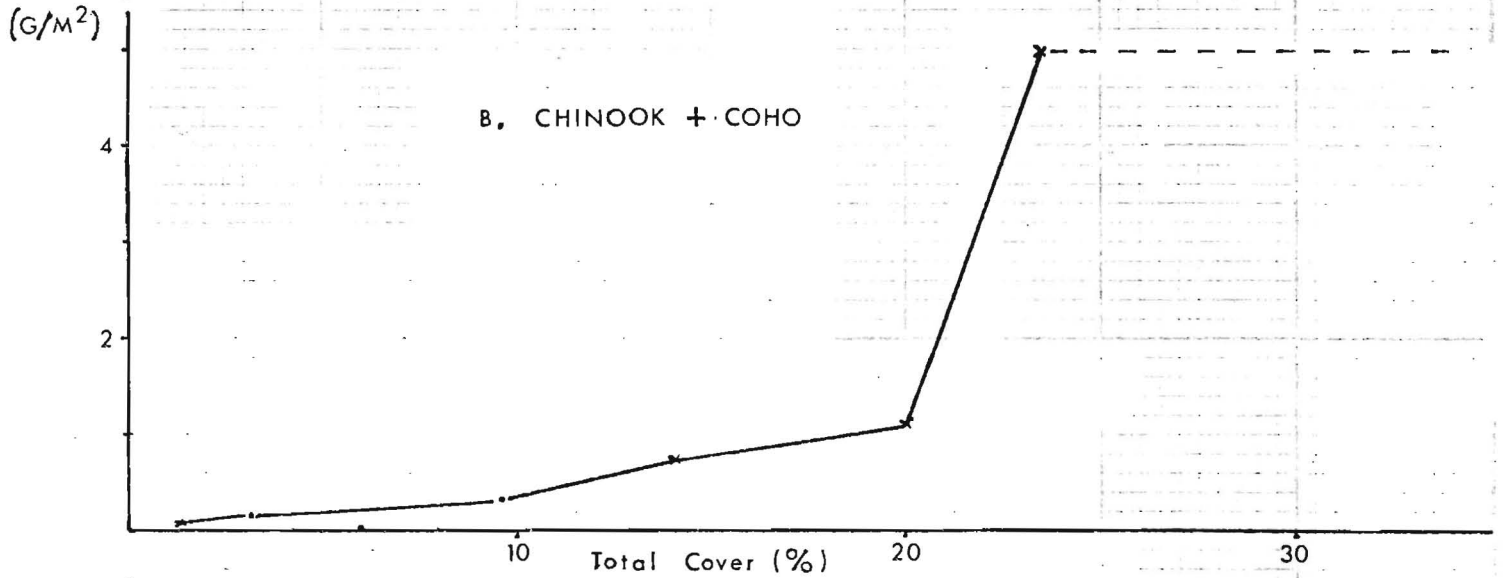
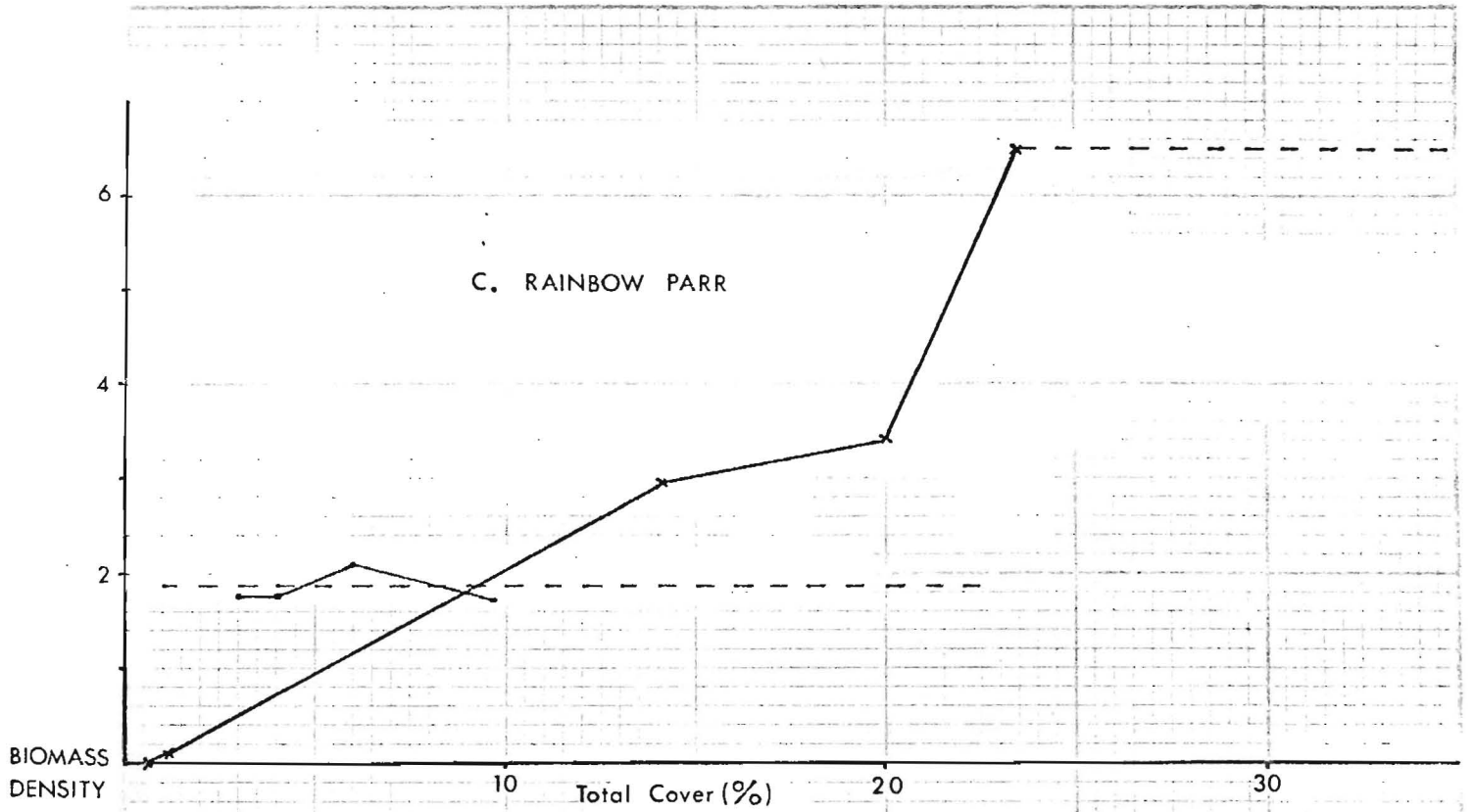


