

Observations on Juvenile Chinook Salmon (Oncorhynchus tshawytscha) and Rainbow Trout (Oncorhynchus mykiss) in the Nicola River watershed, British Columbia

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**ABSTRACT**

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Juvenile chinook salmon (Oncorhynchus tshawytscha) and rainbow trout (Oncorhynchus mykiss) were studied in the Nicola River basin during 1985, 1986 and early 1987. The highest juvenile chinook population densities (12 fish·m<sup>-2</sup>) were found in Guichon Creek, a tributary of the Nicola River, and in the Nicola River (11 fish·m<sup>-2</sup>) at the mouth of Guichon Creek. Juvenile chinook were found closely associated with log debris and cutbank cover. In Guichon Creek, most chinook salmon were found in pool habitats, and rainbow trout in riffle habitats. In the upper part of the watershed, chinook exceeded rainbow trout in April, May and June. In July, chinook decreased and were surpassed by rainbow trout in spring were lower, but increased in summer and fall. In October, rainbow trout densities surpassed chinook. Evidence of temporal and spatial separation of chinook and rainbow trout rearing habitats indicates that interspecific competition is minimized in the Nicola River.

Key words:

**RESUME**

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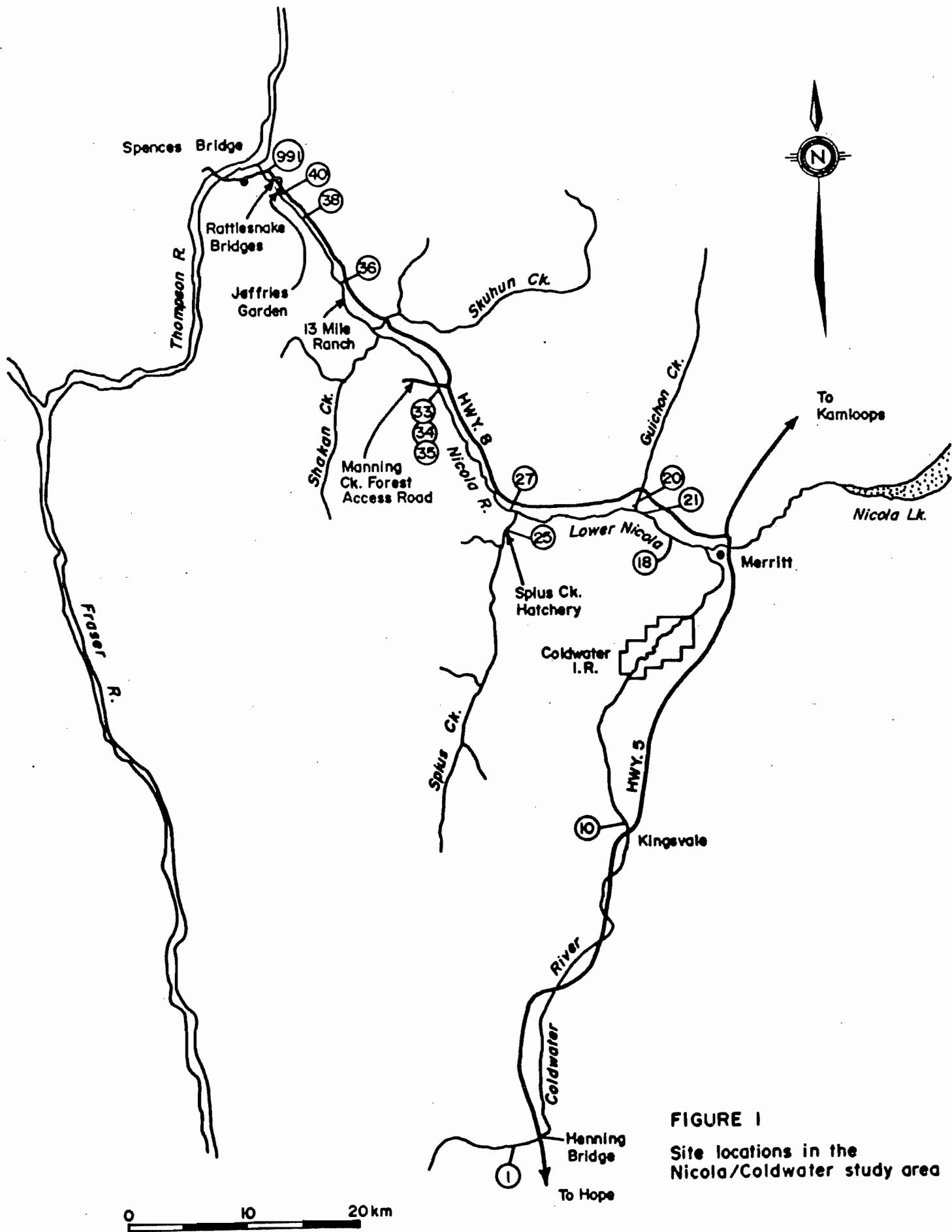
## A. INTRODUCTION

