ASSESSMENT OF STEELHEAD ENHANCEMENT OPPORTUNITIES IN THE MORICE RIVER SYSTEM. PROGRESS IN 1980.

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ABSTRACT

Juvenile salmonid populations in two tributary streams to the Morice River system, Owen and Lamprey Creeks, were assessed by the Fish Habitat Improvement Section in the fall of 1980. Objectives were directed at steelhead enhancement opportunities in the two known steelhead spawning streams. Limited sampling was conducted at other locations within the Morice system (Gosnell Creek, Morice mainstem side channels) to put Owen and Lamprey Creeks into perspective in terms of the whole of the Morice River steelhead population. Sampling indicated that Owen and Lamprey Creeks were very important as spawning and early (1-2 year) rearing areas for steelhead. The lack of older juveniles indicated that juvenile steelhead migrate from these streams to the Morice River for rearing to smolt stage. Enhancement opportunities relating to maximum production of yearling migrants to the Morice River are discussed. The major steelhead enhancement opportunity applicable to the Morice system at this time is seen as fry stocking, based on annual monitoring of fry recruitment at index sites. The recommendation that carrying capacity analysis be expanded to include the entire Morice River system is made.

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1.0 INTRODUCTION

Previous investigations relating to Morice River steelhead enhancement, including radio tagging, have shown that small tributaries of the Morice River provide spawning habitat for a large portion of the steelhead population. Two streams identified as having major significance are Owen and Lamprey Creeks. At the request of Region 6 fisheries staff, the Fish Habitat Improvement Section (F.H.I.S.) conducted a detailed biophysical reconnaissance of Owen and Lamprey Creeks. This involved a detailed habitat evaluation and intensive fish population estimates. Two other areas were sampled, Gosnell Creek and some Morice River sidechannels, in an attempt to put Owen and Lamprey into perspective with the Morice system as a whole. Objectives of this assessment were to provide detailed information on the life history and carrying capacity of juvenile steelhead in Owen and Lamprey Creeks, and to provide recommendations for enhancement. The field program was conducted September 1 to 8, 1980.

The report presented at this time basically represents a summary report in terms of data presentation and analysis. Due to time constraints, no major report in the traditional sense will be prepared.

2.0 LAMPREY CREEK

Lamprey Creek was assessed from the Morice confluence to the Lamprey Lake outlet, including all tributaries (Fig. 1). A total of 18 population estimates were conducted following standard F.H.I.S. techniques (see Stuart, 1981).

2.1 Habitat Description

A brief description of basic reach characteristics is outlined here. Six reaches were identified in Lamprey Creek. Table 1 summarizes reach and tributary habitat data, complete data are included in Appendix 1.

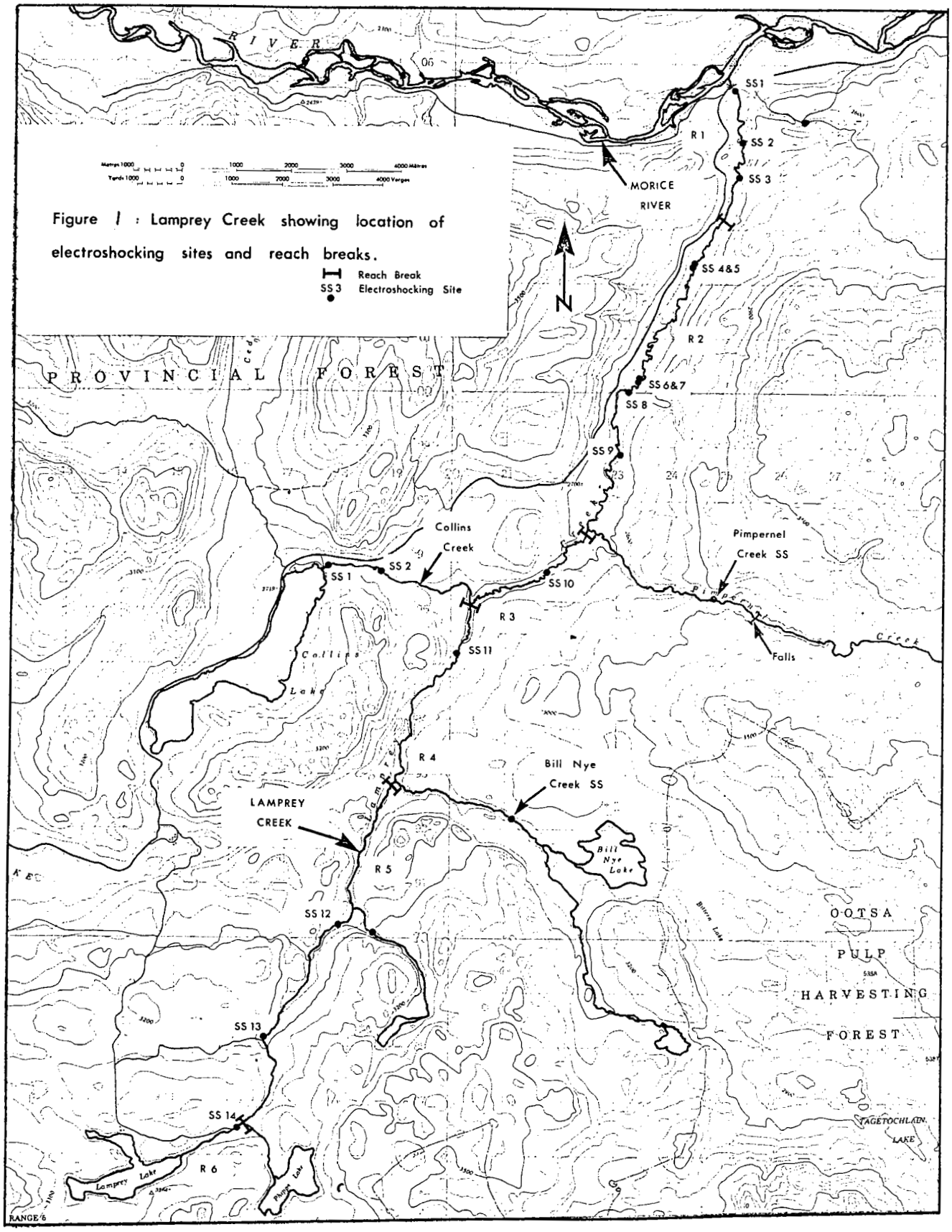

Figure 1 : Lamprey Creek showing location of electroshocking sites and reach breaks.

Reach Break

SS 3 Electroshocking Site

TABLE 1 Lamprey Creek reach breaks and tributary data. Complete data in Appendix 1.

REACH	APPROX. LENGTH (km)	APPROX. GRADIENT[a]	SAMPLE SITES	HABITAT TYPE % POOL	% GLIDE	% RIFFLE	MAJOR SUBSTRATES	ESTIMATED DISCHARGE (m^3/s)	COVER TYPE	MEAN WIDTH (m)	TOTAL AREA (m^2)
Lamprey Creek											
1. Morice - 29.5 mile	3.25	0.9% (0.5-3.0; $\bar{x}$=1.7)	1, 2, 3	6 (canyon like)	39	55	C, B, LG	.38	B, L	9.1	29,600
2. mile 29.5 - Pimpernel	8.3	0.5% (0 -1.5; $\bar{x}$=0.7)	4, 5, 6, 7, 8, 9	74 (some beaverdams)	18	8	SG, F, LG	.25 in lower .04 in upper	L, IV	5.3	43,800
3. Pimpernel - Collins	3.15	0.5% (0.3)	10	91 (beaverdams)	6	3	F, LG, SG	-	OV, L, C	7.8	24,700
4. Collins - Bill Nye	4.15	1.3% (2.0)	11	31	57	12	SG, LG, F	.04	L, C	2.8	11,800
5. Bill Nye - Phipps	7.6	1.8% (0.5)	12, 13	92 (some beaverdams)	2	6	F, C, LG	.05	OV, IV, C	3.0	22,600
6. Phipps - Lamprey Lake	2.7	1.4% (1-2; $\bar{x}$=1.5)	14	48	0	52	SG, F, LG	.05	OV, L	1.5	4,000
Tributaries											
T1 to lake	2.3	4.6% (5)	T1	58	13	29	LG, C, B	<.01	OV, C	0.9	2,100
Pimpernel to falls	4.0	3.2% (2.5)	1		65	35	LG, SG, C	.13	L, B, C	4.4	17,800
Collins to lake	3.25	2.2% (0.5-2; $\bar{x}$=1.1)	1, 2	90 (some isolated pools)	2	35	SG, F, LG	<.01	OV, L	1.8	5,950
Bill Nye to fork	3.15	1.4% (0.5)	1	98	0	2	F, SG, LG	<.01	L, C, IV	4.9	15,600
T5 to lake	2.85	3.9% (5.5)	1	64	10	26	SG, LG, F	<.01	OV, L	1.2	3,450
Phipps to lake	1.2	4.3%		(isolated pools)							

[a] map measured; sampled in brackets

Reach 1 of Lamprey Creek extends from the Morice confluence upstream through a relatively steep walled "canyon" area for 3.25km. This area was of moderate to high gradient with cobble and boulder substrates, and boulder cover type. Mean stream wetted width was roughly 9m. Reach 2, a moderate to low gradient area with some beaverdam activity, covered roughly 8.3km up to the Pimpernel Creek confluence. Substrates were mainly small gravels and fines, and mean wetted width was 5.3m. Reach 3, between Pimpernel and Collins Creeks, was a very low gradient, slow flowing area with abundant beaver dams. Substrates were mainly fines with gravel, and wetted width was 7.8m. The greater wetted width despite similar or lower discharge was due to the ponding effect of beaverdams. Above Collins Creek, Lamprey Creek becomes quite a small stream. Reach 4, from Collins to Bill Nye had a wetted width of only 2.8m. Gradient was higher at 1.3 to 2%, with stream characteristics being small glide and pool areas with abundant log cover. Substrates were gravels and fines. Reach 5, above Bill Nye, becomes more enclosed with overhanging vegetation. Beaver activity was somewhat more pronounced, though habitat remained pool-riffle with small substrate and abundant instream cover. Reach 6, to Lamprey Lake, was similar, though gradient was greater.

The major tributary in terms of flow (and effects on fish habitat) was Pimpernel Creek. Lamprey Creek was a much larger, more "salmonid type" stream below Pimpernel. Pimpernel itself, up to the falls 4.0km upstream of Lamprey, was a fairly high gradient stream with good salmonid rearing qualities. T1, T5 and Phipps Creeks were unimportant. All were fairly high gradient with very small flow volumes. Collins Creek also had very low discharge, particularly in the area near Collins Lake where isolated pools existed. Lower Collins was more suitable for salmonid rearing.

2.2 Fish Sampling

In this section, all aspects of sportfish populations including distribution, abundance, age/growth, etc. will be discussed. Species of fish captured in Lamprey Creek included rainbow trout (resident and steelhead), cutthroat trout, Dolly Varden, coho, mountain whitefish, longnose dace, suckers and pacific lamprey. Complete data regarding population estimates, sample site habitat descriptions, scale analysis, condition

factor, etc. are included in Appendix 2. Table 2 outlines distribution and sampled abundance of sportfish in sample sites.

2.2.1 Coho

Juvenile coho salmon were found only in Reach 1 and at the lowest site in reach 2. In this area, density ranged from 0.01 to 0.58/m^2 with a mean of 0.33/m^2. Habitat with high coho density included glide-riffle near the Morice confluence (site 1) and pool habitat (site 4). Lower densities were found in shallow glide-riffle areas.

Ages of coho included 0+ and 1+; 108 of 113 (96%) captures were 0+. Mean fry size was 60.2mm; mean yearling size was 87.6mm.

Assuming coho distribution was restricted to the sampled range (roughly 4.75km up to site 4), total standing crop was roughly 11,625 (30.5kg) coho fry and 750 (6.05kg) coho yearlings. Assuming 100 smolts/kg (S.E.R.C. 1980) roughly 3,650 smolts may be produced, for an estimated adult escapement of 240 (Appendix 3a). Whether this represents the total escapement to Lamprey Creek is not known; many juveniles (fry) may out-migrate soon after emergence to rear in the Morice, most yearling coho requiring further freshwater rearing may downstream to the Morice, and some juveniles may migrate into Lamprey Creek from the Morice. Low flows in the fall are likely the restrictive factor in coho distribution up Lamprey Creek (likely impassable beaverdams). Substantial beaver activity begins in reach 2, thus restricting coho to reach 1 and lower reach 2.

2.2.2 Dolly Varden

Dolly Varden were not numerous in Lamprey Creek. They were found only at one site in the lower stream area (site 4, reach 7) and in reaches 4 and 5 (sites 11, 12 and 13). In tributaries, Dolly Varden were found only at Bill Nye and T5 sample sites. Too few were captured for any discussion of mean size of age groups and standing crop.

TABLE 2 Sportfish distribution and abundance (no./m^2) in the Lamprey Creek watershed, September 1 to 8, 1980.

REACH	SITE	RAINBOW			COHO		DOLLY VARDEN		CUTTHROAT	
		0+	1+	2+	0+	1+	0+	1+	$\bar{>}$0+	$\bar{>}$1+
1	1	.32	.10	0	.56	.02				
	2	.08	.07	.01	.18	.02				
	3	.28	.13	.01	.01	0				
	$\bar{x}$	.23	.10	.01	.25	.01				
2	4	.70	.44	.05	.49	.03	0	.03		
	5	.29	0	0	0	0	0	0		
	6	.14	.26	.02	0	0	0	0		
	7	.48	0	0	0	0	0	0		
	8	.49	.11	.01	0	0	0	0		
	9	.43	.04	0	0	0	0	0		
	$\bar{x}$	.42	.14	.01	.08	<.01	0	<.01		
3	10	.39	.12	0	0	0	0	0	0	.02
4	11	.12	.17	0	0	0	.03	.01	.08	.03
5	12	0	0	0	0	0	.07	.09	.27	.25
	13	.33	.36	.03	0	0	0	.20	0	0
	$\bar{x}$	.17	.18	.02	0	0	.04	.15	.14	.13
6	14	2.41	.37	0	0	0	0	0	0	0
Tributary 1									2.46	.37
Pimpernel		.51	.19	0						
Collins	1	0	0	0					3.27	0
	2	0	.07	0					1.66	.23
	$\bar{x}$	0	.04	0					2.47	.12
Bill Nye		.67	.26	0			.03	0	0	.09
Tributary 5							.08	.60	1.36	.38

2.2.3 Cutthroat

Cutthroat trout were present in all tributaries except Pimpernel Creek, and in the middle reaches of Lamprey Creek (sites 10, 11 and 12 in reaches 3, 4 and 5). Cutthroat populations seemed to be restricted to stream areas where rainbow trout were not abundant. Competition from rainbow, whether resident or anadromous, appears to set both upper (lake resident rainbow) and lower (steelhead) limits of distribution.

Cutthroat density was very high in some tributaries, up to 3.27 fry/m^2 in upper Collins Creek and 2.46 fry/m^2 in T1. Both Collins and T1 lakes were cutthroat lakes. As indicated, no cutthroat were found in Pimpernel Creek and low densities were found in Bill Nye Creek. In the mainstem, cutthroat were most abundant at site 12 in reach 5; no cutthroat were found at upstream sample sites as rainbow had taken over. Reach 4, site 11 had low densities of both cutthroat and rainbow. Below this point (in reach 3) cutthroat were rare.

Age groups present in mainstem and tributary sites were mainly fry and 1+; only one 2+ cutthroat was captured. Mean fry size ranged from 38.9 to 51.2mm in tributary samples, and from 38.4 to 53.2 in mainstem samples.

2.2.4 Rainbow

In the Lamprey Creek watershed, rainbow trout appear to be of two stocks; resident and anadromous. Resident rainbow distribution is centered in Lamprey, Phipps and Bill Nye Lakes and associated stream areas. Steelhead distribution covers the lower mainstem, probably up to and including lower Bill Nye Creek, lower Collins Creek and Pimpernel Creek.

2.2.4.1 Resident rainbow

Resident rainbow distribution in the Lamprey Creek watershed covered the area downstream from Lamprey Lake to between sites 12 and 13

in reach 5, and Bill Nye and Phipps Creeks. These areas are likely recruitment sites for the headwater lakes. Steelhead/resident division is apparent because of areas with relatively high cutthroat density and very small or non-existent rainbow population between the lower (steelhead) and upper (lake rainbow) population centers.

Age groups of resident rainbow present in fish samples included fry, yearlings and one two-year-old. Mean size of fry was 43.6mm, ranging from 40.3mm at site 14 below Lamprey Lake to 47.7mm in Bill Nye Creek. Densities, which ranged up to 2.41 fry/m^2 and 0.39 parr/m^2 are probably highly dependent on proximity to the parent lakes.

2.2.4.2 Steelhead

Juvenile steelhead were present throughout Lamprey Creek up to near Bill Nye Creek, in Pimpernel Creek up to the falls, in lower Collins Creek, and possibly in lower Bill Nye Creek. The major portion of the steelhead population was present throughout reaches 1, 2 and 3 and Pimpernel Creek. Sampled density was significantly lower in reach 4 of Lamprey Creek (site 11), and considering the increasing cutthroat population, this site is probably nearing the upper limits of the steelhead range.

Age groups of juvenile steelhead captured included 0+ (70.0%), 1+ (28.3%) and 2+ (1.7%). Mean size of fry was 47.8mm; yearlings, 87.5mm and two year olds, 122.7mm. Densities at sample sites are outlined in Table 2.

Standing crop of juvenile steelhead was calculated on the basis of sampled fish density, sample site habitat and reach habitat characteristics (Appendix 3b). Total standing crop was estimated at 211kg, or roughly 44,800 (68.6%) fry, 19,300 (29.6%) yearlings and 1,100 (1.7%) two year olds. These figures are roughly equal to direct sampling results, indicating that sample sites were basically representative of available habitat.

2.3 Juvenile Steelhead Life History/Population Dynamics

Whately et al (1978) found that adult Morice River steelhead had spent two (0.2%), three (23.5%), four (69.9%) and five (6.4%) winters in

freshwater before migrating seaward. Because steelhead juveniles present in Lamprey Creek were virtually all fry or yearlings, it is clear that later stages of rearing to smolt formation (2+ through 4+) occur in the Morice River. Lamprey Creek, and perhaps other tributaries, are used as a site for spawning and rearing to the two-year-old stage. Any enhancement targets must be set at maximizing yearling and two-year-old recruitment to the Morice.

Bustard (1981-2, in prep.) has suggested that many juvenile steelhead leave tributaries in the late summer/fall period to overwinter in the Morice River. In spring, juveniles may migrate into the tributaries in response to higher stream temperatures. The extent to which this may occur in Lamprey Creek is unclear. Overwinter habitat may be limited (in terms of flow volume) in reach 1 (3.15km) but throughout reaches 2, 3 and 4 was considered good because high pool habitat representation (reach 2 - 75% pool, reach 3 - 91% pool, reach 4 - 31% pool as opposed to reach 1 - 6% pool; Appendix 1). Fall migrations out of reach 2 and areas above are considered unlikely. Immigration of juveniles may occur in spring, but beaver activity may restrict these to reach 1 and lower reach 2.

Calculated standing crop estimates suggest a very high ratio of yearlings to fry. Assuming a closed system (no migrations in or out) and a steady state (equal yearling recruitment), survival from fall fry to fall 1+ was 43%. Although this is an extremely high value in comparison to generally accepted survival rates (density dependent, in the 5 to 15% range), it is consistent with rates determined for coho in stable streams containing pools and beaver ponds (eg. Carnation Creek data).

The reasons for this apparent high survival rate could be many, including (i) migration of yearlings into Lamprey Creek from the Morice, (ii) low fry recruitment in 1980 relative to 1979, or (iii) a truly high survival rate. Immigrations will not be considered, as regardless of where the fish overwinter, they remain a component of the Lamprey Creek population. A combination of fry recruitment fluctuations and a high survival rate (per year class) are considered to be the major influences.

Steelhead fry recruitment in 1980 must have been low in comparison to 1979. Assuming 20% fry to 1+ survival, more than twice the sampled fry

numbers (about 96,000) would be required to produce the observed fall 1+ population. Mean sampled density of 0.35 fry/m^2 (Appendix 3b) is low when compared to suggested optimum densities. S.E.R.C. (1980) recommends for high TDS, high complexity streams an optimum fry density of 0.7 fry/m^2, twice that sampled in Lamprey Creek in 1980.