TABLE 2 Habitat parameters used in standing crop calculations for the Deadman River (summarized from Appendix II).

REACH	HABITAT TYPE	LENGTH	TOTAL AREA	POOLS					RIFFLES					GLIDES				
				AREA	%	\bar{D}	\bar{V}	%TC	AREA	%	\bar{D}	\bar{V}	%TC	AREA	%	\bar{D}	\bar{V}	%TC
<u>Deadman River</u>																		
1	1	6,650	54,748	5,256	9.6	.4	.19	7.7	31,973	58.4	.2	.33	3.3	17,519	32	.3	.25	2.5
2	1	6,180	51,047	5,105	(10.0)				22,971	(45.0)				22,971	(45.0)			
3	2	3,480	27,495	2,859	(10.4)				11,658	(42.4)				12,978	(47.2)			
4	2	5,230	41,322	4,308	10.4	.8	.11	9.7	17,527	42.4	.2	.35	3.7	19,487	47.2	.3	.26	5.4
5	1	2,380	17,724	931	5.2	1.1	.07	24.0	7,502	42.3	.2	.43	6.3	9,291	52.4	.3	.28	4.7
6	2	1,980	13,457	2,225	16.5	.5	.16	10.6	3,493	26.0	.2	.35	13.1	7,739	57.5	.3	.24	8.9
7	1	550	4,047	0	0.0				1,349	33.3	.2	.38	13.1	2,698	66.7	.3	.29	8.7
8	2	3,720	22,245	4,589	20.6	.7	.10	10.6	6,293	28.3	.2	.32	3.4	11,363	51.1	.3	.23	5.6
9	2	1,980	12,670	1,986	15.7	.4	.16	1.7	5,348	42.2	.1	.41	0.6	5,336	42.1	.2	.20	0.3
10	1	3,960	25,783	1,444	5.6	.7	.13	8.4	14,641	56.8	.2	.38	7.6	9,698	37.6	.3	.25	4.1
11	1	1,340	8,844	884	(10.0)				5,307	(60.0)				2,653	(30.0)			
<u>Criss Creek</u>																		
1	1	4,800	19,877	6,184	31.1	.3		4.0	10,336	52.0	.1		19.7	3,357	16.9	.3		16.0
2	1	7,400	36,397	992	2.7	.3		2.8	16,487	45.3	.1		7.8	18,918	52.0	.2		4.2
3	1	9,000	60,111	17,370	28.9	.3		2.8	21,259	35.4	.1		5.1	21,482	35.7	.2		4.5

TABLE 3(a) Deadman River standing crop calculations - Rainbow fry.