Requirements for information to manage chinook rearing habitat in the Nicola River valley, as well as data gaps on the fate of hatchery reared chinook (Shepherd et al. 1986) stimulated a research program in this area. The Nicola River, a tributary of the Thompson River, which is a major Fraser River tributary in the southern interior of British Columbia (Fig. 1), supports resident and anadromous fish. The Nicola River basin has agricultural and industrial developments which may affect fish rearing habitat (Ministry of Environment 1983). The Nicola valley is mainly a ranching area in a dry climate. Water withdrawal for irrigation during summer is a major concern (Kosakoski and Hamilton 1982). Water for irrigation is now mainly obtained by screened pumps, however, open irrigation ditches have been used in recent years. Mortality of chinook juveniles has been observed in these ditches (Fleming et al. 1987). Runoff from cattle feedlots and fertilizer applications, and sewage effluent discharge from the communities of Merritt and Lower Nicola have affected water quality (Langer and Nassichuk 1976). Construction of the Coquihalla Highway through the Coldwater subbasin has caused changes in rearing and spawning habitats and compensation measures were implemented (Rosenau and Andrew 1985; Beniston et al. 1987; Beniston et al. 1988). Active logging is carried out in the Coldwater and Spius subbasins, but no data are available on the impacts of this activity.

Anadromous species using the Nicola River basin include chinook (*Oncorhynchus tshawytscha*, coho (*O. kisutch*), and pink salmon (*O. gorbuscha*, Pacific lamprey (*Lampetra tridentatus*), and steelhead trout (*O. mykiss*). The system also supports hatchery reared chinook and coho salmon and steelhead trout. Since 1985, the Department of Fisheries and Oceans Spius Creek hatchery has been releasing chinook and coho salmon in the Nicola River and selected tributaries. A summary of hatchery chinook releases is shown in Table 1. The British Columbia Ministry of Environment has been releasing steelhead trout in the Nicola River system since 1986. A summary of steelhead releases is shown in Table 2.

Scale analysis from chinook returning to the Nicola system showed all adults were stream type migrants (Neil Todd, pers. comm.), which typically overwinter and rear in freshwater for one year before migration to sea. Chinook spawning escapements in recent years to the Nicola system are shown in Table 3. Chinook spawn during August and September, and fry emergence occurs in April and May. Young of the year fry migrate from late April until freeze-up, but emigration through the winter has also been observed (Levings and Lauzier 1989). Chinook that overwinter usually emigrate in late March and April.

Coho spawning, occurring in October and November, and fry emergence, occurring in May and June, is later than chinook spawning and emergence. Coho spend at least one year in fresh water, and have been documented to use off-channel habitat in the Nicola River system (Swales et al. 1986). In the Coldwater River, coho juveniles may rear for two years before emigration (Wightman 1979). Steelhead trout enter the Nicola system starting early in April and continuing into May, and spawn in May in selected tributaries. Emergence of steelhead fry occurs in July and August. Pink salmon spawning occurs in the lower Nicola River, below river kilometre 40.