Whether the sampled results represent saturation or not is another question. Clearly mean fry population density in 1980 was well below optimum levels (optimum meaning requirement to produce maximum at limiting phase). Looking at individual sites (or reaches) lowest fry density occurred throughout reach 4 (0.12/m^2). Other reaches were basically near the 0.35/m^2 average. Mean yearling density of 0.15/m^2 is relatively high when compared to other sampled streams, although higher densities are common (eg. Silverhope Creek 0.205 - 1+/m^2, Griffith, 1980; Prudhomme Creek 0.22 parr/m^2, Tredger, 1981). What this mean density represents in terms of saturation for Lamprey Creek is not known, as all streams differ in carrying capacity. This can be tested only under saturated conditions.

2.4 Lamprey Creek Steelhead Enhancement

Recommendations for enhancement of Morice River steelhead via Lamprey Creek basically amount to fry stocking. Other options, including flow control, will be discussed.

2.4.1 Enhancement objectives and benefits

As determined by Lamprey Creek, habitat quality and juvenile steelhead life history, objectives of enhancement in Lamprey Creek would be to increase recruitment of older juveniles (mainly 2 year olds) to the Morice River. Direct smolt yield will not occur from Lamprey Creek. Benefits from any enhancement must therefore consider mortality in the Morice River prior to smolting. At this point the assumption is made that the limiting phase in Morice River smolt production occurs at the 0+ and 1+ stages; 2+, 3+ and 4+ habitat is assumed plentiful and under-utilized. This may be totally mistaken, but at this time we have no data to prove the point

either way (we have no way to collect this information in the short term either).

If we assume survival rates of 50% 1+ to 2+, 80% 2+ to 3+ and 80% 3+ to 4+, then the 19,000 yearlings in Lamprey Creek should result in 6,180 Morice steelhead smolts (Appendix 3b). This equals about 0.3 smolts per late summer 1+.

2.4.2 Flow control

The idea of flow control at Collins Lake has been considered as a potential enhancement technique. Rationale was to increase winter flow to improve overwinter survival (Lough, 1980). In light of results presented in this report (good overwinter habitat and high apparent fry to yearling survival) this is not recommended as a high priority. Winter habitat may be increased in Collins Creek and in reach 1 by this technique. Assuming a density of 0.15 yearlings/m^2, flow control might increase yearling numbers by 1,960, translating into 590 smolts and an additional escapement of 20 steelhead adults (Appendix 4). This project might have a major impact on the Collins Lake cutthroat trout, as steelhead might outcompete cutthroat in upper Collins Creek, wiping out the only apparent recruitment site for Collins Lake.

2.4.3 Fry stocking

Fry population in 1980 was estimated at roughly half the requirement for maintenance of the observed yearling population. Obviously fry recruitment is changeable on an annual basis. Above the "main stream" of steelhead population (above Collins Creek) viable steelhead habitat was present but appeared to have very low fry recruitment in 1980. Morris and Eccles (1975) cite a local report of steelhead observed at the road crossing above site 12 (reach 5). Sampling in 1980 found no evidence of steelhead juveniles in this area. Good (though small stream) rearing habitat was available in reach 5, and offers potential for overwinter survival as evidenced by the cutthroat population. Adult access to this area

is likely the major problem.

Recommendations for fry stocking, therefore, include extending the range of steelhead recruitment to reach 5 and ensuring that adequate recruitment occurs in all areas annually. Extension of the range to include reach 5 would increase smolt yield by 1,260, and escapement by approximately 50 adults (Appendix 4). Adequate recruitment to all areas (at 0.70 fry/m^2) would ensure the maintenance of the yearling population (0.15/m^2), smolt yield and escapement at 1980 levels. Without adequate recruitment, smolt yield and escapement may fluctuate by as much as 50% (270 to 540 escapement given 0.35 and 0.70 fry/m^2 respectively; Appendix 4). This rate of fluctuation is consistent with other documented values (Burns, 1971; Glova and Mason, 1976) and is related to escapement/recruitment fluctuations.

Both fry stocking options are dependent on the annual range and magnitude of steelhead recruitment. This should be checked through an annual monitoring program prior to any fry release. This information can be used to select the areas which require additional fry. Unfortunately there is no lead time in terms of having fry on hand for such a stocking program. Fry should be available for this purpose annually; perhaps in conjunction with other Morice tributaries.

3.0 OWEN CREEK

Owen Creek was assessed from the Morice River upstream to Owen Lake. Owen Lake tributaries were also investigated. A total of 9 mainstem and 1 tributary sample sites were conducted (Fig. 2).

3.1 Habitat Description

Owen Creek was divided into 6 reaches from the Morice River to Owen Lake. Reach designation is similar to that given by Schultze (1980), but reaches 1 and 2 were combined as a single reach in this report. A brief summary of habitat parameters is given in Table 3; complete habitat data is included in Appendix 5.

Habitat in Owen Creek is composed of areas of moderate gradient riffle-glide and areas of slough with beaver activity. Reaches 1 and 2 (Morice to 4.8 km) contain moderate gradient habitat with abundant gravels and a high percentage of glides. Reach 2 (0.85 km) is a somewhat more confined canyon type reach. Reach 3 forms an extemsive "slough" area with a large amount of beaver activity. Reach 4 is a combination glide-pool-riffle area with extensive instream log debris and some patches of gravel. Reach 5 was of relatively low gradient with extensive beaver activity and combination beaver pond-glide riffle habitat. Reach 6, to Owen Lake, was a riffle glide environment with small gravel (angular) substrates. Stream discharge was much lower at sites 8 and 9, probably because of the influence of Puport Creek.

3.2 Fish Sampling

Fish species captured in Owen Creek included rainbow trout (resident and anadromous), Dolly Varden, mountain whitefish, coho salmon, sculpins, suckers, northern squawfish and pacific lamprey. Complete distribution and density information is included in Appendix 6; a summary is given in Table 4.

Table 3 Summary of Owen Creek reach habitat characteristics.

REACH	APPROX. LENGTH (km)	APPROX. GRADIENT (MEASURED)	SAMPLE SITES	HABITAT TYPE			MAJOR SUBSTRATES	ESTIMATED DISCHARGE (m^3/s)	COVER TYPE	MEAN WIDTH (m)	TOTAL AREA (m^2)
				% POOL	% GLIDE	% RIFFLE					
1. Morice R.	3.95	1.2%	1, 2, 3	7	67	26	SG, F, LG	0.75	L, C, OV	6.9	27,320
2.	0.85	1.5%	4	0	82	18	LG, C, SG	0.8	L, OV, B	10.0	8,490
3.	1.70	≈0.0%	5	100 (beaver activity)	0	0	F (slough)	0.6	IV, OV, L	75	127,500
4.	1.0	0.5%	6	19	64	17	F, SG, LG	0.6	L, C, OV	9.2	9,248
5.	4.65	1.0%	7	39 (beaver activity)	46	15	SG, F, LG	0.7	OV, L, C	8.7	40,529
6. to Owen Lake	1.6	>0.5%	8, 9	36	42	22	LG, SG, F (angular gravels)	0.1	OV, L, C	3.2	5,091
Klate Creek	4.06	2.5%	10	4	37	59	SG, F, LG	0.02	OV, L	2.2	8,864

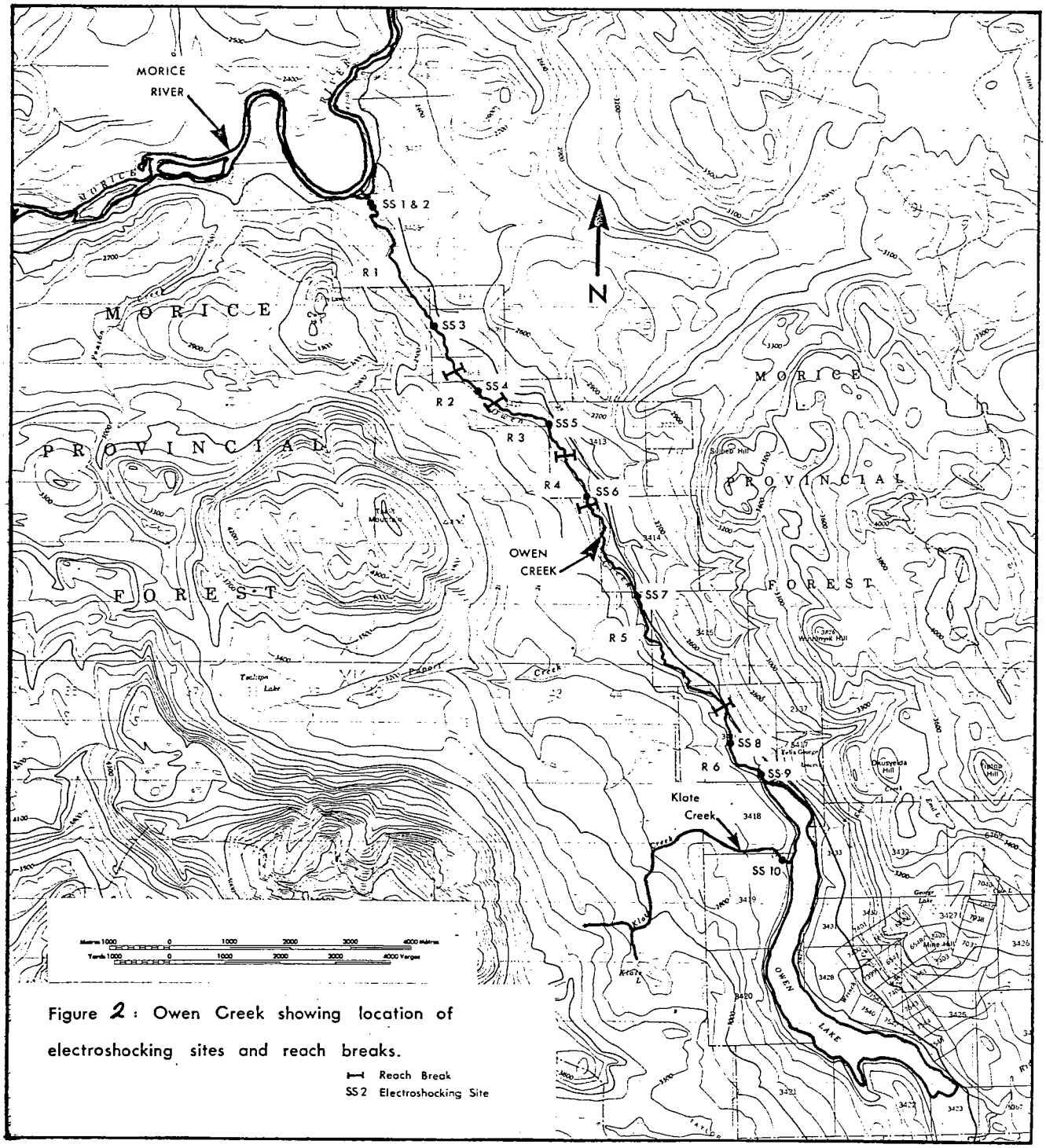

Figure 2 : Owen Creek showing location of electroshocking sites and reach breaks.

TABLE 4 Summary of Owen Creek fish sampling results.

REACH	SITE	RAINBOW			COHO		DOLLY VARDEN		OTHER	
		0+	1+	2+	0+	1+	0+	≥1+		
1	1	.78	.18	0	.25	0	0	.02	-	
	2	.37	.02	0	.08	0	0	0	-	
	3	.78	.11	0	.08	0	.04	0	m. whitefish	.04
2	4	.52	.14	0	0	0	0	0	m. whitefish	.01
									suckers	.01
3	5	0	.06	.02	0	.14	0	0	-	
4	6	.16	.09	0	0	0	.05	.03	-	
5	7	.41	.22	.03	0	0	.01	.10	-	
6	8	.05	.01	.01	0	0	0	0	sculpins	.01
									suckers	.06
									squawfish	.18
	9	1.05	.04	0	0	0	0	0	sculpins	.88
Klate Creek		.39	.29	0	0	0	.10	0	-	

3.2.1 Coho

Juvenile coho were found in 4 of 10 sample sites, extending into reach 3. Fry were found only in reach 1 with a mean density of $0.14/m^2$ (range .08 to $.25/m^2$). Coho yearlings were found at site 5 (reach 3) at $0.14/m^2$. No coho were found in reach 2, reach 4, or areas above. Based on this distribution, standing crop was estimated at 3,850 (7.9 kg) fry and 17,850 (216 kg) yearlings (Appendix 7). The yearling standing crop is very likely grossly overestimated. As was surmised for Lamprey Creek, low fall flows and beaver dams restricting adult access are likely the limiting factors in coho distribution. Juveniles may immigrate throughout the spring and summer periods. If estimates are accurate, then recruitment of the 1980 year class was very clearly low in comparison to the 1979 year class.

3.2.2 Dolly Varden

Dolly Varden were present at low densities throughout the majority of Owen Creek, but were absent from the slough habitat sample (site 5 reach 3) and from sites 8 and 9 near Owen Lake (reach 6).

3.2.3 Rainbow Trout

Rainbow were captured at all sample sites in the Owen Creek system. Both steelhead and lake resident stock are suspected of being present. Distribution of steelhead and lake stock is difficult to differentiate in this case as there is an area of overlap. Schultze (1980) indicates steelhead spawning up to roughly the top of reach 7 (about 2 km from the lake). Lake recruitment must also come from this area. A comparison of rainbow fry size in reaches 1 through 5 with sizes in reach 6 and Klate Creek indicates much smaller fry were present in reach 6 and Klate Creek (50.7 mm in reaches 1-5, 43.3 mm in reach 6 and Klate Creek; Appendix 6). For standing crop estimates, lake resident fish will be assumed to comprise half of the population in the area covering reach 6 and the upper half of reach 5. Lake tributaries, of which Klate Creek is the only major one, are assumed to contain resident stock.

3.2.3.1 Steelhead

Age groups of steelhead captured in Owen Creek included fry (78%), yearlings (21%) and two year olds (1%). Mean size of fry was 50.5 mm; yearlings, 92.0 mm and two year olds, 128.0 mm. Standing crop calculations (Appendix 7b) estimate 38,330 (63%) fry, 18,715 (31%) yearlings and 3,460 (6%) two year olds. Mean density over the whole of Owen Creek was 0.18 fry/m^2, 0.086 yearlings/m^2 and 0.016 two year olds/m^2. Total biomass was 285 kg.

3.3 Steelhead Life History and Population Dynamics

As in Lamprey Creek, the lack of older juveniles in Owen Creek suggests the primary importance of this stream lies in production of late fry, yearlings and perhaps two year olds. Significant out-migrations from Owen Creek of fry, 1+ and 2+ for rearing to 3, 4 and 5 year old smolts in the Morice River must occur annually. Enhancement targets must therefore be set on the basis of production of such migrants to the Morice.

Standing crop calculations again indicate a high instantaneous fry to yearling survival rate of 48% (assuming "steady state" recruitment and a closed system). As suggested for Lamprey Creek, low 1980 fry recruitment and truly high fry to yearling survival rates are suspected to explain the Owen Creek population structure.

Despite the high apparent survival from fry to yearling, both fry density and yearling density were relatively low in comparison to Lamprey Creek. Fry density averaged $0.18/m^2$ in Owen Creek compared to $0.35/m^2$ in Lamprey Creek and $0.70/m^2$ as a suggested optimum level (S.E.R.C. 1980). Similarly, yearling density averaged $0.086/m^2$ in Owen compared to $0.15/m^2$ in Lamprey. Carrying capacity for Owen (or Lamprey) is unknown, but is not expected to significantly differ from Lamprey Creek. For Owen Creek, low fry and yearling density may be an indicator of consecutive years of low recruitment.

3.4 Owen Creek Steelhead Enhancement

As in Lamprey Creek, enhancement objectives should be aimed at maximizing production of yearlings for recruitment to the mainstem Morice. Habitat for juvenile rearing (up to 2+) and for overwinter survival appeared good in Owen Creek due to abundant deep water areas. The probable major limiting factor in Owen Creek steelhead (yearling) production was fry recruitment.

3.4.1 Flow control

At present, deeper pool habitat (overwintering areas) is in short supply only in reaches 1 and 2. Assuming winter habitat is limiting in these reaches, then increased winter flow might increase yearling yield to the mainstem. In terms of summer carrying capacity, an increase from the present $0.10/m^2$ to $0.15/m^2$ in reach 1, and from $0.14/m^2$ to $0.15/m^2$ in reach 2 may be expected. This maximum density of 0.15 yearlings/m^2 is a guess based on Lamprey Creek sampling, and may not be correct. However, using this figure, increased yearling numbers in Owen Creek as a result of flow control are estimated at roughly 1,450, translating into about 435 smolts, 65 adults and 16 adult escapement (Appendix 8).

3.4.2 Fry recruitment

Because of the general similarities between Owen and Lamprey Creeks, it is reasonable to assume equal yearling density at saturation for these streams. Given full recruitment (optimum levels), Owen Creek should support a yearling population equal in density to that of Lamprey Creek (0.15 yearlings/m^2). On this basis, Owen Creek yearling numbers under full recruitment should amount to roughly 14,500 yearlings and subsequently 4,350 smolts and 160 adult escapement to the Morice system (Appendix 8).

Methods to bring about increased recruitment include fry stocking and spawning area improvements. Pinsent (1969) suggested the need for spawning area improvements at the outlet of Owen Lake. This is a good area for such a program because it is located at the highest possible recruitment point (downstream displacement of fry will seed areas below) and flows are probably relatively stable. Currently, angular substrates predominate in this area. Before a program of gravel addition (gravel platform construction) is undertaken, more knowledge of present gravel (spawning area) distribution and spring hydraulic conditions is required. Access for spawners to any enhanced area must be guaranteed. This may involve some limited beaver control in downstream reaches.

In order to bring fry recruitment up to optimum levels for yearling production, a fry stocking program should be considered. The greatest need is foreseen for middle and upper reaches (ie. 3, 4, 5 and 6). Required fry numbers, to bring mean density to $0.70/m^2$ from the present (1980) density of $0.18/m^2$, total roughly 118,000 ($227,000m^2$ X 0.52 fry/m^2). This number of fry is of course variable, depending on annual recruitment levels. As in Lamprey Creek, this must be monitored to determine annual fry requirements.

4.0 GOSNELL CREEK

Very limited sampling was conducted in the Gosnell Creek system in 1980. Three sample sites were conducted; two in Gosnell Creek and one in a tributary, Cox Creek. Because of the huge size of the Gosnell Creek system (Fig. 3), no habitat description (based on three sites) will be attempted at this time.

4.1 Fish Sampling

Results of sampling in Gosnell Creek are summarized in Table 5, with complete data included in Appendix 9. The three sample sites conducted indicate relatively small juvenile steelhead populations were present. Maximum fry density of $0.18/m^2$ was found at the lowest site; mean of all three samples was $0.09/m^2$.

TABLE 5 Summary of Gosnell Creek fish population estimates.

SITE	RAINBOW			COHO		DOLLY VARDEN	OTHER SPECIES
	0+	1+	2+	0+	1+	0+	
1	0.18	0.11	0	0	0	0.04	mountain whitefish longnose dace
2	0.02	0	0	0.03	0	0.07	
Cox Creek	0.06	0.02	0	0.23	0.08	0.01	

Yearling density was also low, averaging $0.04/m^2$. Maximum density of $0.11/m^2$, sampled at the lowest site, is in the range of densities sampled in Lamprey ($0.15/m^2$) and Owen ($0.086/m^2$) Creeks.