REACH #	POOLS			RIFFLES			GLIDES			TOTAL		
	AREA	BIOMASS/ m ²	TOTAL BIOMASS	AREA	BIOMASS/ m ²	TOTAL BIOMASS	AREA	BIOMASS/ m ²	TOTAL BIOMASS	AREA	BIOMASS/ m ²	TOTAL BIOMASS
<u>Deadman River</u>												
1	5,256	0.03	160	31,973	0.03	960	17,519	0.03	530	54,748	.03	1,640
2	(5,102)	0.10	510	(22,971)	0.10	2,300	(22,971)	0.10	2,300	51,047	.10	5,110
3	(2,859)	1.00	2,860	(11,658)	3.60	41,970	(12,978)	3.10	40,260	27,495	3.10	85,060
4	4,308	1.00	4,310	17,527	3.60	63,100	19,487	3.10	60,410	41,332	3.10	127,810
5	931	1.00	930	7,502	2.00	15,000	9,291	3.80	35,310	17,724	2.89	51,240
6	2,225	1.35	3,000	3,493	3.60	12,570	7,739	3.10	23,990	13,457	2.94	39,570
7	0	-	-	1,349	2.00	2,700	2,698	3.80	10,250	4,047	3.20	12,950
8	4,589	1.00	4,590	6,293	3.60	22,650	11,363	3.10	35,230	22,245	2.81	62,470
9	1,986	2.70	5,360	5,348	1.20	6,420	5,336	3.40	18,140	12,670	2.36	29,920
10	1,444	1.00	1,440	14,641	2.00	29,280	9,698	3.80	36,850	25,783	2.62	67,580
11	(884)	1.00	880	(5,307)	2.00	10,610	(2,653)	3.80	10,080	8,844	2.43	21,570
Σ			24,040			207,560			273,350			504,930
ΣΣ = 504,930 ÷ 1.27g/fry = 397,600 ≈ 400,000 fry												

<u>Criss Creek</u>	TOTAL AREA	BIOMASS/m ²	TOTAL BIOMASS
1	19,877	1.56	31,000
2	36,397	1.56	56,780
3	30,055	1.56	46,890
Σ			134,670g ÷ 1.27g/fry = 106,000 ≈ 100,000 fry

TABLE 3(b) Deadman River standing crop calculations - Rainbow parr

REACH #	POOLS			RIFFLES			GLIDES			TOTAL		
	AREA	BIOMASS/ m ²	TOTAL BIOMASS	AREA	BIOMASS/ m ²	TOTAL BIOMASS	AREA	BIOMASS/ m ²	TOTAL BIOMASS	AREA	BIOMASS/ m ²	TOTAL BIOMASS
Deadman River												
1	5,256	0.75 ^a	3,942	31,973	0.9 ^a	28,776	17,519	0.9 ^a	15,767	54,748	0.89	48,485
2	(5,102)	(1.50)	7,653	(22,971)	(1.85)	42,496	(22,971)	(1.85)	42,496	51,047	1.81	92,654
3	(2,859)	(2.00)	5,718	(11,658)	(0.70)	8,161	(12,978)	(1.00)	12,978	27,495	0.98	26,857
4	4,308	2.0	8,616	17,527	0.70	12,269	19,487	1.0	19,487	41,322	0.98	40,372
5	931	6.5	6,052	7,502	1.85	13,879	9,291	1.85	17,188	17,724	2.09	37,119
6	2,225	2.15	4,784	3,493	2.70	9,431	7,739	1.80	13,930	13,457	2.09	28,145
7	0	-	0	1,349	1.85	2,496	2,698	1.85	4,991	4,047	1.85	7,487
8	4,589	2.15	9,866	6,293	0.6	3,776	11,363	1.1	12,499	22,245	1.18	26,141
9	1,986	0.2	397	5,348	0	0	5,336	0	0	12,670	0.03	397
10	1,444	0.85 ^a	1,227	14,641	0.9 ^a	13,177	9,698	0.9 ^a	8,728	25,783	0.90	23,132
11	884	(0.85) ^a	751	(5,307)	(0.9) ^a	4,776	(2,653)	(0.9) ^a	2,388	8,844	0.89	7,915
Σ			49,006			139,237			150,452			338,704
ΣΣ			338,700g @ 75% 1+ ^b = 254,000g ÷ 13.04g/fish = 19,480 1+									
			@ 25% 2+ ^b = 84,700g ÷ 40.82g/fish = 2,070 2+									