**FIGURE 1**  
 Site locations in the Nicola/Coldwater study area

**Table 1. Number of chinook salmon juveniles released by the Spius Creek hatchery into the Nicola River system from 1985 to 1990. (from Spius Creek hatchery records).**

Year	Spring Release	Fall Release	Year Total
1985	301,251		301,251
1986	279,450	109,210	388,660
1987	424,645	150,100	574,745
1988	704,522	109,834	814,356
1989	866,088		866,088
1990	864,491		864,491

**Table 2. Number of rainbow trout/steelhead juveniles released into the Nicola River system from 1986 to 1990. (from Ministry of Environment, Recreational Fisheries records).**

Year	Stock	Release Site	Number	Year Total
1986	Coldwater	Coldwater	135,000	
1986	Spius	Maka	32,000	
1986	Spius	Spius	63,000	230,000
1987	Coldwater	Coldwater	104,000	
1987	Spius	Maka	36,800	
1987	Spius	Spius	38,800	179,600
1988	Coldwater	Coldwater	36,708	
1988	Spius	Spius	97,984	134,692
1989	Coldwater	Coldwater	109,285	
1989	Spius	Maka	36,800	
1989	Spius	Spius	38,200	184,285
1990	Coldwater	Coldwater	115,545	
1990	Spius/Maka	Maka	36,800	
1990	Spius/Maka	Spius	54,690	207,035

**Table 3. Chinook spawning escapements to the Nicola River system from 1975 to 1989.**  
(from DFO Kamloops District records)

Year	Coldwater River	Nicola River	Spius Creek	Total Nicola Escapement
1975	1500	4500	850	6850
1976	500	3500	200	4200
1977	600	2700	150	3450
1978	750	3100	80	3930
1979	300	2300	50	2650
1980	710	5000	200	5910
1981	200	2500	100	2800
1982	800	3750	200	4750
1983	547	1800	102	4399
1984	598	3700	256	4554
1985	2061	5800	100	7961
1986	2100	6500	350	8950
1987	550	3500	475	4525
1988	220	2490	150	2860
1989		3500	500	

## B. STUDY AREA

### I. WATERSHED CHARACTERISTICS

The Nicola River drains an extensive basin (7,280 sq km) between the Thompson and Okanagan valleys. Three major tributaries join the Nicola River between 50 and 75 km upstream; Spius Creek, Guichon Creek and the Coldwater River. The majority of the Nicola basin is in the dry interior Ponderosa Pine-Bunchgrass biogeoclimatic zone, except for the upper reaches of the Coldwater River and Spius Creek, which extend into the Cascade Range and the interior Douglas Fir biogeoclimatic zone. The interior Ponderosa Pine-Bunchgrass zone is characterized by very low precipitation (mean 30 cm/y), cold winters and hot dry summers. Because the Nicola basin also incorporates climate features of the

Coldwater River in the coastal biogeoclimatic zone, runoff patterns are affected by coastal and interior weather systems. Heavy winter rains and snow in the Cascade range can cause rapid increases in winter flows (November-February), as well as the regular spring runoff resulting from snow-melt (May-June). Annual mean discharge (1976-1986) for the Nicola River was 22.3 cu m/sec (Water Survey of Canada, Surface Water Data; Station 08LG006, 13 km from the confluence with the Thompson River). The hydrographs for 1985 and 1986 are depicted in Figure 2. The mean annual discharge (1976-1986) for the Coldwater River at Merritt was 7.21 cu m/sec (Water Survey of Canada, Surface Water Data; Station 08LG010). The mean annual discharge (1976-1986) for Spius Creek at the Prospect Creek Forest Access Road bridge was 9.09 cu m/sec (Water Survey of Canada, Surface Water Data; Station 08LG008, and the mean annual discharge (1976-1984) for Guichon Creek at the Highway 8 bridge was 0.875 cu m/sec (Water Survey of Canada, Surface Water Data; Station 08LG004).