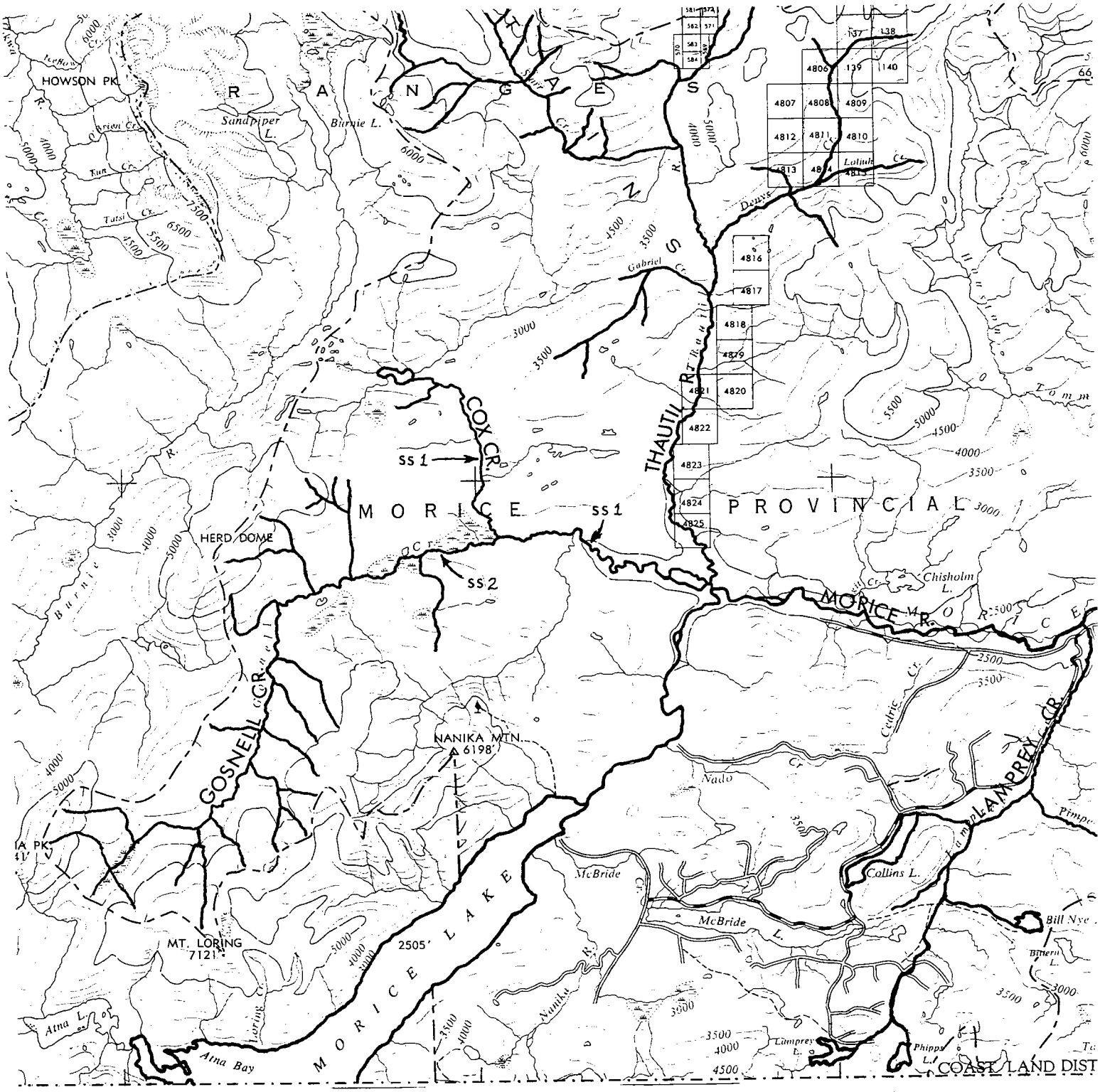

Figure 3 Gosnell Creek – Thautil River System. Scale 1:250,000

4.2 Steelhead Life History and Population Dynamics

Because so few samples were taken in this very large system, no meaningful discussion of population dynamics can be made. More sampling is necessary. However, there are consistencies in Gosnell Creek results when compared to Owen and Lamprey Creek results. Firstly, no two year olds were present in the sample sites chosen. This suggests that the Gosnell performs a role similar to Owen and Lamprey Creeks in steelhead life history; the primary use being spawning and early rearing of juveniles. Secondly, low fry density was found in all three samples. Comparison of yearlings to fry at the lowest site suggests poor recruitment in 1980. This is consistent with Owen/Lamprey Creek findings as well.

4.3 Further Sampling Requirements

It is recommended that further sampling of Gosnell Creek be conducted in order to verify the role of this stream in steelhead life history (eg. migrant production) and annual recruitment rates. Habitat characteristics and steelhead distribution should also be assessed.

Number of sample sites required is very dependent on access; sufficient information can be collected with roughly six sample sites.

5.0 MORICE RIVER SIDECHANNELS

Seven sample sites were conducted in sidechannels and mainstem edge habitat of the Morice River. There is an extensive series of side-channels in the middle reaches of the stream (eg. Gosnell to Owen). An attempt was made to sample different types of side channel (eg. open gravel channels, narrow complex channels, etc.) to get an idea of the range in fish populations associated with habitat types. No attempt to define standing crop or carrying capacity (amount of each side channel type and associated fish density) will be made at this time.

5.1 Fish Sampling

Results of fish population estimates are summarized in Table 6 with complete data in Appendix 10. Sportfish species present in the side-channels included juvenile steelhead, coho and chinook. Coho were present in 5 of 7 samples, with a mean density of 0.07 fry/m^2. Maximum density, found at mile 32 (sidechannel with cover), was 0.28 fry/m^2. Chinook were found in 4 of 7 samples, up to a maximum of 0.17 fry/m^2. Mean density was 0.03 fry/m^2.

Juvenile steelhead were present in all 7 sample sites. Mean fry density was 0.14/m^2, with a range from 0.09 to 0.24/m^2. Yearling density averaged 0.02/m^2 (0 to 0.04/m^2 range) while two year olds were present at less than 0.01/m^2.

5.2 Steelhead Life History and Population Dynamics

Age groups of steelhead captured in Morice River sidechannels included 0+, 1+ and very few 2+. These findings suggest that habitat for older juveniles (eg. 2+ to 4+ pre-smolts) was not abundant in sidechannels. The majority of older parr habitat is likely located in deeper mainstem areas.

Steelhead fry density was not high in sidechannels or mainstem edge habitat. The mean of 0.14/m^2 was well below suggested optimum levels

TABLE 6 Summary of Morice River mainstem and sidechannel fish population estimates.

SITE	HABITAT	RAINBOW			COHO	CHINOOK		OTHER SPECIES
		0+	1+	2+	0+	0+	1+	
Mile 33	sidechannel	.18	.01	.01	.06	0	0	mountain whitefish, longnose dace
Mile 33	mainstem edge	.09	0	0	0	0	0	longnose dace
Mile 32	sidechannel with cover	.24	.03	0	.28	0	0	mountain whitefish, longnose dace
Mile 32	wide sidechannel (no cover)	.11	.01	0	0	<.01	0	squawfish, longnose dace
Lamprey Creek	sidechannel (no cover)	.11	.04	.01	.12	.17	0	mountain whitefish, longnose dace
Lamprey Creek	sidechannel (no cover)	.11	0	0	.03	0	.01	longnose dace
Mile 21	open sidechannel	.11	.02	<.01	.01	.04	0	mountain whitefish, longnose dace
Mean		.14	.02	<.01	.07	.03	<.01	

(eg. 0.7/m^2). Yearling density was similarly low (0.02/m^2). This information indicates that low recruitment to these areas may be a common occurrence. The capacity of these areas to rear fry and yearlings is unknown and cannot be determined unless more is known about fry recruitment rates and sites. Because sidechannels are often dependent on stream discharge for their very existence (eg. de-watered at low flow) there is reason to suspect that rearing capacity may be lower than might be expected for a more stable area (eg. tributary or sidechannel). Sidechannels may be useful only as short-term (ephimeral) rearing areas (depending on sidechannel type).

5.3 Further Sampling Requirements

To understand carrying capacity and the role of sidechannels in Morice River steelhead production it would be useful to collect information on the amount (length and area) of sidechannel habitat available, habitat types of the sidechannels, and the effects of discharge (high and low) on sidechannel habitat. Much of this can be done by air photo analysis. Fish population information should be collected in the same way as the 1980 sampling, selecting sites in a variety of habitat and sidechannel types.

Annual sampling of fry and yearling populations should be conducted to monitor recruitment rates in the mainstem Morice River. Further data regarding maximum fry densities (carrying capacity), spawning site locations and sidechannel habitat types is required before any possible enhancement techniques can be suggested.

6.0 DISCUSSION

Results of fish sampling in Lamprey, Owen and Gosnell Creeks, and in Morice River sidechannels, indicate that particularly Owen and Lamprey Creeks are very important in Morice River steelhead production. The primary role of these (and probably all tributaries) is production of fry, yearling and two year old migrants. Older juveniles (2+ to 4+) undoubtedly rear to smolt stage in mainstem Morice River areas. The lack of high fry density in sidechannels and mainstem edge habitat suggests that, relatively speaking, tributaries are of major importance. This is probably true of overall fry and yearling production as well.

As Owen and Lamprey have been found to be important, sampling should now shift to other tributaries which may or may not have potential for enhancement. Major areas for study include the Gosnell system, Thautil River and Houston Tommy Creek. Some of the smaller tributaries (eg. Tagit) should be sampled; however, their expected contribution to overall standing crop is expected to be small.

One of the major assumptions made in this report was the statement that parr habitat in the Morice River mainstem was not limiting. This is stated without any knowledge of population densities and habitat characteristics in this area. The basis for this assumption is simply that steelhead populations were at one time larger (apparently), therefore less recruitment should produce some undersaturated habitat (despite density compensation). Sampling of the mainstem should be attempted to accept or reject this assumption. Unfortunately this is easier said than done, as snorkelling is not effective in the Morice (poor visibility in water), and short sampling cannot reach 2+, 3+ and 4+ habitat. The use of a boat shocker and mark recapture techniques should be considered. However, this would take a much greater effort.

7.0 RECOMMENDATIONS

1. Fry stocking should be the major enhancement tool in the Morice River at this time. Areas for fry release should be based on annual monitoring of fry populations at "index" sites in selected areas.

2. More information is required on sidechannel carrying capacity before enhancement in these areas can be prescribed.

3. Areas of the Morice requiring further analysis include Houston Tommy and Gosnell Creeks. Carrying capacity analysis should be conducted.

4. Sampling of the mainstem Morice River should be considered.

5. The possibility of gravel introductions into Owen Creek should be assessed.

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REFERENCES

Burns, J. W. 1971. The carrying capacity for juvenile salmonids in some northern California streams. California Fish and Game 57(1): 44-57.

Bustard, D. 1981-2 (In prep.) Preliminary data on the Morice River system.

Griffith, R. P. 1980. The enhancement of summer run steelhead in Silverhope Creek. Progress in 1979. Unpublished M.S., Fish and Wildlife Branch, Victoria, B. C.

Glova, G. J. and J. C. Mason. 1976. Interactive ecology of juvenile salmon and trout in streams. III. Progress during 1975. M.S. Report Series No. 1400. Fisheries Research Board of Canada.

Lough, M. J. 1980. S.E.P. Planning for Region VI. File 1020. August 5, 1980. Fish and Wildlife Branch, Smithers, B. C.

Morris, M. and B. Eccles. 1975. Morice River Stream Survey. Unpublished M.S. Fish and Wildlife Branch, Smithers, B. C.

Pinsent, M. E. 1969. A report regarding the suitability of Owen Creek, B. C., as a potential site for the construction of artificial spawning facilities for steelhead trout. Unpublished M.S., Fish and Wildlife Branch, Smithers, B. C.

Schultze, C. G. 1980. A preliminary look at Owen Creek prior to a standing stock assessment. Unpublished M.S. Fish and Wildlife Branch, Smithers, B. C.

S.E.R.C. 1980. Preliminary review of the predictability of smolt yield for wild stocks of chinook salmon, steelhead trout and coho salmon. Unpublished M.S. Prepared for S.E.P. management committee.

Stuart, K. M. 1981. Juvenile steelhead carrying capacity of the Kispiox River system in 1980, with reference to enhancement opportunities. Unpublished M.S. Fish and Wildlife Branch, Victoria, B. C.

Tredger, C. D. 1981. Natural rearing capacity of the Kloiya River system, near Prince Rupert, B. C. with reference to the Kloiya River Community Development Program under S.E.P. Unpublished M.S. Fish and Wildlife Branch, Victoria, B. C.

APPENDIX 1 Summary of habitat characteristics of Lamprey Creek and tributaries.

Habitat characteristics of

LAMPREY CR. REACH 1 PILE PHASE

HABITAT TYPE
REACH LENGTH (m) 3,250 m

Habitat unit	POOL		RIFFLE		GLIDE	
	Value	%	Value	%	Value	%
No. of units sampled	3		18		14	
Average length (m)	10.67	(9)	8.19	(47)	11.29	(44)
Average wetted width (m)	5.15		7.06		6.68	
Average channel width (m)	15.33		13.11		13.64	
Average depth (cm)	0.40		0.20		0.21	
Average area (m^2)	62.50	(6)	92.46	(55)	84.36	(39)
Total no. of units in reach	27.41		186.51		126.66	
Total area of units in reach (m^2)	1713.33		17244.52		10685.10	
Average area log debris cover (m^2)	4.40		0.32		0.95	
Average area boulder cover (m^2)	3.07		5.49		4.29	
Average area instream vegetation (m^2)	0.00		0.03		0.50	
Average area overstream vegetation (m^2)	1.00		0.56		1.34	
Average area cutbanks (m^2)	0.00		0.00		0.07	
Average area total cover (m^2)	8.47	(14)	6.40	(7)	6.96	(8)
Average % substrate fines	15.00		2.22		6.43	
Average % substrate small gravel	6.67		6.94		9.64	
Average % substrate large gravel	21.67		19.72		25.36	
Average % substrate cobbles	25.00		42.22		37.50	
Average % substrate boulder	25.00		28.33		21.43	
Average % substrate bedrock	0.00		0.00		0.00	

Habitat characteristics of

LAMPREY CK. REACH 2 (mi. 29.5 ⇒ PIMPERNEL)

HABITAT TYPE
REACH LENGTH (m) 8,300 m

Habitat unit	POOL		RIFFLE		GLIDE	
	Value	%	Value	%	Value	%
No. of units sampled	11		12		7	
Average length (m)	41.00	(70)	5.99	(19)	17.00	(11)
Average wetted width (m)	7.91		4.67		4.97	
Average channel width (m)	15.82		12.75		12.93	
Average depth (cm)	0.59		0.08		0.26	
Average area (m^2)	233.23	(74)	22.95	(8)	88.71	(18)
Total no. of units in reach	141.71		263.27		53.71	
Total area of units in reach (m^2)	33050.40		6042.10		4764.25	
Average area log debris cover (m^2)	15.57		0.81		2.42	
Average area boulder cover (m^2)	0.13		0.58		0.00	
Average area instream vegetation (m^2)	17.59		1.08		1.00	
Average area overstream vegetation (m^2)	4.77		0.65		4.21	
Average area cutbanks (m^2)	0.26		0.04		0.32	
Average area total cover (m^2)	38.84	(17)	2.42	(11)	7.96	(9)
Average % substrate fines	50.00		9.17		27.14	
Average % substrate small gravel	34.55		67.50		67.86	
Average % substrate large gravel	13.64		19.58		5.00	
Average % substrate cobbles	1.82		3.75		0.00	
Average % substrate boulder	0.00		0.00		0.00	
Average % substrate bedrock	0.00		0.00		0.00	

Habitat characteristics of

LAMPREY CK. REACH 3 (PIMPERNEL ⇒ COLLINS)

HABITAT TYPE
REACH LENGTH (m) 2150 m

Habitat unit	POOL		RIFFLE		GLIDE	
	Value	%	Value	%	Value	%
No. of units sampled	5		2		4	
Average length (m)	38.00	(80)	6.50	(14)	8.50	(6)
Average wetted width (m)	8.40		2.00		2.75	
Average channel width (m)	12.40		7.50		9.00	
Average depth (cm)	0.64		0.04		0.08	
Average area (m^2)	334.40	(91)	29.00	(3)	26.00	(6)
Total no. of units in reach	66.32		67.85		22.24	
Total area of units in reach (m^2)	22176.00		1967.54		578.12	
Average area log debris cover (m^2)	4.46		0.10		0.46	
Average area boulder cover (m^2)	0.40		0.00		0.00	
Average area instream vegetation (m^2)	0.80		0.00		0.00	
Average area overstream vegetation (m^2)	8.20		0.38		0.31	
Average area cutbanks (m^2)	5.64		0.00		0.31	
Average area total cover (m^2)	19.50	(6)	0.48	(2)	1.08	(4)
Average % substrate fines	67.00		25.00		43.75	
Average % substrate small gravel	16.00		30.00		21.25	
Average % substrate large gravel	10.00		32.50		26.25	
Average % substrate cobbles	6.00		12.50		8.75	
Average % substrate boulder	1.00		0.00		0.00	
Average % substrate bedrock	0.00		0.00		0.00	

Habitat characteristics of

LAMPREY CK. REACH 4 (COLLINS → BILL NYE)

HABITAT TYPE
REACH LENGTH (m) 4,150

Habitat unit	POOL Value	%	RIFFLE Value	%	GLIDE Value	%
No. of units sampled	2		5		5	
Average length (m)	7.75	(22)	2.80	(20)	8.00	(58)
Average wetted width (m)	4.00		1.70		2.70	
Average channel width (m)	7.00		7.00		7.20	
Average depth (cm)	0.33		0.02		0.13	
Average area (m^2)	30.50	(31)	4.80	(12)	22.50	(57)
Total no. of units in reach	117.81		296.43		300.88	
Total area of units in reach (m^2)	3593.10		1422.86		6769.69	
Average area log debris cover (m^2)	1.00		0.10		0.36	
Average area boulder cover (m^2)	0.00		0.00		0.00	
Average area instream vegetation (m^2)	0.00		0.00		0.00	
Average area overstream vegetation (m^2)	0.25		0.00		0.20	
Average area cutbanks (m^2)	0.50		0.00		0.15	
Average area total cover (m^2)	1.75	(6)	0.10	(2)	0.71	(3)
Average % substrate fines	27.50		1.00		9.00	
Average % substrate small gravel	57.50		43.00		58.00	
Average % substrate large gravel	15.00		53.00		31.80	
Average % substrate cobbles	0.00		2.00		1.20	
Average % substrate boulder	0.00		0.00		0.00	
Average % substrate bedrock	0.00		0.00		0.00	

Habitat characteristics of

LAMPREY CK. REACH 5 (BILL NYE → PHIPPS)

HABITAT TYPE
REACH LENGTH (m) 7,600 m

Habitat unit	POOL		RIFFLE		GLIDE	
	Value	%	Value	%	Value	%
No. of units sampled	8		6		4	
Average length (m)	35.25	(87)	5.50	(10)	2.75	(3)
Average wetted width (m)	2.88		1.75		1.38	
Average channel width (m)	3.63		2.67		3.00	
Average depth (cm)	0.40		0.13		0.23	
Average area (m^2)	111.38	(92)	10.00	(6)	3.63	(2)
Total no. of units in reach	187.57		138.18		82.91	
Total area of units in reach (m^2)	20892.04		1381.82		300.96	
Average area log debris cover (m^2)	6.56		0.21		0.18	
Average area boulder cover (m^2)	0.88		6.17		0.50	
Average area instream vegetation (m^2)	15.15		3.17		0.88	
Average area overstream vegetation (m^2)	22.00		2.08		0.69	
Average area cutbanks (m^2)	8.80		0.19		0.20	
Average area total cover (m^2)	53.39	(48)	12.19	(122)	2.44	(67)
Average % substrate fines	58.13		35.83		58.75	
Average % substrate small gravel	3.75		6.67		6.25	
Average % substrate large gravel	9.38		15.00		12.50	
Average % substrate cobbles	25.63		27.50		12.50	
Average % substrate boulder	4.38		15.00		10.00	
Average % substrate bedrock	0.00		0.00		0.00	

Habitat characteristics of

LAMPREY CK. REACH 6 (PHIPPS → LAMPREY LK.)