at least 12%

Criss Creek	TOTAL AREA	1+		2+		3+	
		BIOMASS/m ²	TOTAL BIOMASS	BIOMASS/m ²	TOTAL BIOMASS	BIOMASS/m ²	TOTAL BIOMASS
1	19,877	3.23 ^c	64,203	1.9	37,770	0.4	7,950
2	36,397	3.23 ^c	117,562	1.9	69,150	0.4	14,560
3	30,055	3.23 ^c	97,078	1.9	57,100	0.4	12,020
	ΣBiomass		278,843		164,020		34,530
	weight/fish		7.90		26.94		38.47
	ΣNumbers		35,286		6,090		900

^a because of suspected undersaturated conditions predicted values were halved.

^b based on sampled biomass ratio of 1+ to 2+ in the population estimates.

^c this value used because of suspected inflation of the 7.32g/m² of 1+ sampled at site 1, due to a barrier to downstream migration.

TABLE 3(c) Deadman River standing crop calculations - chinook and coho.

REACH	POOLS			RIFFLES			GLIDES			TOTAL		
	AREA	BIOMASS(g)/ m ²	TOTAL BIOMASS(g)	AREA	BIOMASS(g)/ m ²	TOTAL BIOMASS(g)	AREA	BIOMASS(g)/ m ²	TOTAL BIOMASS(g)	AREA	BIOMASS(g)/ m ²	TOTAL BIOMASS(g)
<u>Deadman River</u>												
1	5,256	.3	1,580	31,973	.15	4,800	17,519	.1	1,750	54,748	0.15	8,130
2	(5,102)	(.3)	1,530	(22,971)	(.15)	3,450	(22,971)	(.1)	2,300	51,047	0.14	7,280
3	(2,859)	(.35)	1,000	(11,658)	(.20)	2,330	(12,978)	(.2)	2,600	27,495	0.22	5,930
4	4,308	(.35)	1,500	17,527	(.20)	3,500	19,487	.2	3,900	41,322	0.22	8,900
5	931	5.0	4,660	7,502	.20	1,500	9,291	.2	1,860	17,724	0.45	8,020
6	2,225	.4	890	3,493	.60	2,100	7,739	.3	2,320	13,457	0.39	5,310
7		-	0	1,349	.60	810	2,698	.3	810	4,047	0.40	1,620
8	4,589	.4	1,840	6,293	.20	1,260	11,363	.2	2,270	22,245	0.24	5,370
9	1,986	-	0	5,348	0	0	5,336	0	0	12,670	0	0
10	1,444	-	0	14,641	-	0	9,498	-	0	25,783	0	0
11	(884)	-	0	(5,307)	-	0	(2,653)	-	0	8,844	0	0
Σ			13,000			19,750			17,810			50,560

ΣΣ = 50,560g ÷ 3.71g/fish = 13,630 chinook & coho

	n	mean length	k	mean weight
chinook	112	69.8	1.10 x 10 ⁻⁵	3.74g
coho	22	66.1	1.20 x 10 ⁻⁵	3.47g
mean	134	69.2	1.12 x 10 ⁻⁵	3.71g

$$n \text{ chinook} = 13,630 \times \frac{112}{134} = 11,400$$

$$n \text{ coho} = 13,630 \times \frac{22}{134} = 2,200$$

APPENDIX X Downstream migration of fish from the Deadman River, 1977 and 1978. All data reprinted from Starr (1979).

Albuquerque, NM
1979

Table 17. Total Downstream Migration by Species for the Periods July 22 to October 13, 1977 (83 days) and July 13 to September 19, 1978 (68 days) in Deadman River