HABITAT TYPE
REACH LENGTH (m) 2,700m

Habitat unit	POOL Value	%	RIFFLE Value	%	GLIDE Value	%
No. of units sampled	3		3			
Average length (m)	3.33	(53)	3.00	(47)		
Average wetted width (m)	1.33		1.50			
Average channel width (m)	1.67		1.83			
Average depth (cm)	0.10		0.05			
Average area (m^2)	4.50	(48)	4.83	(52)		
Total no. of units in reach	429.73		423.00			
Total area of units in reach (m^2)	1933.78		2043.09			
Average area log debris cover (m^2)	0.43		0.10			
Average area boulder cover (m^2)	0.03		0.37			
Average area instream vegetation (m^2)	0.33		0.00			
Average area overstream vegetation (m^2)	2.83		2.83			
Average area cutbanks (m^2)	0.30		0.17			
Average area total cover (m^2)	3.93	(87)	3.47	(72)		
Average % substrate fines	36.67		26.67			
Average % substrate small gravel	50.00		26.67			
Average % substrate large gravel	11.67		16.67			
Average % substrate cobbles	1.67		20.00			
Average % substrate boulder	0.00		10.00			
Average % substrate bedrock	0.00		0.00			

Habitat characteristics of
TRIBUTARY 1 (TO LAKE)

HABITAT TYPE
REACH LENGTH (m) 2,300m

Habitat unit	POOL		RIFFLE		GLIDE	
	Value	%	Value	%	Value	%
No. of units sampled	2		3		1	
Average length (m)	1.50	(32)	1.67	(53)	1.50	(15)
Average wetted width (m)	1.50		0.50		0.75	
Average channel width (m)	1.50		1.83		2.00	
Average depth (cm)	0.20		0.10		0.15	
Average area (m^2)	2.50	(58)	0.83	(29)	1.13	(13)
Total no. of units in reach	490.67		729.94		230.00	
Total area of units in reach (m^2)	1226.67		605.85		259.90	
Average area log debris cover (m^2)	0.00		0.00		0.00	
Average area boulder cover (m^2)	0.15		0.10		0.10	
Average area instream vegetation (m^2)	0.00		0.00		0.00	
Average area overstream vegetation (m^2)	1.50		0.63		1.00	
Average area cutbanks (m^2)	0.50		0.07		0.10	
Average area total cover (m^2)	1.70	(68)	0.80	(96)	1.20	(106)
Average % substrate fines	0.00		0.00		10.00	
Average % substrate small gravel	5.00		0.00		10.00	
Average % substrate large gravel	37.50		20.00		50.00	
Average % substrate cobbles	17.50		30.00		20.00	
Average % substrate boulder	5.00		16.67		10.00	
Average % substrate bedrock	35.00		33.33		0.00	

Habitat characteristics of

PIMPERNEL CREEK (TO FALLS)

HABITAT TYPE
REACH LENGTH (m) 4,000 m

Habitat unit	POOL Value	%	RIFFLE Value	%	GLIDE Value	%
No. of units sampled			3		3	
Average length (m)			10.67	(43)	14.00	(57)
Average wetted width (m)			4.00		4.50	
Average channel width (m)			8.00		6.33	
Average depth (cm)			0.18		0.45	
Average area (m^2)			38.00	(35)	71.67	(65)
Total no. of units in reach			161.20		162.86	
Total area of units in reach (m^2)			6125.59		11671.97	
Average area log debris cover (m^2)			1.67		10.33	
Average area boulder cover (m^2)			0.17		3.00	
Average area instream vegetation (m^2)			0.00		0.00	
Average area overstream vegetation (m^2)			1.67		1.67	
Average area cutbanks (m^2)			0.67		2.33	
Average area total cover (m^2)			4.17	(11)	17.33	(24)
Average % substrate fines			5.00		25.00	
Average % substrate small gravel			30.00		33.33	
Average % substrate large gravel			43.33		23.33	
Average % substrate cobbles			21.67		18.33	
Average % substrate boulder			1.67		0.00	
Average % substrate bedrock			0.00		0.00	

Habitat characteristics of

COLLINS CREEK (TO LAKE).

HABITAT TYPE Mainly isolated pools in upper section
REACH LENGTH (m) 3,250 m

Habitat unit	POOL Value	%	RIFFLE Value	%	GLIDE Value	%
No. of units sampled	12		13		1	
Average length (m)	7.83	(64)	3.72	(33)	4	(3)
Average wetted width (m)	2.11		0.46		1.2	
Average channel width (m)	4.79		4.92		4	
Average depth (cm)	0.14		0.04		0.05	
Average area (m^2)	20.14	(90)	1.67	(8)	4.0	(2)
Total no. of units in reach	265.64		288.31		24.38	
Total area of units in reach (m^2)	5350.09		481.47		117.00	
Average area log debris cover (m^2)	0.63		0.10		0.00	
Average area boulder cover (m^2)	0.14		0.03		0.10	
Average area instream vegetation (m^2)	0.27		0.04		0.00	
Average area overstream vegetation (m^2)	1.00		0.78		0.00	
Average area cutbanks (m^2)	0.40		0.00		0.10	
Average area total cover (m^2)	2.43	(12)	0.94	(56)	0.20	(4)
Average % substrate fines	41.67		18.85		20	
Average % substrate small gravel	28.33		44.23		30	
Average % substrate large gravel	17.92		22.69		30	
Average % substrate cobbles	8.75		11.15		15	
Average % substrate boulder	3.34		3.08		5	
Average % substrate bedrock	0.00		0.00		0	

Habitat characteristics of

BILL NYE CREEK (TO FORK)

HABITAT TYPE
REACH LENGTH (m) 3,150

Habitat unit	POOL Value	%	RIFFLE Value	%	GLIDE Value	%
No. of units sampled	3		3			
Average length (m)	11.00	(92)	0.92	(8)		
Average wetted width (m)	5.33		3.50			
Average channel width (m)	7.67		4.67			
Average depth (cm)	0.43		0.05			
Average area (m^2)	58.33	(98)	0.92	(2)		
Total no. of units in reach	263.45		273.91			
Total area of units in reach (m^2)	15367.30		252.00			
Average area log debris cover (m^2)	2.00		0.50			
Average area boulder cover (m^2)	0.00		0.00			
Average area instream vegetation (m^2)	1.50		0.17			
Average area overstream vegetation (m^2)	1.00		0.00			
Average area cutbanks (m^2)	2.30		0.00			
Average area total cover (m^2)	6.80	(12)	0.67	(73)		
Average % substrate fines	66.67		58.33			
Average % substrate small gravel	15.00		23.33			
Average % substrate large gravel	16.67		18.33			
Average % substrate cobbles	0.00		0.00			
Average % substrate boulder	5.00		0.00			
Average % substrate bedrock	0.00		0.00			

Habitat characteristics of

TRIBUTARY 5 (TO LAKE)

HABITAT TYPE
REACH LENGTH (m) 2,850

Habitat unit	POOL		RIFFLE		GLIDE	
	Value	%	Value	%	Value	%
No. of units sampled	4		5		3	
Average length (m)	3.38	(49)	2.08	(38)	1.17	(13)
Average wetted width (m)	1.63		0.76		1.00	
Average channel width (m)	4.13		3.80		3.50	
Average depth (cm)	0.13		0.02		0.07	
Average area (m^2)	5.31	(64)	1.72	(26)	1.17	(10)
Total no. of units in reach	413.17		520.67		316.67	
Total area of units in reach (m^2)	2193.91		895.56		370.50	
Average area log debris cover (m^2)	053		0.04		0.10	
Average area boulder cover (m^2)	0.05		0.02		0.00	
Average area instream vegetation (m^2)	0.00		0.00		0 00	
Average area overstream vegetation (m^2)	0.50		0.60		0.10	
Average area cutbanks (m^2)	0.23		0.04		0.13	
Average area total cover (m^2)	1.30	(24)	0.70	(41)	0.34	(29)
Average % substrate fines	11.25		9.00		11.67	
Average % substrate small gravel	18.75		54.00		60.00	
Average % substrate large gravel	32.50		24.00		1.67	
Average % substrate cobbles	10.00		3.00		0.00	
Average % substrate boulder	2.50		1.00		0.00	
Average % substrate bedrock	0.00		0.00		0.00	

APPENDIX 2a Population estimate results and sample site habitat descriptions for Lamprey Creek.

LAMPREY CREEK BRIDGE SITE DATE 3/9/80 AREA 150.7 M² SITE # 1
LENGTH 20.4 M

SPECIES	AGE	fl-RANGE	$\bar{fl}$	MEAN WEIGHT	C_1	$\bar{p}$	$\bar{n}$	TOTAL BIOMASS	No/M² DENSITY	BIOMASS DENSITY	No / linear meter
Rainbow	0+	32-57	46.7	1.15	39	0.8	48.75	55.96	0.32	0.37	2.39
	1+	88-115	98.4	10.39	12	0.8	15.00	155.87	0.10	1.03	0.74
	Σ								0.42	1.40	3.13
Coho	0+	38-81	56.6	2.35	68	0.8	85.00	199.49	0.56	1.32	4.17
	1+	82-93	87.5	8.13	2	0.8	2.50	20.34	0.02	0.13	0.12
	Σ								0.58	1.46	4.29
LN Dace	Σ	35-69	48.8	1.23	37	0.8	46.25	56.94	0.31	0.38	2.27
Suckers	Σ	64-85	73.8	6.16	4	0.8	5.00	30.79	0.03	0.20	0.25
M. whitefish	0+		45	1.23	1	0.8	1.25	1.54	0.01	0.01	0.08

HABITAT DESCRIPTION: riffle-glide habitat

Discharge 0.38 m³/s (13.4 cfs) Gradient 1%

Temperature (°C) 7.5 Turbidity clear

Hydraulic Type	Pool	Glide	Riffle
% area		63	37
mean width		7.5	7.2
mean depth		0.10	0.25
% cover		15	10
cover type[1]		B	B
substrate[2]		F5, SG10, LG45 C35, B5	LG20, C60 B20

COMMENTS:

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

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

LAMPREY CREEK DATE 4/9/80 AREA 156.3 M^2 SITE # 2
GRAVEL PIT AREA LENGTH 24.8M

SPECIES	AGE	fl-RANGE	$\bar{fl}$	MEAN WEIGHT	C_1	$\bar{p}$	$\bar{n}$	TOTAL BIOMASS	No/M^2 DENSITY	BIOMASS DENSITY	No / linear meter
Rainbow	0+	42-62	54.2	1.76	9	0.7	12.86	22.59	0.08	0.14	0.52
	1+	79-107	94.1	9.09	8	0.7	11.43	103.94	0.07	0.66	0.46
	2+		125	20.80	1	0.7	1.43	29.72	0.01	0.19	0.06
	Σ								0.16	0.99	1.04
Coho	0+	57-76	66.7	3.62	20	0.7	28.57	103.47	0.18	0.66	1.15
	1+	85-90	87.5	8.06	2	0.7	2.86	23.03	0.02	0.15	0.12
	Σ							126.50	0.20	0.81	1.27
Suckers	Σ	71-110	85.0	9.57	6	0.7	8.57	82.00	0.05	0.52	0.35
LN Dace	Σ	26-70	46.2	1.23	6	0.7	8.57	10.54	0.05	0.07	0.35

HABITAT DESCRIPTION: deep pool habitat with log jam, plus part of riffle.

Discharge — Gradient 2-3%

Temperature (°C) 9 Turbidity clear

Hydraulic Type	Pool	Glide	Riffle
% area	77		23
mean width	6.7		5.25
mean depth	0.50		0.10
% cover	15		42
cover type[1]	L, B, OV		B
substrate[2]	F15, SG 5, LG 20 C 20, B 40		F5, SG 10, LG 10 C 25, B 50

COMMENTS: most rb taken from riffle, coho in pool.

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

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

LAMPREY CREEK DATE 4/9/80 AREA 157 M^2 SITE # 3

29 MILE LENGTH 15.7 M

SPECIES	AGE	fl-RANGE	$\bar{fl}$	MEAN WEIGHT	C_1	$\bar{p}$	$\bar{n}$	TOTAL BIOMASS	No/M^2 DENSITY	BIOMASS DENSITY	No / linear meter
Rainbow	0+	41-61	51.7	1.53	31	0.7	44.29	67.58	0.28	0.43	2.82
	1+	76-100	90.6	8.08	14	0.7	20.00	161.53	0.13	1.03	1.27
	2+		138	27.99	1	0.7	1.43	39.98	0.01	0.25	0.09
	Σ								0.42	1.71	4.18
Coho	0+		73	4.67	1	0.7	1.43	6.67	0.01	0.04	0.09
LN Dace	Σ	40-85	55.8	2.11	9	0.7	12.86	27.11	0.08	0.17	0.82
Sucker	Σ		140	37.91	2	0.7	2.86	108.32	0.02	0.69	0.18

HABITAT DESCRIPTION: riffle-glide in cobble habitat

Discharge 0.16 m^3/s (5.7 cfs) Gradient 1 %

Temperature (°C) 8.5 Turbidity clear

Hydraulic Type	Pool	Glide	Riffle
% area		83	17
mean width		10	10
mean depth		0.15	0.07
% cover		1	1
cover type[1]		B, L	B
substrate[2]		F5, SG5, LG5 C 60, B25	F5, SG5, LG15 C 25, B50

COMMENTS: cover in this site was mostly cobble substrate cover (ie, too small for boulder cover)

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

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

LAMPREY CREEK DATE 4/9/80 AREA 59.3 M^2 SITE # 4
LENGTH 10.3 M

SPECIES	AGE	fl-RANGE	$\bar{fl}$	MEAN WEIGHT	C_1	$\bar{p}$	$\bar{n}$	TOTAL BIOMASS	No/M^2 DENSITY	BIOMASS DENSITY	No / linear meter
Rainbow	0+	30-58	44.9	1.02	27	0.65	41.54	42.28	0.70	0.71	4.03
	1+	65-95	81.3	5.91	17	0.65	26.15	154.64	0.44	2.61	2.54
	2+	110-130	120	18.79	2	0.65	3.08	57.80	0.05	0.97	0.30
	Σ								1.19	4.29	6.87
Coho	0+	41-81	65.5	3.64	19	0.65	29.23	106.42	0.49	1.79	2.84
	1+		88	8.18	1	0.65	1.54	12.58	0.03	0.21	0.15
	Σ								0.52	2.00	2.99
Dolly Varden	1+		80	5.12	1	0.65	1.54	7.88	0.03	0.13	0.15
mW	Σ	71-134	96.0	15.28	5	0.65	7.69	117.51	0.13	1.98	0.75
LN Dace	Σ	21-51	33.8	0.50	5	0.65	7.69	3.87	0.13	0.07	0.75
Suckers	Σ	41-83	59.0	3.53	10	0.65	15.38	54.35	0.26	0.92	1.49

HABITAT DESCRIPTION: pool habitat in reach 2

Discharge 0.22 m^3/s (7.6 cfs) Gradient 1.5 %
Temperature (°C) 9.5 Turbidity clear

Hydraulic Type	Pool	Glide	Riffle
% area	100		
mean width	5.9		
mean depth	0.75		
% cover	3		
cover type[1]	L, OV, C, IV		
substrate[2]	F60, SG5 LG25, C10		

COMMENTS:

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

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

LAMPREY CREEK DATE 4/9/80 AREA 23 M^2 SITE # 5

LENGTH 4.6 M

SPECIES	AGE	fl-RANGE	$\bar{fl}$	MEAN WEIGHT	C_1	$\bar{p}$	$\bar{n}$	TOTAL BIOMASS	No/M^2 DENSITY	BIOMASS DENSITY	No / linear meter
Rainbow	0+	40-53	46.0	1.07	5	0.75	6.67	7.15	0.29	0.31	1.45
Sucker	Σ	47-71	59.0	3.50	2	0.75	2.67	9.33	0.12	0.41	0.58

HABITAT DESCRIPTION: riffle habitat in reach 2

Discharge 0.22 m^3/s (7.6 cf_3) Gradient 1.5%

Temperature (°C) 9.5 Turbidity clear

Hydraulic Type	Pool	Glide	Riffle
% area			100
mean width			5.0
mean depth			0.15
% cover			0
cover type[1]			—
substrate[2]			SG 5, LG 60 C 35

COMMENTS:

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

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

LAMPREY CREEK DATE 4/9/80 AREA 134.6 M^2 SITE # 6

32 MILE BRIDGE - POOL SITE LENGTH 24.8 M

SPECIES	AGE	fl-RANGE	$\bar{fl}$	MEAN WEIGHT	C_1	$\bar{P}$	$\bar{n}$	TOTAL BIOMASS	No/M^2 DENSITY	BIOMASS DENSITY	No / linear meter
Rainbow	0+	42-56	49.9	1.35	12	0.65	18.46	24.88	0.14	0.18	0.74
	1+	68-95	82.6	6.14	23	0.65	35.38	217.21	0.26	1.61	1.43
	2+	105-118	111.5	14.91	2	0.65	3.08	45.89	0.02	0.34	0.12
	Σ							287.98	0.42	2.13	2.29
LN Dace	Σ	20-105	59.5	4.61	15	0.65	23.08	106.34	0.17	0.79	0.93

HABITAT DESCRIPTION: pool habitat

Discharge 0.039 m^3/s (1.4 cfs) Gradient 0.5 %

Temperature (°C) 8 Turbidity clear

Hydraulic Type	Pool	Glide	Riffle
% area	100		
mean width	5.4		
mean depth	0.60		
% cover	7		
cover type[1]	L, OV, C		
	IV		
substrate[2]	F 30, SG 45		
	LG 25		

COMMENTS: substrate covered with algae

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

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

LAMPREY CREEK DATE 4/9/80 AREA 66.5 M² SITE # 7

MILE 32 BRIDGE - RIFFLE SITE LENGTH 17 M

SPECIES	AGE	fl-RANGE	$\bar{fl}$	MEAN WEIGHT	C_1	$\bar{p}$	$\bar{n}$	TOTAL BIOMASS	No/M² DENSITY	BIOMASS DENSITY	No / linear meter
Rainbow	0+	43-58	50.2	1.37	27	0.85	31.76	43.52	0.48	0.65	1.87
LN Dace	Σ	35-87	53.1	2.00	28	0.85	32.94	65.92	0.50	0.99	1.94

HABITAT DESCRIPTION: riffle habitat

Discharge 0.039 m³/s (1.4 cfs) Gradient 0.5%

Temperature (°C) 8 Turbidity clear

Hydraulic Type	Pool	Glide	Riffle
% area			100
mean width			3.9
mean depth			0.01
% cover			0
cover type[1]			-
substrate[2]			F5, 30SG 65 LG

COMMENTS:

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

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

LAMPREY CREEK DATE 4/9/80 AREA 115.5 M² SITE # 8

MILE 32 - GLIDE SITE LENGTH 22.5 M

SPECIES	AGE	fl-RANGE	$\bar{fl}$	MEAN WEIGHT	C_1	$\bar{p}$	$\bar{n}$	TOTAL BIOMASS	No/M² DENSITY	BIOMASS DENSITY	No / linear meter
Rainbow	0+	40-60	50.3	1.40	45	0.8	56.25	78.60	0.49	0.68	2.50
	1+	72-97	83.1	6.31	10	0.8	12.50	78.90	0.11	0.68	0.55
	2+		114	15.78	1	0.8	1.25	19.72	0.01	0.17	0.05
	Σ							177.22	0.61	1.53	3.10
LN Dace	Σ	35-48	40.1	0.75	16	0.8	20.00	15.02	0.17	0.13	0.89

HABITAT DESCRIPTION: glide with cover, plus small side pool and riffle

Discharge 0.039 m³/s (1.4 cfs) Gradient 0.5 %

Temperature (°C) 8 Turbidity clear

Hydraulic Type	Pool	Glide	Riffle
% area	3	75	22
mean width	1.6	3.8	3.7
mean depth		0.30	0.02
% cover		6	0
cover type[1]		OV, IV, L	-
substrate[2]		F20, SG 70	F80, SG 15
		LG 10	LG 5

COMMENTS: substrate covered with algae

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

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

LAMPREY CREEK DATE 3/9/80 AREA 118.6 M^2 SITE # 9

LENGTH 27 M

SPECIES	AGE	fl-RANGE	$\bar{fl}$	MEAN WEIGHT	C_1	$\bar{p}$	$\bar{n}$	TOTAL BIOMASS	No/M^2 DENSITY	BIOMASS DENSITY	No / linear meter
Rainbow	0+	41-56	47.5	1.16	41	0.8	51.25	59.49	0.43	0.50	1.90
	1+	79-95	88.0	7.36	4	0.8	5.00	36.81	0.04	0.31	0.19
	Σ								0.47	0.81	2.09
MW	0+	63-72	67.5	4.21	2	0.8	2.50	10.52	0.02	0.09	0.09
LN Dace	Σ	22-39	29.3	0.33	7	0.8	8.75	2.88	0.07	0.02	0.32

HABITAT DESCRIPTION:

Discharge 0.04 m^3/s (1.27 cfs) Gradient 0 - 1%

Temperature (°C) — Turbidity clear

Hydraulic Type	Pool	Glide	Riffle
% area	89		11
mean width	5.3		1.8
mean depth	0.30		0.01
% cover	5		40
cover type[1]	IV, OV, C		IV, L
substrate[2]	F60, SG 40		F50, SG 50

COMMENTS:

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

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

LAMPREY CREEK BELOW COLLINS CREEK — DATE 8/9/80 — AREA 80.6 M^2 — LENGTH 17.1 M — SITE # 10

SPECIES	AGE	fl-RANGE	$\bar{fl}$	MEAN WEIGHT	C_1	$\bar{p}$	$\bar{n}$	TOTAL BIOMASS	No/M^2 DENSITY	BIOMASS DENSITY	No / linear meter
Rainbow	0+	40-58	49.1	1.29	22	0.7	31.43	40.59	0.39	0.50	1.84
	1+	71-102	89.6	7.91	7	0.7	10.00	79.11	0.12	0.98	0.58
	Σ							119.70	0.51	1.48	2.42
Cutthroat	1+		92	8.29	1	0.7	1.43	11.85	0.02	0.15	0.08
m. whitefish	0+		69	4.43	1	0.7	1.43	6.34	0.02	0.08	0.08
LN Dace	Σ	26-27	26.5	0.21	2	0.7	2.86	0.61	0.04	0.01	0.17
Suckers	Σ	87-101	94.8	12.41	4	0.7	5.71	70.91	0.07	0.88	0.33

HABITAT DESCRIPTION: pool - riffle in relatively swampy, beaver dam laden area.

Discharge ≈ 0.036 m^3/s (1.3 cfs) — Gradient 0.4%

Temperature (°C) 8 — Turbidity clear

Hydraulic Type	Pool	Glide	Riffle
% area	70		30
mean width	4.8		4.6
mean depth	1.00		0.03
% cover	6		11
cover type[1]	C, OV, L		L
substrate[2]	F 80, SG 15		F 30, SG 40
	LG 5		LG 30

COMMENTS:

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

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

LAMPREY CREEK DATE 8/9/80 AREA 89.4 M^2 SITE # 11
BELOW BILL NYE CREEK LENGTH 21.1 M

SPECIES	AGE	fl-RANGE	$\bar{fl}$	MEAN WEIGHT	C_1	$\bar{p}$	$\bar{n}$	TOTAL BIOMASS	No/M^2 DENSITY	BIOMASS DENSITY	No / linear meter
Rainbow	0+	47-55	49.9	1.34	9	0.85	10.59	14.16	0.12	0.16	0.50
	1+	78-100	90.2	7.95	13	0.85	15.29	121.56	0.17	1.36	0.72
	Σ							135.72	0.29	1.52	1.22
Cutthroat	0+	49-58	53.2	1.62	6	0.85	7.06	11.42	0.08	0.13	0.33
	1+	102-105	103.5	11.82	2	0.85	2.35	27.80	0.03	0.31	0.11
	Σ							39.22	0.11	0.44	0.44
Dolly Varden	0+	60-61	60.5	2.21	2	0.85	2.35	5.21	0.03	0.06	0.11
	1+		103	10.93	1	0.85	1.18	12.86	0.01	0.14	0.06
	Σ							18.07	0.04	0.20	0.17
LN Dace	Σ	44-58	51.0	1.61	2	0.85	2.35	3.79	0.03	0.04	0.11
Sucker	Σ		100	14.39	1	0.85	1.18	16.98	0.01	0.19	0.06

HABITAT DESCRIPTION: riffle-glide-pool-glide habitat

Discharge 0.036 m^3/s (1.3 cfs) Gradient 2.0%

Temperature (°C) 7 Turbidity clear

Hydraulic Type	Pool	Glide	Riffle
% area	65	19	16
mean width	6.25	2.5	3.6
mean depth	0.40	0.15	0.01
% cover	4	1	0
cover type[1]	L	L	-
substrate[2]	F20, SG 55 LG 25	F5, SG 60 LG 35	SG 50, LG 50

COMMENTS:

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

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

LAMPREY CREEK DATE 3/9/80 AREA 57.4 M^2 SITE # 12

ABOVE T-5 LENGTH 17.4 M

SPECIES	AGE	fl-RANGE	$\bar{fl}$	MEAN WEIGHT	C_1	$\bar{P}$	$\bar{n}$	TOTAL BIOMASS	No/M^2 DENSITY	BIOMASS DENSITY	No / linear meter
Cutthroat	0+	32-47	38.4	0.63	11	0.7	15.71	9.94	0.27	0.17	0.90
	1+	67-105	81.4	6.10	10	0.7	14.29	87.12	0.25	1.52	0.82
	Σ								0.52	1.69	1.72
Dolly Varden	0+	40-67	56.3	2.01	3	0.7	4.29	8.62	0.07	0.15	0.25
	1+		103	10.93	1	0.7	1.43	15.61	0.02	0.27	0.08
	2+	124-142	136	25.44	3	0.7	4.29	109.05	0.07	1.90	0.25
	Σ								0.16	2.32	0.58

HABITAT DESCRIPTION: pool-glide-riffle in small silt covered cobbled stream

Discharge 0.027 m^3/s (0.95 cfs) Gradient 0.5%

Temperature (°C) 8 @ 1220 hrs Turbidity clear

Hydraulic Type	Pool	Glide	Riffle
% area	74	14	12
mean width	2.0	1.5	2.0
mean depth	0.40	0.15	0.10
% cover	52	44	60
cover type[1]	L, OV, C	OV, L, C	OV
substrate[2]	F65, SG5	F85, SG5	F70, SG15
	LG20, C10	LG5, C5	LG10, C5

COMMENTS:

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

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

LAMPREY CREEK DATE 3/9/80 AREA 36 M^2 SITE # 13

LENGTH 15 M

SPECIES	AGE	fl-RANGE	$\bar{fl}$	MEAN WEIGHT	C_1	$\bar{p}$	$\bar{n}$	TOTAL BIOMASS	No/M^2 DENSITY	BIOMASS DENSITY	No / linear meter
Rainbow	0+	37-51	47.4	1.27	10	0.85	11.76	14.90	0.33	0.41	0.78
	1+	70-128	91.2	8.91	11	0.85	12.94	115.25	0.36	3.20	0.86
	2+		135	26.20	1	0.85	1.18	30.83	0.03	0.86	0.08
	Σ								0.72	4.47	1.72
Dolly Varden	1+	87-118	99.0	10.04	6	0.85	7.06	70.85	0.20	1.97	0.47

HABITAT DESCRIPTION:

Discharge 0.028 m^3/s (1 cfs) Gradient 4.5 %

Temperature (°C) Turbidity clear

Hydraulic Type	Pool	Glide	Riffle
% area	50		50
mean width	3.0		2.0
mean depth	0.15		0.10
% cover	77		≈ 100
cover type[1]	OV, B, L, C		B, IV, OV L, C
substrate[2]	LG 10, C 80 B 10		LG 20, C 40 B 40

COMMENTS:

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

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

LAMPREY CREEK DATE 3/9/80 AREA 19 M^2 SITE # 14

BELOW LAMPREY LAKE LENGTH 12.5 M

SPECIES	AGE	fl-RANGE	$\bar{fl}$	MEAN WEIGHT	C_1	$\bar{p}$	$\bar{n}$	TOTAL BIOMASS	No/M^2 DENSITY	BIOMASS DENSITY	No / linear meter
Rainbow	0+	31 - 51	40.3	0.74	39	0.85	45.88	33.86	2.41	1.78	3.67
	1+	63 - 105	76.3	5.28	6	0.85	7.06	37.29	0.37	1.96	0.56
	Σ								2.78	3.74	4.23

HABITAT DESCRIPTION: pool - riffle complex

Discharge 0.023 m^3/s (0.8 cfs) Gradient 1 - 2 %

Temperature (°C) - Turbidity clear

Hydraulic Type	Pool	Glide	Riffle
% area	55		45
mean width	1.5		1.25
mean depth	0.10		0.05
% cover	73		35
cover type[1]	OV, IV, C, L		OV, C
substrate[2]	F40, SG 55		F40, SG 35
	LG 2.5, C 2.5		LG 10, C 15

COMMENTS: short pockets of gravel present for spawning purposes

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

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

LAMPREY CREEK TRIBUTARY 1 DATE 3/9/80 AREA 37.5 M^2 SITE # ____
LENGTH 25 M

SPECIES	AGE	fl-RANGE	$\bar{fl}$	MEAN WEIGHT	C_1	$\bar{p}$	$\bar{n}$	TOTAL BIOMASS	No/M^2 DENSITY	BIOMASS DENSITY	No / linear meter
Cutthroat	0+	31-62	43.4	0.93	60	0.65	92.31	85.54	2.46	2.28	3.69
	1+	78-120	92.6	9.00	14	1.00	14.00	126.07	0.37	3.36	0.56
	Σ								2.83	5.64	4.25

HABITAT DESCRIPTION:

Discharge 0.007 m^3/s (0.25 cfs) Gradient 5%
Temperature (°C) 8 Turbidity slightly tannic

Hydraulic Type	Pool	Glide	Riffle
% area	60	10	30
mean width	1.5	0.75	0.5
mean depth	0.20	0.15	0.10
% cover	70	90	24
cover type[1]	OV, C, B	OV, C, B	OV, B, C
substrate[2]	SG 5, LG 38 C 17, B 5, Br 35	F 10, SG 10, LG 50 C 20, B 10	LG 20, C 30 B 17, Br 33

COMMENTS:

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

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

PIMPERNEL CREEK DATE 8/9/80 AREA 70 M^2 SITE # ____
LENGTH 17.5 M

SPECIES	AGE	fl-RANGE	$\overline{fl}$	MEAN WEIGHT	C_1	$\overline{p}$	$\overline{n}$	TOTAL BIOMASS	No/M^2 DENSITY	BIOMASS DENSITY	linear No / meter
Rainbow	0+	39-59	49.2	1.31	27	0.75	36.00	47.22	0.51	0.67	2.06
	1+	73-94	80.4	5.66	10	0.75	13.33	75.52	0.19	1.08	0.76
	Σ							122.74	0.70	1.75	2.82

HABITAT DESCRIPTION: glide and part of riffle

Discharge 0.13 m^3/s (4.6 cfs) Gradient 2.5 %

Temperature (°C) 7 Turbidity clear

Hydraulic Type	Pool	Glide	Riffle
% area		71	29
mean width		4.0	4.0
mean depth		0.60	0.25
% cover		22	26
cover type[1]		L, OV, C	OV, L, C
substrate[2]		F 40, SG 20, LG 20 C 20	F 5, SG 20 LG 50, C 30

COMMENTS:

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

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

COLLINS CREEK DATE 3/9/80 AREA 8.5 M^2 SITE # 1
UPPER SITE LENGTH 6.0 M

SPECIES	AGE	fl-RANGE	$\bar{fl}$	MEAN WEIGHT	C_1	$\bar{P}$	$\bar{n}$	TOTAL BIOMASS	No/M^2 DENSITY	BIOMASS DENSITY	No / linear meter
Cutthroat	0+	39-59	51.2	1.48	25	0.9	27.78	41.21	3.27	4.85	4.63

HABITAT DESCRIPTION: isolated pools

Discharge 0 Gradient 1 %
Temperature (°C) 7 @ 1400 hrs Turbidity clear

Hydraulic Type	Pool	Glide	Riffle
% area	75		25
mean width	1.75		1.0
mean depth	0.08		< 0.01
% cover	33		33
cover type[1]	IV, OV, L		C, B
substrate[2]	F 60, SG 20		F 35, SG 47
	LG 10, C 10		LG 2, C 15

COMMENTS: because this site was isolated pools, densities are very likely unrealistically inflated.

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

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

COLLINS CREEK — DATE 4/9/80 — AREA 46.3 M^2 — SITE # 2

MIDDLE SECTION — LENGTH 14.7 M

SPECIES	AGE	fl-RANGE	$\bar{fl}$	MEAN WEIGHT	C_1	$\bar{p}$	$\bar{n}$	TOTAL BIOMASS	No/M^2 DENSITY	BIOMASS DENSITY	No / linear meter
Cutthroat	0+	38-68	50.2	1.42	50	0.65	76.92	109.00	1.66	2.35	5.23
	1+	91-113	104.3	12.29	6	0.65	9.23	113.47	0.20	2.45	0.63
	2+		150	35.94	1	0.65	1.54	55.30	0.03	1.19	0.10
	Σ								1.89	5.99	5.96
Rainbow	1+	90-96	93	8.59	2	0.65	3.08	26.44	0.07	0.57	0.21
MW	Σ		75	5.70	1	0.65	1.54	8.76	0.03	0.19	0.10
LN Dace	Σ		36	0.54	1	0.65	1.54	0.83	0.03	0.02	0.10

HABITAT DESCRIPTION: riffle-pool site in old beaver dam (pond) area

Discharge 0.0004 m^3/s (0.015 cfs) Gradient > 0.5%

Temperature (°C) 7 Turbidity clear

Hydraulic Type	Pool	Glide	Riffle
% area	78		22
mean width	2.7		0.7
mean depth	0.30		0.02
% cover	11		6
cover type[1]	C, OV, IV		B
substrate[2]	F85, SG5		F15, SG30
	LG5, C5		LG40, C10, B5

COMMENTS: in meadow formed by old beaver dam. Many cutthroat fry present in all pools

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

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

BILL NYE CREEK DATE 8/9/80 AREA 42.8 M^2 SITE # ____
LENGTH 17.7 M

SPECIES	AGE	fl-RANGE	$\bar{fl}$	MEAN WEIGHT	C_1	$\bar{p}$	$\bar{n}$	TOTAL BIOMASS	No/M^2 DENSITY	BIOMASS DENSITY	No / linear meter
Rainbow	0+	32-58	47.7	1.20	23	0.8	28.75	34.47	0.67	0.81	1.62
	1+	75-102	88.3	7.61	9	0.8	11.25	85.58	0.26	2.00	0.64
	Σ							120.05	0.93	2.81	2.26
Cutthroat	1+	74-102	84.7	6.89	3	0.8	3.75	25.84	0.09	0.60	0.21
Dolly Varden	0+		49	1.18	1	0.8	1.25	1.47	0.03	0.03	0.07
M. whitefish	0+		64	3.54	1	0.8	1.25	4.42	0.03	0.10	0.07

HABITAT DESCRIPTION: pool - riffle habitat with small side pool

Discharge 0.01 m^3/s (0.25 cfs) Gradient 0.5 %

Temperature (°C) 7 Turbidity clear

Hydraulic Type	Pool	Glide	Riffle
% area	80		20
mean width	3.0		1.1
mean depth	0.45		0.05
% cover	16		0
cover type[1]	C, L, IV, OV		-
substrate[2]	F50, SG 15		F60, SG 30
	LG 30, B 5		LG 10

COMMENTS:

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

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

LAMPREY CREEK TRIBUTARY 5 DATE 3/9/80 AREA 14.7 M^2 SITE # ____ LENGTH 13.5 M

SPECIES	AGE	fl-RANGE	$\bar{fl}$	MEAN WEIGHT	C_1	$\bar{p}$	$\bar{n}$	TOTAL BIOMASS	No/M^2 DENSITY	BIOMASS DENSITY	No / linear meter
Cutthroat	0+	30-44	38.9	0.64	18	0.9	20.0	12.89	1.36	0.88	1.48
	1+	71-102	88.4	7.75	5	0.9	5.56	43.04	0.38	2.93	0.41
	Σ								1.74	3.81	1.89
Dolly Varden	0+		50	1.25	1	0.9	1.11	1.39	0.08	0.09	0.08
	1+	84-118	96.1	9.19	8	0.9	8.89	81.68	0.60	5.56	0.66
	Σ								0.68	5.65	0.74

HABITAT DESCRIPTION: pool - glide - riffle complex in small high gradient stream

Discharge 0.003 m^3/s (0.12 cfs) Gradient 5.5 %

Temperature (°C) 6 @ 1020 hrs Turbidity clear

Hydraulic Type	Pool	Glide	Riffle
% area	68	14	18
mean width	1.7	1.0	0.6
mean depth	0.13	0.06	0.02
% cover	26	15	0
cover type[1]	L, OV, C, B	OV, C	—
substrate[2]	F12, SG 15, LG 43 C 25, B 5	F 15, SG 50, LG 27 C 3	F 10, SG 57 LG 30, C 3

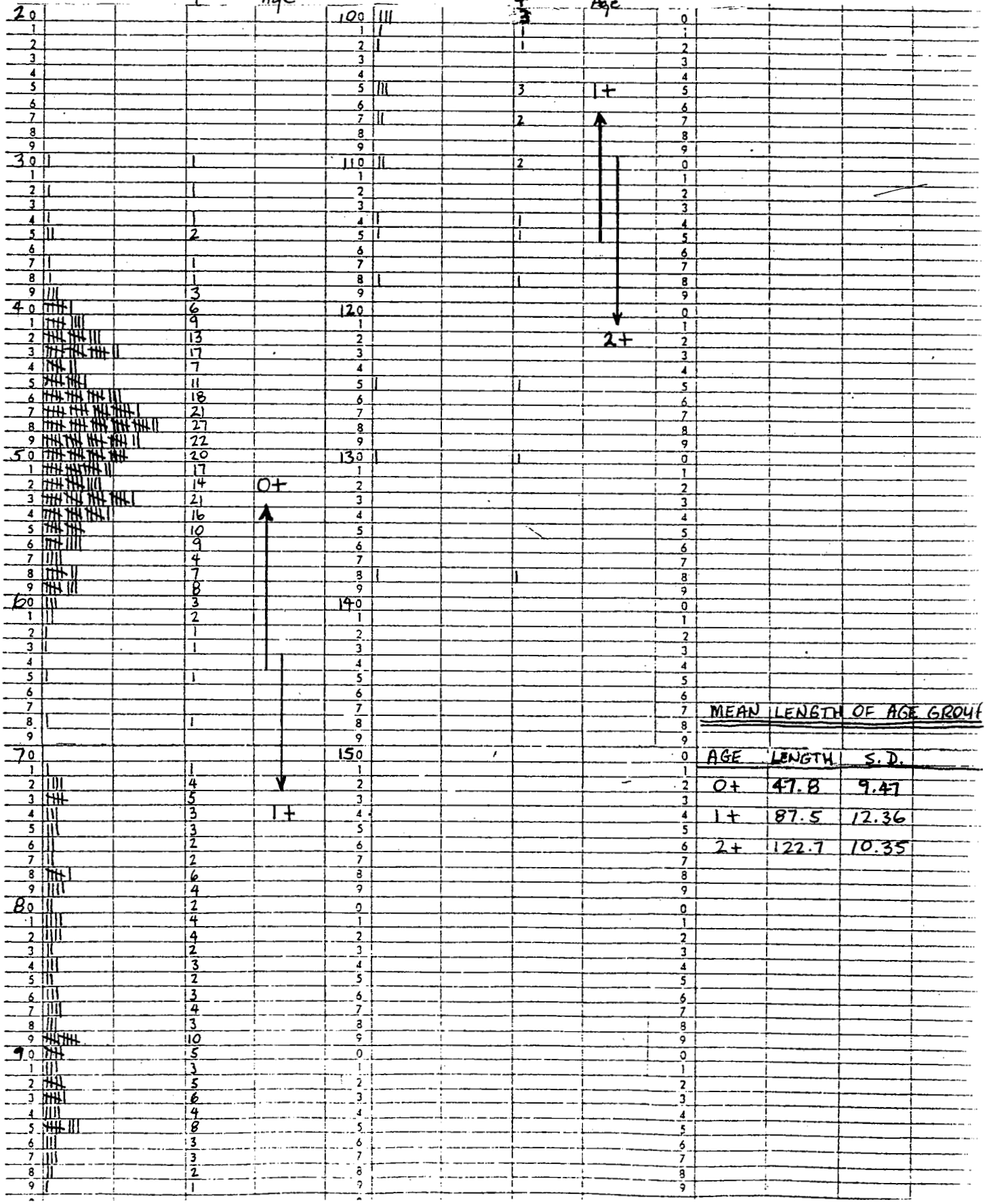
COMMENTS:

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

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

APPENDIX 2b Length frequency and length-weight data for Lamprey Creek steelhead and coho.

Lamprey Creek - juvenile steelhead length frequency.
(includes sites 1 to 11, Pumpernel and Lower Collins)



MEAN LENGTH OF AGE GROUP		
AGE	LENGTH	S.D.
0+	47.8	9.47
1+	87.5	12.36
2+	122.7	10.35

LENGTH-WEIGHT DATA - LAMPREY CREEK

1. Bridge site

   n = 22 $r^2 = 0.97$

   $a = 0.46$

   $b = 1.07014 \times 10^{-5}$

2. 32 mile bridge site

   n = 23 $r^2 = 0.98$

   $a = 4.3 \times 10^{-3}$ (.0043)

   $b = 1.064 \times 10^{-5}$

3. Combined

   n = 45 $r^2 = 0.97$

   $a = 0.23$

   $b = 1.065 \times 10^{-5}$

No significant difference between sites 1 and 2.