	Total Migration		Average Daily Migration		Peak Daily Migration		Date of Peak Migration	
	1977	1978	1977	1978	1977	1978	1977	1978
<u>Chinook pre-smolts</u> (<u>Oncorhynchus tshawytscha</u>)	8,525	5,352	103	79	440	350	Sept 8	Sept 6
Rainbow 0+	52,826	59,609	636	877	3,383	7,673	Sept 25	Sept 5
<u>Rainbow 1+</u> (<u>Salmo gairdneri</u>)	9,480	16,140	114	237	570	772	Sept 25	Aug 16
<u>Coho pre-smolts</u> (<u>Oncorhynchus kisutch</u>)	119	72	1.4	1.1	8	6	Aug 3	July 26
<u>Sucker</u> (<u>Catostomus sp.</u>)	766	1,241	9.2	18.3	92	82	July 24	July 14
<u>Squaw fish</u> (<u>Ptychocheilus oregonensis</u>)	1	4	0.01	0.1	1	1	Aug 19	July 25
<u>Rocky-mountain whitefish</u> (<u>Prosopium williamsoni</u>)	201	181	2.4	2.7	38	35	Aug 10	July 28
<u>Brook lamprey</u> (<u>Lampetra richardsoni</u>)	9	34	0.1	0.5	2	9	Aug 21	July 14
<u>Pacific lamprey</u> (<u>Entosphenus tridentatus</u>)	3	18	0.04	0.3	1	4	Aug 19	July 14
<u>Sculpin sp.</u> (<u>Cottus sp.</u>)	18	16	0.2	0.2	8	4	Oct 5	July 14
<u>Burbot</u> (<u>Lota lota</u>)	1	2	0.01	0.03	1	1	Aug 15	Aug 26
<u>Red-side shiner</u> (<u>Richardsonius balteatus</u>)	0	2	-	0.03	-	1	-	July 26
<u>Dace</u> (<u>Rhinichthys. sp.</u>)	0	3	-	0.04	-	1	-	July 19
<u>Brook trout</u>			0.01			1		Sept 12

Appendix VIIa. Average size of migrant chinook pre-smolts and yearling rainbow trout captured at the weir in Deadman River over the period July 26 to October 8, 1977. Growth rates by length and correlation coefficients are weighted by the number of fish measured on each date.

Date	CHINOOK			RAINBOW TROUT		
	No. Fish	Mean fork length (mm)	95% Conf. Limits (mm)	No. Fish	Mean fork length (mm)	95% Conf. Limits (mm)
Jul 26	-	-	-	25	106.4	6.2
Jul 29	100	65.3	1.1	50	120.6	4.3
Aug 4	50	64.6	1.5	73	117.9	3.6
Aug 13	50	66.6	1.3	100	116.8	3.7
Aug 19	50	67.1	1.6	130	117.5	4.0
Aug 26	117	70.2	1.1	124	120.3	3.3
Sep 3	75	69.7	1.5	73	118.2	3.7
Sep 9	100	69.8	1.2	78	120.0	4.3
Sep 17	79	72.3	1.8	73	119.0	4.3
Sep 24	100	73.8	2.2	111	118.3	3.3
Oct 1	88	74.1	1.8	96	112.6	3.5
Oct 8	100	71.2	1.5	57	119.5	5.6
% growth rate (%/day)		0.167 (±.005)			-.003 (±.007)	
Arithmetic growth rate (mm/day)		0.119 (±.038)			-.003 (±.008)	
Corr. coefficient		0.901 (P=.01)			-.022 (n.s.)	

Appendix VIib. Average size of 1978 migrant chinook pre-smolts and yearling rainbow trout captured at the 2 x 3 floating trap (April dates) and the juvenile weir (July - September dates) in Deadman River. Growth rates by length and correlation coefficients are weighted by the number of fish measured on each date and are computed for the summer dates only.

Date (1978)	Chinook			Rainbow Trout		
	No Fish	Mean Fork Length (mm)	95% Conf Limits (mm)	No Fish	Mean Fork Length (mm)	95% Conf Limits (mm)
Apr 18	100	86.1	1.2	191	76.9	2.1
25	11	29.6(1)	1.2	196	76.8	1.9
26	93	86.5	1.3	-	-	-
July 17	75	64.6	1.4	-	-	-
24	91	67.5	1.1	100	113.7	3.5
31	75	66.1	1.2	125	118.4	3.6
Aug 1	30	67.3	1.9	25	117.6	8.7
8	33	68.0	1.7	100	117.6	3.4
15	62	71.5	3.2	84	121.6	4.8
22	98	70.5	1.3	121	116.8	3.7
29	91	77.5	1.5	130	118.0	3.0
Sept 5	64	75.6	1.4	100	114.7	3.3
12	114	76.3	1.1	101	114.9	4.7
19	69	79.5	1.5	81	127.3	4.5

% Growth Rate (July-Sept dates only) : 0.314 (\pm 0.007) 0.051 (\pm 0.010)

Arith. Growth rate (mm/day) (July-Sept dates only) : 0.224 (\pm 0.005) 0.063 (\pm 0.012)

Correlation coefficient : 0.950 (p = .01) 0.306 (p = .01)

(1) Lengths are taken from preserved fish and may not be representative