Empirical formula:

$$wt(g) = 1.065 \times 10^{-5}(\ell)^3$$

Lamprey Creek Length - Weight Data

red = bridge site
grey = mile 32 bridge

length (mm)	wt (g)
40	
41	1.95
42	
43	0.7, 1.7, 1.16, 0.8
44	0.83
45	1.85
46	1.1
47	1.3
48	1.38
49	1.26, 1.40, 1.21
50	1.21, 1.41
51	1.35
52	1.25
53	1.83
54	1.84
55	1.83
56	2.55, 3.85, 2.45
57	
58	
59	
60	1.86
61	2.31
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63	
64	
65	
66	
67	
68	
69	
70	
71	
72	4.05
73	3.92
74	
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76	
77	
78	
79	5.44
80	
81	
82	5.96, 5.97
83	
84	
85	
86	6.50
87	
88	6.9
89	6.95, 6.94
90	8.5
91	10.56
92	
93	10.9
94	
95	8.31
96	8.85
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98	9.8
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length (mm)	wt (g)
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111	16.4
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115	15.6
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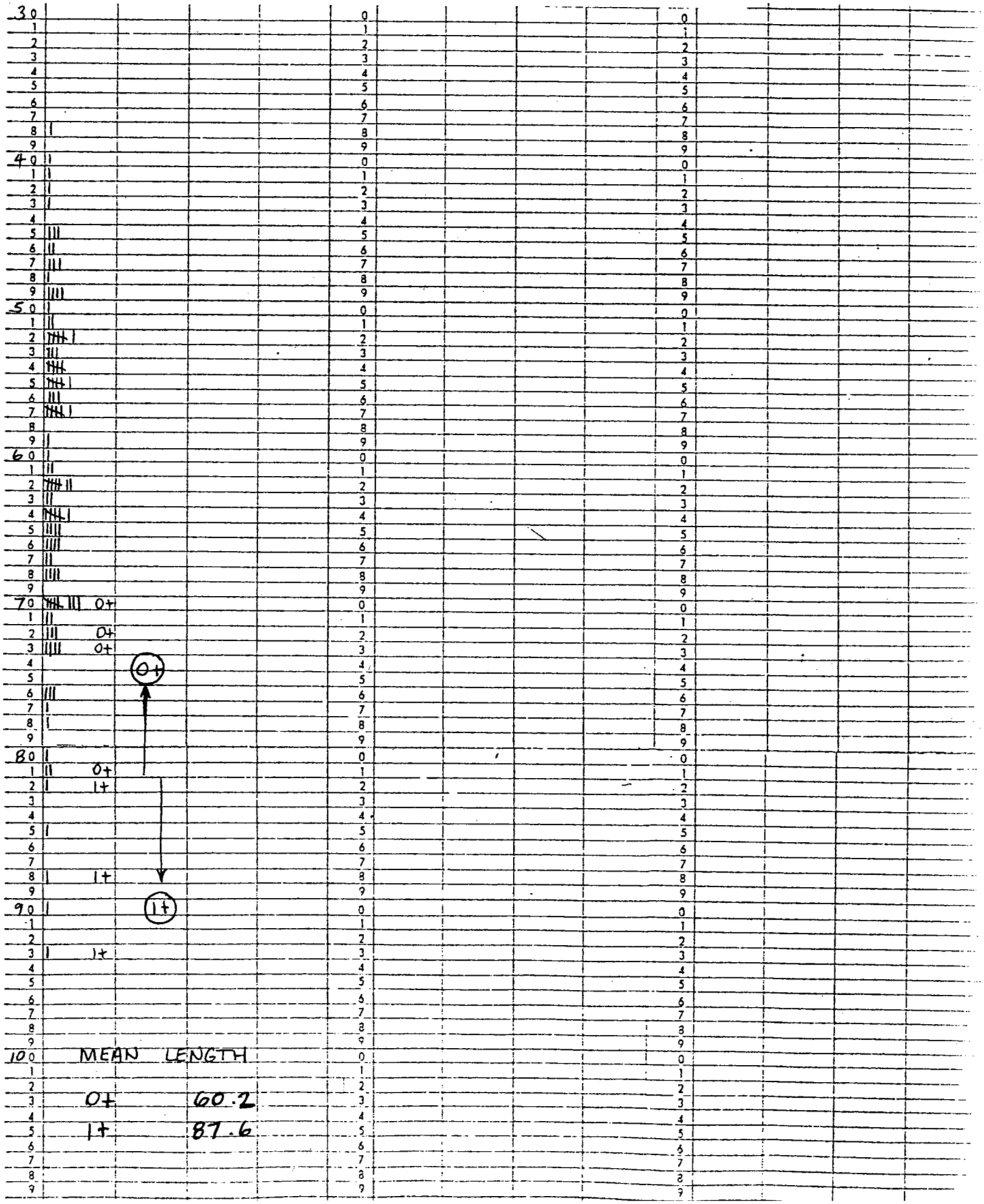
Cumulative length - frequency - Coho - Lamprey Creek



APPENDIX 3 Standing crop calculations for Lamprey Creek coho and steelhead based on distribution and mean density as sampled September 3 to 8, 1980.

Standing Crop Calculations for Lamprey Creek Coho
and Steelhead Based on Distribution and Mean Density
As Sampled September 3 to 8, 1980

a) Coho

Distribution of coho is taken as roughly 4.75km from the Morice confluence. No coho were found above this point.

Mean density in sample sites 1 through 4 was 0.31 fry/m^2 and 0.02 yearlings/m^2.

Total area of distribution equals 29,600m^2 in reach 1 and 7,900m^2 in reach 2; overall total was 37,500m^2.

0+ standing crop = 37,500m^2 x 0.31 fry/m^2 = 11,625 coho fry
1+ standing crop = 37,500m^2 x 0.02 yearlings/m^2 = 750 coho 1+

Mean fish weight = $1.20 \times 10^{-5}(\ell^3)$
$= 1.20 \times 10^{-5}(60.2)^3 = 2.62$ g/fry
$= 1.20 \times 10^{-5}(87.6)^3 = 8.07$ g/1+

Total biomass = 11,625 x 2.62g = 30.50kg fry
= 750 x 8.06g = 6.05kg 1+
36.55kg total

Assuming 100 coho smolts/kg biomass (standing crop), roughly 3,650 smolts may be produced. Adult return @ 1.25:1 catch to escapement and 15% smolt to adult survival equals 240.

b)

TABLE 1 Standing crop of steelhead in Lamprey Creek, Sept. 3 - 8, 1980.

	STANDING CROP (TABLE 2)	MEAN LENGTH (mm)	MEAN WEIGHT[1] (g)	BIOMASS (kg)
0+	44,750	47.8	1.16	51.910
1+	19,320	87.5	7.13	137.752
2+	1,116	122.7	19.67	21.952
Total				211.614

[1] condition factor = 1.065×10^{-5}

Theoretical steelhead smolt yield and adult escapement from Lamprey Creek based on yearling population and survival rates.

1+ standing crop	19,320	
		50% survival
estimated 2+ population	9,660	
		80% survival
estimated 3+ population	7,728	
		80% survival
estimated 4. smolt yield	6,180	

(This assumes 100% 4. smolt age. In fact roughly 25% smolt at 3., 70% at 4. and 5% at 5., therefore 4. yield may be regarded as minimum.)

		15% survival
adult production	928	
		3:1 catch:escapement
escapement	232	

TABLE 2 Calculation of steelhead standing crop in Lamprey Creek based on habitat type.

REACH	HABITAT	SITE	STEELHEAD DENSITY (fish/m^2) 0+	1+	2+	REACH HABITAT	AREA (m^2)	%	STEELHEAD NUMBERS 0+	1+	2+
1	pool	2	.08	.07	.01	pool	1,713	(6)	137	120	17
	glide/riffle	1	.32	.10	0	glide	10,685	(36)}	5,380	2,062	90
		3	.28	.13	.01	riffle	17,244	(58)}			
		$\bar{x}$	.30	.115	.005		29,642		5,417	2,182	107
2	pool	4	.70	.44	.05	pool	33,050	(75)	13,881	8,263	661
		6	.14	.26	.02						
		9	.43	.04	0						
		$\bar{x}$	.42	.25	.02						
	glide	8	.49	.11	.01	glide	4,764	(11)	2,334	524	48
	riffle	5	.29	0	0	riffle	6,042	(14)	2,356	0	0
		7	.48	0	0						
		$\bar{x}$	.39	0	0				18,571	8,787	1,009
3	pool/glide	10	.39	.12	0	representative	24,721		9,641	2,967	0
4	pool/glide/riffle	11	.12	.17	0	representative	11,785		1,414	2,003	0
Pimpernel	glide/riffle		.51	.19	0	representative	17,797		9,076	3,381	0
Total			.35	.15	.009		127,800		44,749	19,320	1,116

APPENDIX 4 Projected benefits (smolt yield) from Lamprey Creek enhancement.

a) Flow control

	AREA (m^2)	YEARLING DENSITY			INCREASED YEARLING NUMBERS
		Present	Enhanced	Increase	
Collins Creek	5,950	0.07	0.15	0.08	480
Reach 1	29,600	0.10	0.15	0.05	1,480
					1,960

Assuming 0.3 smolts/yearling roughly 590 smolts, 88 adults, and 20 adult escapement might be produced.

b) Fry stocking

(i) range extension to reach 5

	AREA	FRY DENSITY (NO./M^2)			FRY NO. REQUIRED	YEARLING INCREASE	
		Present	Enhanced	Increase			
reach 4	11,800	0.35	0.70	0.35	4,100	0.07	826
reach 5	22,600	0	0.70	0.70	15,800	0.15	3,390
					19,900		4,216

Assuming 0.3 smolts/yearling roughly 1,265 smolts, 190 adults, and 50 adult escapement might be produced.

(ii) ensuring adequate recruitment

Assuming that fry to yearling survival would remain high at roughly 20%, the 1980 fry population is expected to produce a 1981 parr population roughly 1/2 that observed in 1980 (0.08 compared to 0.15/m^2). Adequate recruitment (0.70 fry/m^2 to produce 0.15 yearlings/m^2) on an annual basis would ensure the highest possible yearling and (subsequently) smolt production. If we assume 1/2 the fry population will produce 1/2 the yearling population, and subsequently 1/2 the smolt population, then escapement would fluctuate by the same magnitude (270 to 540).

APPENDIX 5 Summary of habitat characteristics of Owen Creek.

Habitat characteristics of Reach 1

HABITAT TYPE
REACH LENGTH (m) 3950

Habitat unit	POOL		RIFFLE		GLIDE	
	Value	%	Value	%	Value	%
No. of units sampled	2		10		12	
Average length (m)	8.0		6.2		15.8	
Average wetted width (m)	8.0		7.1		5.2	
Average channel width (m)	17.5		12.2		10.8	
Average depth (cm)	88		13		40	
Average area (m^2)	64		48		104	
Total no. of units in reach	29		147		177	
Total area of units in reach (m^2)	1860	7	7060	26	18400	67
Average area log debris cover (m^2)	1.5		1.0		1.8	
Average area boulder cover (m^2)	0		0.4		0.2	
Average area instream vegetation (m^2)	0		0.2		0.2	
Average area overstream vegetation (m^2)	1.8		0.8		1.8	
Average area cutbanks (m^2)	2.0		0.8		0.7	
Average area total cover (m^2)	4.3	6.6	3.2	6.6	4.7	4.5
Average % substrate fines		70		8		33
Average % substrate small gravel		30		49		39
Average % substrate large gravel		0		32		22
Average % substrate cobbles		0		10		5
Average % substrate boulder		0		1		1
Average % substrate bedrock		0		0		0

Habitat characteristics of Reach 2

HABITAT TYPE
REACH LENGTH (m) 850

Habitat unit	POOL Value	%	RIFFLE Value	%	GLIDE Value	%
No. of units sampled	0		6		6	
Average length (m)			8.5		29.5	
Average wetted width (m)			9.5		11.5	
Average channel width (m)			11.0		14.3	
Average depth (cm)			18		38	
Average area (m^2)			71		315	
Total no. of units in reach			22		22	
Total area of units in reach (m^2)			1560	18	6930	82
Average area log debris cover (m^2)			6.1		5.7	
Average area boulder cover (m^2)			2.7		3.7	
Average area instream vegetation (m^2)			0		0.4	
Average area overstream vegetation (m^2)			1.8		6.7	
Average area cutbanks (m^2)			0.3		1.2	
Average area total cover (m^2)			10.8	15.2	17.7	5.6
Average % substrate fines			7		15	
Average % substrate small gravel			28		17	
Average % substrate large gravel			28		29	
Average % substrate cobbles			26		23	
Average % substrate boulder			11		15.5	
Average % substrate bedrock			0		0.5	

Habitat characteristics of Reach 3

HABITAT TYPE Slough
REACH LENGTH (m) 1700

Habitat unit	POOL Value	%	RIFFLE Value	%	GLIDE Value	%
No. of units sampled	1					
Average length (m)	1700					
Average wetted width (m)	75					
Average channel width (m)	75					
Average depth (cm)	120					
Average area (m^2)	127,500					
Total no. of units in reach	1					
Total area of units in reach (m^2)	127,500					
Average area log debris cover (m^2)	12,750					
Average area boulder cover (m^2)	0					
Average area instream vegetation (m^2)	38,250					
Average area overstream vegetation (m^2)	12,750					
Average area cutbanks (m^2)	0					
Average area total cover (m^2)	63,750					
Average % substrate fines	100					
Average % substrate small gravel	0					
Average % substrate large gravel	0					
Average % substrate cobbles	0					
Average % substrate boulder	0					
Average % substrate bedrock	0					

Habitat characteristics of Reach 4

HABITAT TYPE
REACH LENGTH (m) 1000

Habitat unit	POOL Value	%	RIFFLE Value	%	GLIDE Value	%
No. of units sampled	2		5		5	
Average length (m)	21.5		8.0		29.6	
Average wetted width (m)	9.0		9.0		9.3	
Average channel width (m)	12.0		13.4		13	
Average depth (cm)	85		33		48	
Average area (m^2)	194		71		270	
Total no. of units in reach	9		22		22	
Total area of units in reach (m^2)	1746	19	1562	17	5940	64
Average area log debris cover (m^2)	12		13.2		44.8	
Average area boulder cover (m^2)	0		0		0	
Average area instream vegetation (m^2)	3		0		5.4	
Average area overstream vegetation (m^2)	2.5		0.6		6.6	
Average area cutbanks (m^2)	1		1.3		12.8	
Average area total cover (m^2)	18.5	9.5	15.1	21	69.6	26
Average % substrate fines	80		36		72	
Average % substrate small gravel	15		37		16	
Average % substrate large gravel	2.5		27		12	
Average % substrate cobbles	2.5		0		0	
Average % substrate boulder						
Average % substrate bedrock						

Habitat characteristics of Reach 5

HABITAT TYPE
REACH LENGTH (m) 4,650 m

Habitat unit	POOL		RIFFLE		GLIDE	
	Value	%	Value	%	Value	%
No. of units sampled	3		4		4	
Average length (m)	13.00	(25)	6.75	(18)	22.25	(57)
Average wetted width (m)	10.67		7.00		7.25	
Average channel width (m)	16.33		13.50		15.00	
Average depth (cm)	1.20		0.19		0.46	
Average area (m^2)	175.00	(39)	51.50	(15)	155.25	(46)
Total no. of units in reach	89.42		124.00		119.12	
Total area of units in reach (m^2)	15649.04		6386.00		18493.94	
Average area log debris cover (m^2)	3.67		1.25		11.75	
Average area boulder cover (m^2)	0.00		2.00		1.25	
Average area instream vegetation (m^2)	0.00		0.00		0.00	
Average area overstream vegetation (m^2)	8.67		2.25		12.50	
Average area cutbanks (m^2)	5.33		0.75		6.25	
Average area total cover (m^2)	17.67	(10)	6.25	(12)	31.75	(20)
Average % substrate fines	63.33		3.75		2250	
Average % substrate small gravel	36.67		17.50		51.25	
Average % substrate large gravel	0.00		46.25		21.25	
Average % substrate cobbles	0.00		25.00		3.75	
Average % substrate boulder	0.00		7.50		1.25	
Average % substrate bedrock	0.00		0.00		0.00	

Habitat characteristics of Reach 6

HABITAT TYPE
REACH LENGTH (m) 1,600 m

Habitat unit	POOL Value	%	RIFFLE Value	%	GLIDE Value	%
No. of units sampled	3		11		9	
Average length (m)	18.33	(25)	5.89	(29)	11.22	(46)
Average wetted width (m)	4.13		2.88		2.83	
Average channel width (m)	12.00		12.50		11.80	
Average depth (cm)	0.35		0.07		0.23	
Average area (m^2)	84.27	(36)	13.80	(22)	33.0	(42)
Total no. of units in reach	21.82		78.78		65.60	
Total area of units in reach (m^2)	1838.95		1087.13		2164.71	
Average area log debris cover (m^2)	0.67		0.09		2.18	
Average area boulder cover (m^2)	0.00		0.00		0.00	
Average area instream vegetation (m^2)	0.33		0.01		0.00	
Average area overstream vegetation (m^2)	0.25		0.09		10.17	
Average area cutbanks (m^2)	0.17		0.06		1.31	
Average area total cover (m^2)	1.42	(2)	0.25	(2)	6.88	(21)
Average % substrate fines	45.00		9.09		11.78	
Average % substrate small gravel	25.00		26.82		26.17	
Average % substrate large gravel	21.67		40.00		41.67	
Average % substrate cobbles	8.33		26.36		20.44	
Average % substrate boulder	0.00		0.45		0.56	
Average % substrate bedrock	0.00		0.00		0.00	

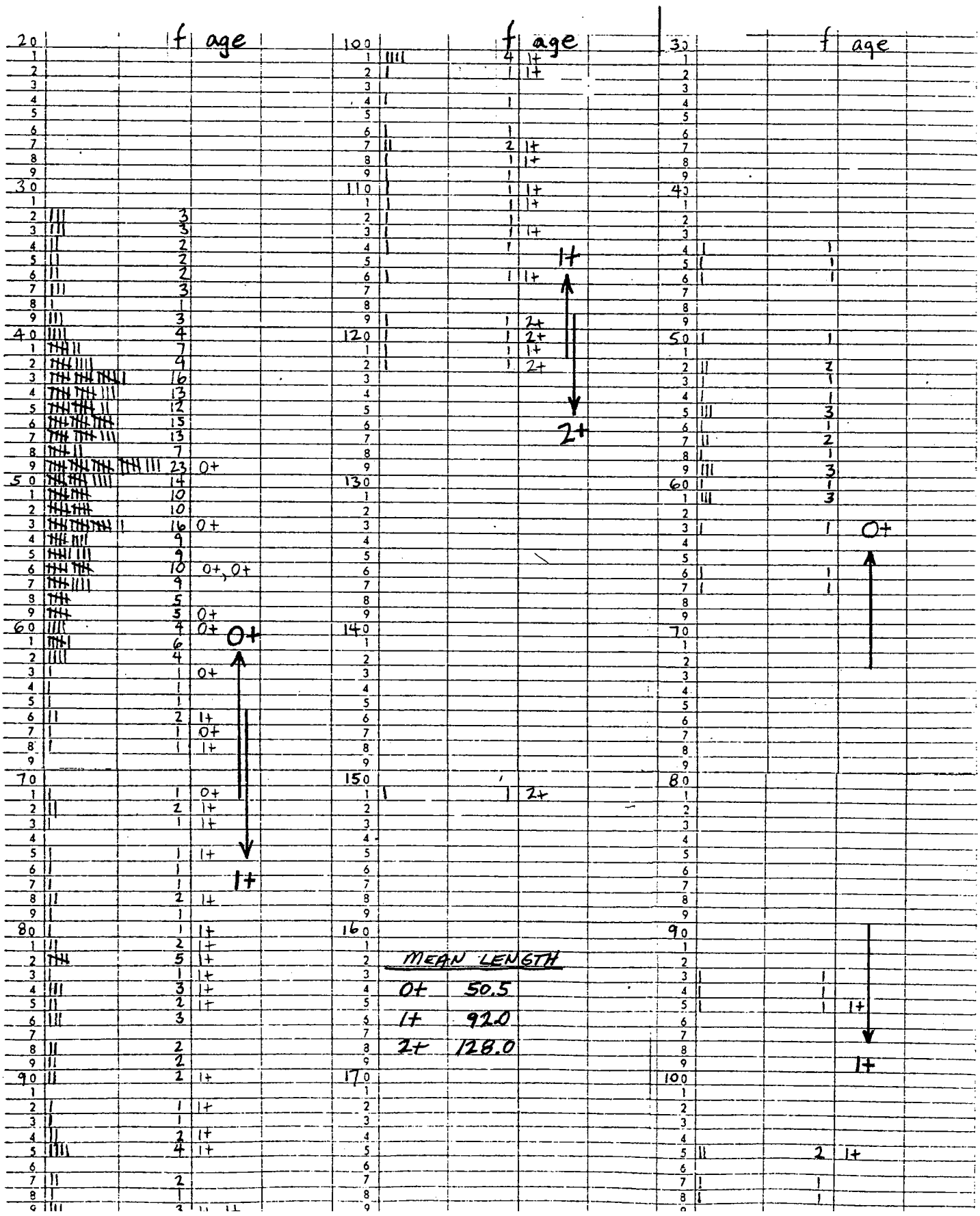
Habitat characteristics of Klate Creek (Queen Lake tributary).

HABITAT TYPE
REACH LENGTH (m) 4,060 m

Habitat unit	POOL		RIFFLE		GLIDE	
	Value	%	Value	%	Value	%
No. of units sampled	1		6		5	
Average length (m)	2.5	(5)	4.17	(51)	5.80	(44)
Average wetted width (m)	2		1.95		2.60	
Average channel width (m)	4		2.75		3.10	
Average depth (cm)	0.35		0.13		0.26	
Average area (m^2)	5	(4)	7.73	(59)	15.00	(37)
Total no. of units in reach	81.20		496.55		308.00	
Total area of units in reach (m^2)	406.00		3838.31		4620.00	
Average area log debris cover (m^2)	1		2.25		5.00	
Average area boulder cover (m^2)	0		0.00		0.00	
Average area instream vegetation (m^2)	0		0.00		0.00	
Average area overstream vegetation (m^2)	1		4.17		6.20	
Average area cutbanks (m^2)	.5		0.58		1.10	
Average area total cover (m^2)	2.5	(50)	7.00	(91)	12.30	(82)
Average % substrate fines	60		23.33		42.00	
Average % substrate small gravel	40		63.33		46.00	
Average % substrate large gravel	0		13.33		12.00	
Average % substrate cobbles	0		0.00		0.00	
Average % substrate boulder	0		0.00		0.00	
Average % substrate bedrock	0		0.00		0.00	

APPENDIX 6 Results of Owen Creek fish population estimates.

Owen Creek : Cumulative length - frequency analysis.



Mean fry size by sample site in Owen Creek.

REACH	SITE	MEAN FRY SIZE (fork length [mm])
1	1	45.0
	2	46.4
	3	51.1
2	4	55.5
3	5	-
4	6	53.8
5	7	52.2
6	8	43.2
	9	42.6
Klate Creek		44.0
mean 1 - 5		50.7
mean 6 and Klate Creek		43.3

OWEN CREEK DATE 5/9/81 AREA 81.5 M^2 SITE # 1
LENGTH 21.7 M

SPECIES	AGE	fl-RANGE	$\bar{fl}$	MEAN WEIGHT	C_1	$\bar{p}$	$\bar{n}$	TOTAL BIOMASS	No/M^2 DENSITY	BIOMASS DENSITY	No / linear meter
Rainbow	0+	32-62	45.0	1.03	51	0.8	63.75	65.63	0.78	0.81	2.94
	1+	68-94	82.1	6.03	12	0.8	15.0	90.38	0.18	1.11	0.69
	Σ							156.01	0.96	1.92	3.63
Coho	0+	45-67	56.2	2.21	16	0.8	20.0	44.17	0.25	0.54	0.92
Dolly Varden	1+		108	12.60	1	0.8	1.25	15.75	0.02	0.19	0.06

HABITAT DESCRIPTION: side channel of main stream

Discharge 0.11 m^3/s (4 cfs) Gradient 1.2 %

Temperature (°C) 9 @ 1345 hrs. Turbidity 0.7 m

Hydraulic Type	Pool	Glide	Riffle
% area		85	15
mean width		4.75	3.0
mean depth		0.25	0.075
% cover		14	5
cover type[1]		L, OV, C, IV	IV, OV, C
substrate[2]		F 60, SG 35, C 5	F 10, SG 90

COMMENTS:

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

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

OWEN CREEK DATE 5/9/81 AREA 96.9 M^2 SITE # 2
LENGTH 8.4 M

SPECIES	AGE	fl-RANGE	$\bar{fl}$	MEAN WEIGHT	C_1	$\bar{p}$	$\bar{n}$	TOTAL BIOMASS	No/M^2 DENSITY	BIOMASS DENSITY	No / linear meter
Rainbow	0+	42-57	46.4	1.10	18	0.5	36.0	39.46	0.37	0.41	4.29
	1+		76	4.68	1	0.5	2.0	9.35	0.02	0.10	0.24
	Σ							48,81	0.39	0.51	4.53
Coho	0+	55-61	57.8	2.32	4	0.5	8.0	18.57	0.08	0.19	0.95

HABITAT DESCRIPTION: Gravel riffle area with back channel

Discharge 0.75 m^3/s (26 cfs) Gradient

Temperature (°C) 9 @ 1400 hrs Turbidity 0.7 m

Hydraulic Type	Pool	Glide	Riffle
% area	22		78
mean width	3.4		8.3
mean depth	0.40		0.15
% cover	15		0
cover type[1]	L, IV, OV		
substrate[2]	F 100		F 5, SG 55, LG 40

COMMENTS: Pool in this site was actually a back channel. This site represents a fry habitat sample only as downstream stop net was washed out during sampling.

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

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

OWEN CREEK DATE 5/9/81 AREA 92.6 M^2 SITE # 3

LENGTH 15.5 M

SPECIES	AGE	fl-RANGE	$\bar{fl}$	MEAN WEIGHT	C_1	$\bar{p}$	$\bar{n}$	TOTAL BIOMASS	No/M^2 DENSITY	BIOMASS DENSITY	No / linear meter
Rainbow	0+	44-62	51.1	1.46	58	0.8	72.5	105.57	0.78	1.14	4.68
	1+	72-114	85.9	7.20	8	0.8	10.0	71.97	0.11	0.78	0.65
	Σ							177.54	0.89	1.92	5.33
Coho	0+	44-65	56.7	2.27	6	0.8	7.5	17.01	0.08	0.18	0.48
Dolly Varden	0+	56-58	57	1.85	3	0.8	3.75	6.95	0.04	0.08	0.24
m. whitefish	Σ	74-123	93	12.68	3	0.8	3.75	47.54	0.04	0.51	0.24

HABITAT DESCRIPTION: glide with small side pool

Discharge 0.75 m^3/s (26 cfs) approx. Gradient 1-2%

Temperature (°C) 9 Turbidity 0.6 m

Hydraulic Type	Pool	Glide	Riffle
% area	10	90	
mean width	3	6	
mean depth	–	0.40	
% cover	–	2	
cover type[1]	L	L	
substrate[2]	F SG	F40, SG40, LG20	

COMMENTS: pool not described

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

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

OWEN CREEK DATE 6/9/80 AREA 123.8 M^2 SITE # 4

LENGTH 18 M

SPECIES	AGE	fl-RANGE	$\bar{fl}$	MEAN WEIGHT	C_1	$\bar{P}$	$\bar{n}$	TOTAL BIOMASS	No/M^2 DENSITY	BIOMASS DENSITY	No / linear meter
Rainbow	0+	44-71	55.5	1.89	42	0.65	64.6	121.99	0.52	0.99	3.59
	1+	77-101	91.7	8.37	11	0.65	16.9	141.69	0.14	1.14	0.94
	Σ							263.68	0.66	2.13	4.53
Dolly Varden	0+		58	1.95	1	0.65	1.54	3.00	0.01	0.02	0.09
m. whitefish	Σ		146	42.01	1	0.65	1.54	64.64	0.01	0.52	0.09
fs. sucker	Σ		143	40.3	1	0.65	1.54	62.06	0.01	0.50	0.09

HABITAT DESCRIPTION: riffle and head of glide in confined "canyon" type area

Discharge 0.8 m^3/s (28 cfs) Gradient 1.5%

Temperature (°C) 9° Turbidity 0.9 m

Hydraulic Type	Pool	Glide	Riffle
% area		54	46
mean width		9	9
mean depth		0.6	0.15
% cover		12	14
cover type[1]		L, OV, B, IV	OV, L, B, C
substrate[2]		F40, SG 30, LG20, C 5, B 2.5, Br 2.5	SG 20, LG 40, C 35, B 5

COMMENTS:

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

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

OWEN CREEK DATE 6/9/80 AREA 75 M² SITE # 5
LENGTH 15 M

SPECIES	AGE	fl-RANGE	$\bar{fl}$	MEAN WEIGHT	C_1	$\bar{p}$	$\bar{n}$	TOTAL BIOMASS	No/M² DENSITY	BIOMASS DENSITY	No / linear meter
Rainbow	1+	75-85	80.3	5.65	3	0.65	4.62	25.68	0.06	0.34	0.31
	2+		122	19.34	1	0.65	1.54	29.75	0.02	0.40	0.10
								55.43	0.08	0.74	0.41
Coho	1+	93-108	101	12.50	7	0.65	10.77	134.63	0.14	1.80	0.72

HABITAT DESCRIPTION: slough type habitat in one channel of braided swamp downstream of beaver dam

Discharge — Gradient 0

Temperature (°C) 8.5 Turbidity 0.7 m

Hydraulic Type	Pool	Glide	Riffle
% area	100		
mean width	4		
mean depth	1.2		
% cover	50		
cover type[1]	IV, OV, L		
substrate[2]	F 100		

COMMENTS: very heavy cover from rooted shrubs, grasses and aquatic weeds

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

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

OWEN CREEK DATE 5/9/80 AREA 130 M^2 SITE # 6
LENGTH 10 M

SPECIES	AGE	fl-RANGE	$\overline{fl}$	MEAN WEIGHT	C_1	$\overline{p}$	$\overline{n}$	TOTAL BIOMASS	No/M^2 DENSITY	BIOMASS DENSITY	No / linear meter
Rainbow	0+	44-66	53.8	1.71	17	0.8	21.25	36.24	0.16	0.28	2.13
	1+	82-101	89.9	7.88	9	0.8	11.25	88.66	0.09	0.68	1.13
	Σ							124.90	0.25	0.96	3.26
Dolly Varden	0+	52-65	56.6	1.85	5	0.8	6.25	11.55	0.05	0.09	0.63
	≥1+	77-153	120.7	21.13	3	0.8	3.75	79.23	0.03	0.61	0.38
	Σ							90.78	0.08	0.70	1.01

HABITAT DESCRIPTION: riffle glide area

Discharge 0.6 m^3/s (21 cfs) Gradient 0.5 %

Temperature (°C) 9 Turbidity 0.85 m

Hydraulic Type	Pool	Glide	Riffle
% area		71	29
mean width		13	7
mean depth		0.65	0.30
% cover		6	7
cover type[1]		L, C	L, C
substrate[2]		F80, SG10, LG10	F50, SG25, LG25

COMMENTS: sampled 2 riffles and portion of long glide

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

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

OWEN CREEK DATE 5/9/80 AREA 104 M^2 SITE # 7
LENGTH 20.2M

SPECIES	AGE	fl-RANGE	$\bar{fl}$	MEAN WEIGHT	C_1	$\bar{p}$	$\bar{n}$	TOTAL BIOMASS	No/M^2 DENSITY	BIOMASS DENSITY	No / linear meter
Rainbow	0+	42-62	52.2	1.55	32	0.75	42.67	66.28	0.41	0.64	2.11
	1+	80-121	102.3	11.74	17	0.75	22.67	266.15	0.22	2.56	1.12
	2+	119-151	135	27.31	2	0.75	2.67	72.82	0.03	0.70	0.13
	Σ							405.25	0.66	3.90	3.36
Dolly Varden	0+		56	1.76	1	0.75	1.33	2.34	0.01	0.02	0.07
	≥1+	111-205	137.1	29.37	8	0.75	10.67	313.23	0.10	3.01	0.53
	Σ							315.57	0.11	3.03	0.60

HABITAT DESCRIPTION: glide - riffle in small and large gravel area

Discharge 0.8 m^3/s (30 cfs) Gradient 1.7%

Temperature (°C) 8 Turbidity 0.6 m

Hydraulic Type	Pool	Glide	Riffle
% area		89	11
mean width		5.4	3.6
mean depth		0.70	0.30
% cover		19	32
cover type[1]		L, OV, C, B	B, OV
substrate[2]		F30, SG 50, LG 15	F5, SG25, LG 35
		B5	C10, B30

COMMENTS: - side riffle areas created by higher than normal flow conditions; not utilized by fry ∴ not included in area
- boulders resulting from road rip-rap

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

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

OWEN CREEK DATE 5/9/80 AREA 526 M^2 SITE # 8
LENGTH 54 M

SPECIES	AGE	fl-RANGE	$\bar{fl}$	MEAN WEIGHT	C_1	$\bar{p}$	$\bar{n}$	TOTAL BIOMASS	No/M^2 DENSITY	BIOMASS DENSITY	No / linear meter
Rainbow	0+	32-56	43.2	0.94	13	0.5	26.0	24.36	0.05	0.05	0.48
	1+	108-112	110	14.18	3	0.5	6.0	85.11	0.01	0.16	0.11
	2+		120	18.40	1	0.5	2.0	36.81	<0.01	0.07	0.04
	Σ							146.28	0.06	0.28	0.63
Sculpins	Σ	30-33	31.7	0.32	3	0.5	6.0	1.91	0.01	<0.01	0.11
Suckers	Σ	28-71	43.3	1.65	16	0.5	32.0	52.70	0.06	0.10	0.59
Squawfish	Σ	18-55	39.7	1.90	47	0.5	94.0	178.37	0.18	0.34	1.74

HABITAT DESCRIPTION: slough habitat in swamp

Discharge — Gradient 0

Temperature (°C) 12 Turbidity —

Hydraulic Type	Pool	Glide	Riffle
% area	100		
mean width	9.7		
mean depth	0.5		
% cover	90		
cover type[1]	IV, L		
substrate[2]	F100		

COMMENTS: 0.7 km downstream from Owen Lake. All trout parr and most fry drawn from vegetation close to open water - not in dense instream vegetation. Site representative of habitat in the area.

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

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

OWEN CREEK DATE 5/9/80 AREA 40.7 M^2 SITE # 9
LENGTH 10.3 M

SPECIES	AGE	fl-RANGE	$\bar{fl}$	MEAN WEIGHT	C_1	$\bar{p}$	$\bar{n}$	TOTAL BIOMASS	No/M^2 DENSITY	BIOMASS DENSITY	linear No / meter
Rainbow	0+	32-53	42.6	0.85	30	0.7	42.86	36.58	1.05	0.90	4.16
	1+		107	13.05	1	0.7	1.43	18.64	0.04	0.46	0.14
	Σ							55.22	1.09	1.36	4.30
Sculpins	Σ	22-72	34.6	0.64	25	0.7	35.71	22.95	0.88	0.56	3.47

HABITAT DESCRIPTION: pool - riffle in gravel area just below Owen Lake

Discharge 0.1 m^3/s (3.5 cfs) Gradient < 0.5 %

Temperature (°C) 12 Turbidity clear

Hydraulic Type	Pool	Glide	Riffle
% area	76		24
mean width	4.4		3.0
mean depth	0.35		0.10
% cover	3		0
cover type[1]	L		—
substrate[2]	F 15, SG 10, LG 50		F 5, SG 20, LG 55
	C 25		C 30

COMMENTS:

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

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

KLATE CREEK (OWEN L. TRIB.) DATE 6/9/80 AREA 24.4 M² SITE # 1
LENGTH 9.0 M

SPECIES	AGE	fl-RANGE	$\bar{fl}$	MEAN WEIGHT	C_1	$\bar{p}$	$\bar{n}$	TOTAL BIOMASS	No/M² DENSITY	BIOMASS DENSITY	No / linear meter
Rainbow	0+	38-53	44.0	0.94	8	0.85	9.41	8.85	0.39	0.36	1.05
	1+	72-92	80.0	5.58	6	0.85	7.06	39.40	0.29	1.61	0.78
	Σ							48.25	0.68	1.97	1.83
Dolly Varden	0+	48-49	48.5	1.14	2	0.85	2.35	2.69	0.10	0.11	0.26

HABITAT DESCRIPTION: Glide - riffle representative of the stream

Discharge 0.02 m³/s (0.75 cfs) Gradient 2.5%

Temperature (°C) — Turbidity clear

Hydraulic Type	Pool	Glide	Riffle
% area		86	14
mean width		3.0	1.7
mean depth		0.25	0.10
% cover		64	74
cover type[1]		L, OV, C	L, OV, C
substrate[2]		F40, SG50, LG10	F20, SG70, LG10

COMMENTS:

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

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

APPENDIX 7 Owen Creek standing crop calculations.

a) Coho

(i) Fry

density $0.14/m^2$ in reach 1

area $27,320\ m^2$

standing crop 3,825 (7.9 kg)

mean weight = $1.2 \times 10^{-5}(55.6)^3 = 2.06g$

(ii) Yearlings

density $0.14/m^2$ in reach 3

area $127,500\ m^2$

standing crop 17,850 (216 kg)

mean weight = $1.2 \times 10^{-5}(100.3)^3 = 12.1g$

b) Steelhead

REACH	HABITAT	SITE	STEELHEAD DENSITY 0+	STEELHEAD DENSITY 1+	STEELHEAD DENSITY 2+	REACH HABITAT	AREA (m^2)	%	STEELHEAD NUMBER 0+	STEELHEAD NUMBER 1+	STEELHEAD NUMBER 2+
1	side channel complex	1	.78	.18	0	pool[a]	1,860	(7)	1,450	204	0
	riffle area	2	.37	.02	0	riffle	7,060	(26)	2,610	52	0
	glide (pool)	3	.78	.11	0	glide	18,400	(67)	14,350	2,024	0
			.64	.10	0		27,320		18,410	2,280	0
2	glide-riffle (representative)	4	.52	.14	0	glide riffle	8,490		4,410	1,190	0
3	slough (representative)	5	0	.06	.02	slough	127,500		0	7,650	2,550
4	riffle glide (representative)	6	.16	.09	0	glide-pool-riffle	9,250		1,480	830	0
5	glide-riffle (representative)	7	.41 (.20)[b]	.22 (.11)	.03 (.015)	glide-pool-riffle	20,270 (20,270)		8,310 4,050	4,460 2,230	600 300
			.30	.17	.02		40,440		12,360	6,690	900
6	slough	8	(.025)	(.005)	(.005)	pool (slough)	1,840	(36)	46	10	10
	pool-riffle	9	(.502)	(.02)	0	riffle glide	3,250	(64)	1,630	65	0
			.261	.013	.003		5,090		1,676	75	10
							218,200		38,330 (.18/m^2)	18,715 (.086/m^2)	3,460 (.016/m^2)

[a] reach 1 pool densities assumed equal to glide densities

[b] half of rainbow population in upper half of reach 5 and reach 6 is assumed lake resident

Steelhead standing crop

fry biomass (kg) = $38,330 \times (1.065 \times 10^{-5}(50.5)^3)$

= $38,330 \times 1.37g$ = 52.5 kg

yearling biomass (kg) = $18,715 \times (1.065 \times 10^{-5}(92.0)^3)$

= $18,715 \times 8.29g$ = 155.1 kg

2+ biomass (kg) = $3,460 \times (1.065 \times 10^{-5}(128)^3)$

= $3,460 \times 22.33g$ = 77.3 kg

total biomass = 284.9 kg

APPENDIX 8 Projected benefits (smolt yield) from Owen Creek enhancement.

a) Flow control

	AREA (m^2)	YEARLING DENSITY (NO./M^2)			INCREASED YEARLING NUMBERS
		PRESENT	ENHANCED	INCREASE	
Reach 1	27,320	.10	.15	.05	1,366
Reach 2	8,490	.14	.15	.01	85
					1,450

Assuming 0.3 smolts/yearling roughly 435 smolts, 65 adults and 16 adult escapement might be produced.

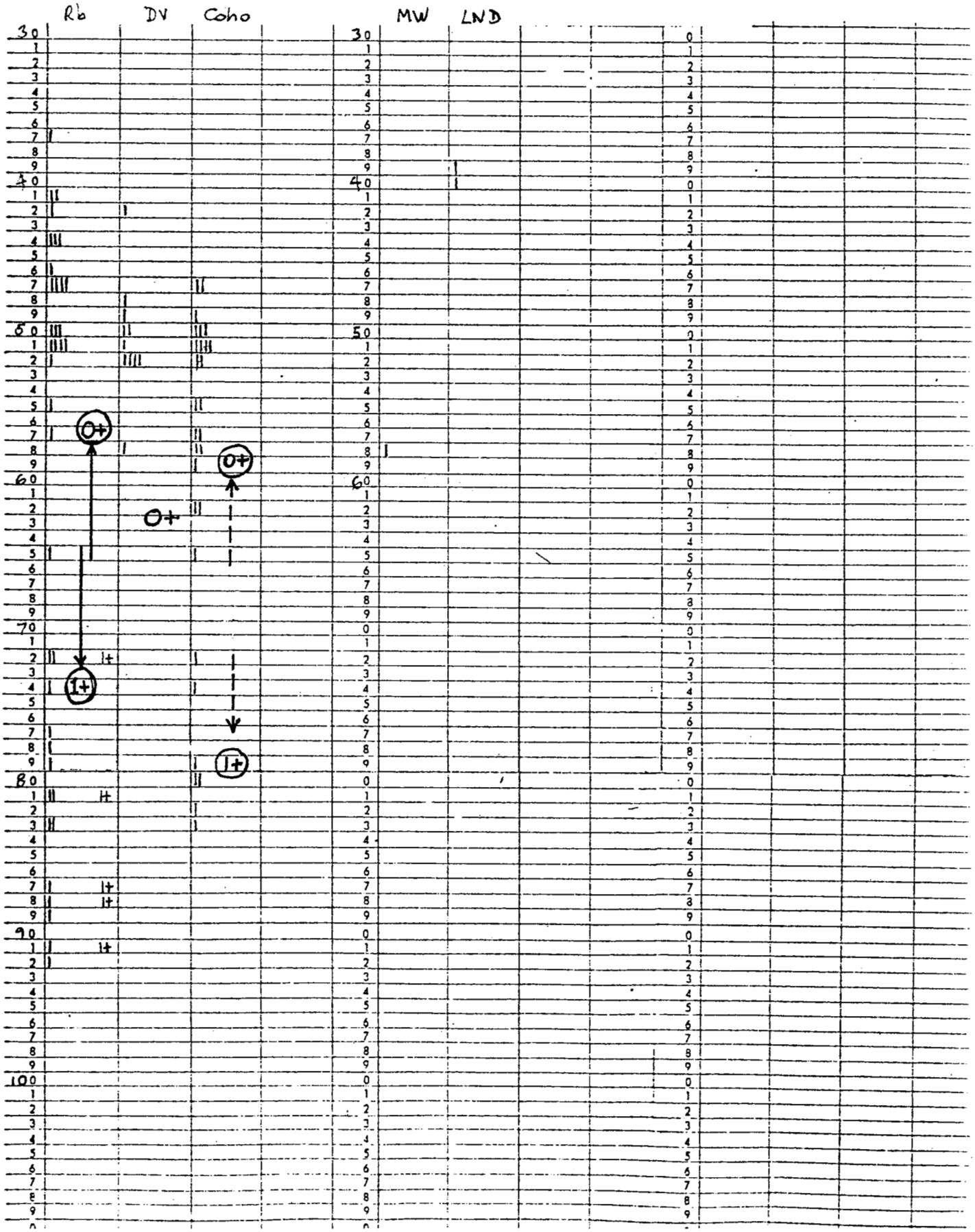
b) Fry recruitment (via stocking and gravel introduction)

	AREA (m^2)	FRY DENSITY (NO./M^2)			FRY NO. REQUIRED	YEARLING INCREASE	
		PRESENT	ENHANCED	INCREASE		DENSITY	NUMBERS
Owen Creek	227,000	0.18	0.7	0.52	118,000	.064	14,500

Assuming 0.3 smolts/yearling roughly 4,350 smolts, 650 adults and 160 adult escapement might be produced.

APPENDIX 9 Results of Gosnell Creek fish population estimates.

Length - frequency of fish captures in Gosnell Creek and a tributary, Cox Creek, September 8, 1980



GOSNELL CREEK DATE 8/9/80 AREA 168 M^2 SITE # 1
LENGTH 21 M

SPECIES	AGE	fl-RANGE	$\bar{fl}$	MEAN WEIGHT	C_1	$\bar{p}$	$\bar{n}$	TOTAL BIOMASS	No/M^2 DENSITY	BIOMASS DENSITY	No / linear meter
Rainbow	0+	37-65	49.2	1.32	18	0.6	30.0	39,68	0.18	0.24	1.43
	1+	77-92	82.4	6.04	11	0.6	18.33	110.78	0.11	0.66	0.87
	Σ							150.46	0.29	0.90	2.30
Dolly Varden	0+	42-58	51.0	1.38	4	0.6	6.67	9.17	0.04	0.05	0.32
m. whitefish	0+		58	2.36	1	0.6	1.67	4.39	0.01	0.03	0.08
LN Dace	—	39-40	39.5	0.71	2	0.6	3.33	2.36	0.02	0.01	0.16

HABITAT DESCRIPTION: edge of riffle - rapid

Discharge 2.8 m^3/s (100 cfs) Gradient 0,7 %

Temperature (°C) 9 @ 1430 hrs Turbidity clear

Hydraulic Type	Pool	Glide	Riffle
% area			100
mean width			19 (5.5 sampled)
mean depth			.25
% cover			1
cover type[1]			L, OV
substrate[2]			FS, SG 45 LG 40, C 10

COMMENTS:

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

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

GOSNELL CREEK DATE 8/9/80 AREA 126.5 M^2 SITE # 2

LENGTH 23 M

SPECIES	AGE	fl-RANGE	$\overline{fl}$	MEAN WEIGHT	C_1	$\overline{p}$	$\overline{n}$	TOTAL BIOMASS	No/M^2 DENSITY	BIOMASS DENSITY	No / linear meter
Rainbow	1+	87-88	87.5	7.14	2	0.7	2.86	20.39	0.02	0.16	0.12
Coho	0+	51-52	51.3	1.62	3	0.7	4.29	6.96	0.03	0.06	0.19
Dolly Varden	0+	49-52	50.7	1.30	6	0.7	8.57	11.16	0.07	0.09	0.37

HABITAT DESCRIPTION: Glide habitat in Gosnell Creek side channel

Discharge - Gradient 0.5 %

Temperature (°C) 6.5 Turbidity clear

Hydraulic Type	Pool	Glide	Riffle
% area		100	
mean width		5.5	
mean depth		0.40	
% cover		8	
cover type[1]		OV, L, C	
substrate[2]		F10, SG50, LG40	

COMMENTS:

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

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

COX CREEK (GOSNELL TRIB.) DATE 8/9/80 AREA 118 M^2 SITE # 1
LENGTH 33 M

SPECIES	AGE	fl-RANGE	$\overline{fl}$	MEAN WEIGHT	C_1	$\overline{p}$	$\overline{n}$	TOTAL BIOMASS	No/M^2 DENSITY	BIOMASS DENSITY	No / linear meter
Rainbow	0+	41-52	45.0	1.00	5	0.7	7.14	7.11	0.06	0.06	0.22
	1+	72-74	73.0	4.15	2	0.7	2.86	11.84	0.02	0.10	0.09
	Σ							18.95	0.08	0.16	0.31
Coho	0+	47-65	54.5	1.99	19	0.7	27.14	54.11	0.23	0.46	0.82
	1+	72-83	78.6	5.86	7	0.7	10.0	58.61	0.08	0.50	0.3[illegible]
	Σ							112.72	0.31	0.96	1.12
Dolly Varden	0+		48	1.11	1	0.7	1.43	1.58	0.01	0.01	0.04

HABITAT DESCRIPTION: riffle-glide-pool habitat in Cox Creek sidechannel

Discharge	0.06 m^3/s (2 cfs)	Gradient	1.5%
Temperature (°C)	10.5 °C	Turbidity	clear

Hydraulic Type	Pool	Glide	Riffle
% area	73	10	17
mean width	4.1	1.25	1.75
mean depth	0.38	0.20	0.15
% cover	18	13	1
cover type[1]	OV, C, L, IV	IV	IV
substrate[2]	F 44, SG 19, LG 34, C 3	F 15, SG 50 LG 30, C 5	SG 25, LG 55 C 20

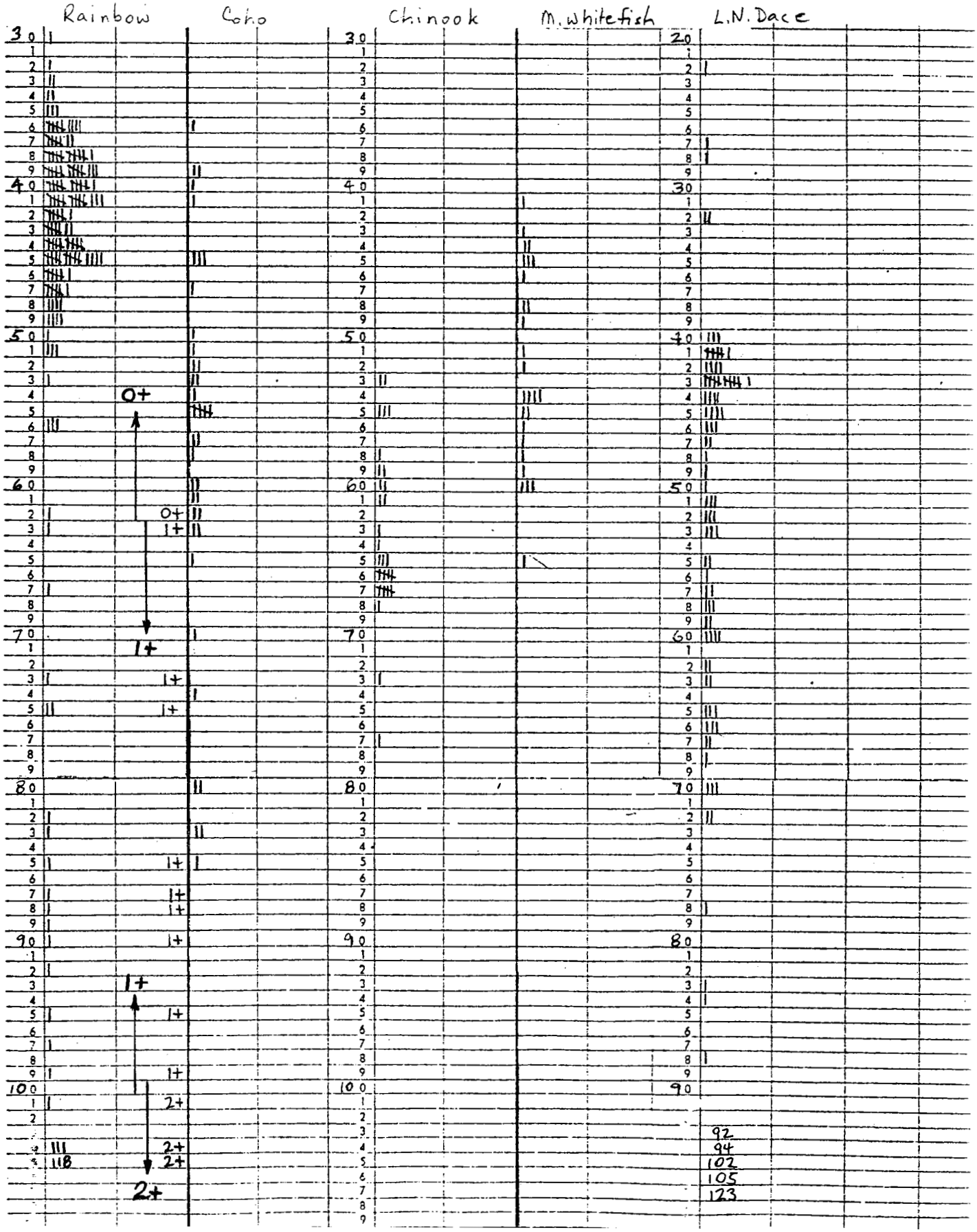
COMMENTS: mainstem at this point was mostly glide with mean wetted width of 15 m x 0.2 m mean depth

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

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

APPENDIX 10 Results of fish population estimates in the Morice River mainstem and sidechannels.

MORICE RIVER SIZE FREQUENCIES



MORICE RIVER SIDE CHANNEL DATE 7/9/80 AREA 120 M^2 SITE # ____

MILE 33 LENGTH 22.6 M

SPECIES	AGE	fl-RANGE	$\bar{fl}$	MEAN WEIGHT	C_1	$\bar{p}$	$\bar{n}$	TOTAL BIOMASS	No/M^2 DENSITY	BIOMASS DENSITY	No / linear meter
Rainbow	0+	34-46	39.8	0.68	19	0.9	21.11	14.46	0.18	0.12	0.93
	1+		75	4.49	1	0.9	1.11	4.99	0.01	0.04	0.05
	2+		118	17.50	1	0.9	1.11	19.44	0.01	0.16	0.05
	Σ							38.89	0.20	0.32	1.03
Coho	0+	38-49	43.9	1.03	7	0.9	7.78	7.99	0.06	0.07	0.34
m.whitefish	0+	54-60	56.4	2.43	5	0.9	5.56	13.51	0.05	0.11	0.25
LN Dace			44	0.98	1	0.9	1.11	1.09	0.01	0.01	0.05

HABITAT DESCRIPTION: riffle and portion of glide in side channel

Discharge Gradient —

Temperature (°C) 11 Turbidity clear

Hydraulic Type	Pool	Glide	Riffle
% area		73	27
mean width		5.2	5.5
mean depth		0.20	0.05
% cover		7	0
cover type[1]		L	—
substrate[2]		F5, SG 80	F80, SG 15
		LG 10, C5	LG 4, C 1

COMMENTS:

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

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

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MORICE RIVER MAINSTEM DATE 7/9/80 AREA 163 M^2 SITE # ____

EDGE MILE 33 LENGTH 21 M

SPECIES	AGE	fl-RANGE	$\bar{fl}$	MEAN WEIGHT	C_1	$\bar{p}$	$\bar{n}$	TOTAL BIOMASS	No/M^2 DENSITY	BIOMASS DENSITY	No / linear meter
Rainbow	0+	30-.49	40.7	0.75	9	0.6	15.0	11.27	0.09	0.07	0.71
LN Dace	0+	32-43	39.8	0.75	4	0.6	6.67	5.00	0.04	0.03	0.32

HABITAT DESCRIPTION: edge of mainstem (fry habitat)

Discharge		Gradient	—
Temperature (°C)	13	Turbidity	clear
Hydraulic Type	Pool	Glide (Flat)	Riffle
% area		100	
mean width		—	
mean depth		0.20	
% cover		>1	
cover type[1]		L	
substrate[2]		FS, SG 20	
		LG 65, C 10	

COMMENTS: substrate laden with fines

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

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

MORICE RIVER SIDE CHANNEL DATE 7/9/80 AREA 113 M^2 SITE # ____
MILE 32 #2 LENGTH 21.3 M

SPECIES	AGE	fl-RANGE	$\bar{fl}$	MEAN WEIGHT	C_1	$\bar{p}$	$\bar{n}$	TOTAL BIOMASS	No/M^2 DENSITY	BIOMASS DENSITY	No / linear meter
Rainbow	0+	35-51	42.3	0.83	19	0.7	27.14	22.48	0.24	0.20	1.27
	1+	73-83	78.0	5.12	2	0.7	2.86	14.62	0.03	0.13	0.13
	Σ							37.10	0.27	0.33	1.40
Coho	0+	45-83	59.1	2.70	22	0.7	31.43	84.94	0.28	0.75	1.48
m.whitefish	0+	44-65	54.1	2.20	14	0.7	20.00	43.98	0.18	0.39	0.94
LN Dace			28	0.25	1	0.7	1.43	0.36	0.01 -	>0.01	0.07

HABITAT DESCRIPTION: small side channel pool habitat with log debris.

Discharge — Gradient 0.5%

Temperature (°C) 11 Turbidity clear

Hydraulic Type	Pool	Glide	Riffle
% area	100		
mean width	5.0		
mean depth	0.35		
% cover	6		
cover type[1]	OV, L		

substrate[2] F20, SG15
LG55, C10

COMMENTS: small side channel with long, flat pool habitat about 250 m long. Log debris at upstream end only (part of shocking site). Fry present in isolated pools in gravel bars along side channel

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

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

MORICE RIVER SIDECHANNEL DATE 7/9/80 AREA 364 M^2 SITE # 1
MILE 32 #1 LENGTH 13.8 M

SPECIES	AGE	fl-RANGE	$\bar{fl}$	MEAN WEIGHT	C_1	$\bar{p}$	$\bar{n}$	TOTAL BIOMASS	No/M^2 DENSITY	BIOMASS DENSITY	No / linear meter
Rainbow	0+	36-62	46.4	1.14	29	0.7	41.43	47.21	0.11	0.13	3.00
	1+	67-95	82.3	6.29	3	0.7	4.29	26.96	0.01	0.07	0.31
	Σ							74.17	0.12	0.20	3.31
Chinook	0+		59	2.25	1	0.7	1.43	3.23	>0.01	0.01	0.10
Squawfish	-		42	2.08	1	0.7	1.43	2.97	>0.01	0.01	0.10
LN Dace	Σ	22-123	68.4	3.73	42	0.7	58.67	218.33	0.16	0.60	4.24

HABITAT DESCRIPTION: glide - riffle in wide side channel

Discharge		Gradient	0.5 %
Temperature (°C)	10	Turbidity	clear
Hydraulic Type	Pool	Glide	Riffle
% area		12	88
mean width		9	36
mean depth		0.40	0.25
% cover		5	0
cover type[1]		L	-
substrate[2]		F10, SG5, LG10 C65, B5	F5, SG5, LG20 C65, B5

COMMENTS:

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

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

(3)

MORICE RIVER SIDE CHANNEL DATE 6/9/80 AREA 107 M^2 SITE # 1
LAMPREY CONFLUENCE LENGTH 15.5 M

SPECIES	AGE	fl-RANGE	$\bar{fl}$	MEAN WEIGHT	C_1	$\bar{p}$	$\bar{n}$	TOTAL BIOMASS	No/M^2 DENSITY	BIOMASS DENSITY	No / linear meter
Rainbow	0+	40-48	44.5	0.95	8	0.7	11.43	10.83	0.11	0.10	0.74
	1+	88-97	91.7	8.25	3	0.7	4.29	35.34	0.04	0.33	0.29
	2+		111	14.57	1	0.7	1.43	20.81	0.01	0.19	0.09
	Σ							66.98	0.16	0.62	1.12
Chinook	0+	53-77	60.2	2.49	13	0.7	18.57	46.28	0.17	0.43	1.20
Coho	Σ	45-85	65.0	3.70	9	0.7	12.86	47.57	0.12	0.44	0.83
Mt. whitefish	0+	43-59	49.0	1.69	3	0.7	4.29	7.25	0.04	0.07	0.28
LN Dace	Σ	44-52	48.0	1.30	2	0.7	2.86	3.71	0.03	0.03	0.18

HABITAT DESCRIPTION:

Discharge — Gradient 0-1%

Temperature (°C) 10 Turbidity clear

Hydraulic Type	Pool	Glide	Riffle
% area		100	
mean width		6.9	
mean depth		0.30	
% cover		13	
cover type[1]		L, OV, C, IV	
substrate[2]		F40, SG 40 LG 20	

COMMENTS: side channel characterized by large sections with little or no cover. Several bays with deep, slow water and good cover

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

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

(2)

MORICE RIVER SIDE CHANNEL DATE 6/9/80 AREA 243 M^2 SITE # 2
LAMPREY CONFLUENCE. LENGTH 23.8 M

SPECIES	AGE	fl-RANGE	$\bar{fl}$	MEAN WEIGHT	C_1	$\bar{p}$	$\bar{n}$	TOTAL BIOMASS	No/M^2 DENSITY	BIOMASS DENSITY	No / linear meter
Rainbow	0+	36-49	43.2	0.87	21	0.8	26.25	22.95	0.11	0.09	1.10
Coho	0+	36-47	40.3	0.80	6	0.8	7.50	6.03	0.03	0.02	0.32
Chinook	1+	59-60	59.5	2.32	2	0.8	2.50	5.79	0.01	0.02	0.11
LN Dace	Σ	51-57	53.0	1.73	3	0.8	3.75	6.48	0.02	0.03	0.16

HABITAT DESCRIPTION: riffle - pool - side pool habitat in side channel

Discharge — Gradient 0-1%

Temperature (°C) 10 — Turbidity clear

Hydraulic Type	Pool	Glide	Riffle
% area	39		61
mean width			
mean depth			
% cover			
cover type[1]			
substrate[2]			

COMMENTS: this is site no. 2 in the Lamprey Confluence side channel

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

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

MORICE RIVER MILE 21 DATE 7/9/80 AREA 535.5 M^2 SITE # ____
LENGTH 34 M

SPECIES	AGE	fl-RANGE	$\bar{fl}$	MEAN WEIGHT	C_1	$\bar{p}$	$\bar{n}$	TOTAL BIOMASS	No/M^2 DENSITY	BIOMASS DENSITY	No / linear meter
Rainbow	0+	32 - 49	39.5	0.68	41	0.7	58.57	39.74	0.11	0.07	1.72
	1+	63 - 99	83.9	6.60	7	0.6	11.67	76.96	0.02	0.14	0.34
	2+		101	10.97	1	0.6	1.67	18.29	≤.01	0.03	0.05
	≥							134.99	0.14	0.24	2.11
Chinook	0+	65 - 73	66.6	3.26	14	0.6	23.33	76.16	0.04	0.14	0.69
Coho	0+	53 - 61	58.3	2.41	3	0.6	5.00	12.06	0.01	0.02	0.15
m.whitefish	0+	41 - 48	45.2	1.26	5	0.6	8.33	10.49	0.02	0.02	0.25
LN Dace	-	27 - 59	44.5	1.07	40	0.6	66.67	71.20	0.12	0.13	1.96

HABITAT DESCRIPTION: Morice River side channel @ mile 21. Glide riffle habitat in gravels

Discharge — Gradient 1.25%

Temperature (°C) 10 Turbidity clear

Hydraulic Type	Pool	Glide	Riffle
% area		47	53
mean width		15	17
mean depth		0.40	0.10
% cover		2	6
cover type[1]		C, L, OV, IV	C, L, OV
substrate[2]		F15, SG 40, LG 45	F5, SG 35, LG 60

COMMENTS: very "open" channel with channel width ≈ 2× wetted width.

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

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