The Nicola and Coldwater Rivers were divided into four reaches for this study (Fig 1). Reach 1 (Sites 1 and 10) consisted of the Coldwater River from the source to the confluence with the Nicola River at Merritt. Reach 2 (Sites 18, 21, 25) consisted of the Nicola River from the Coldwater River confluence (km 68), to the mouth of Spius Creek (km 47). A station on this tributary was also sampled. Reach 3 (Sites 27, 33, 34, 35) consisted of the Nicola River from the mouth of Spius Creek (km 47) to the Gordon Ranch (km 32). Reach 4 (Sites 36, 38, 40, 991) was the lower part of the Nicola River from the Gordon Ranch (km 32) to the confluence with the Thompson River.

### C. TIMING OF SAMPLING

The sampling was initiated on January 16, 1985 and continued on a monthly basis until mid-March 1985. Sampling frequency was then increased to a bi-weekly schedule until freeze-up in early November, 1985. The Coldwater River was only sampled in 1985. Sampling was then resumed in mid-January 1986 and continued on a monthly schedule until mid-March, 1986. Sampling frequency was again increased to bi-weekly intervals until November, 1986. Some sites were sampled on a weekly basis in the summer and fall of 1986. Site 991, adjacent to inclined plane traps used in a concurrent study (Levings and Lauzier 1989), was sampled daily during the summer and fall of 1986.

### D. SAMPLING METHODS

The sampling sites in the Coldwater River (Reach 1) and Guichon Creek, which were sampled from bank to bank, were a series of pools and glides. Sampling sites in the reaches in the Nicola River were sampled along one bank, along the edge of riffles and glides. Substrate and cover composition were visual ground estimates made to the nearest 5%, following the methodology of the Stream Survey Field Guide of the Fish Habitat Inventory and Information Program of the Department of Fisheries and Oceans and the Ministry of Environment. Cover composition was estimated as a percent of the total sample area for each

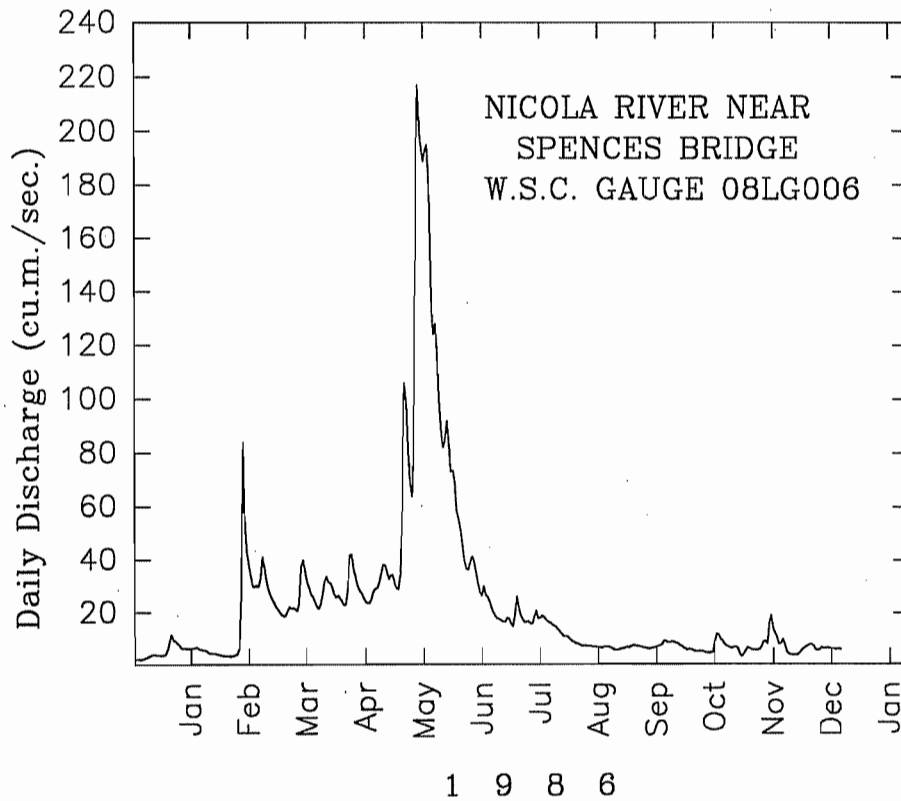
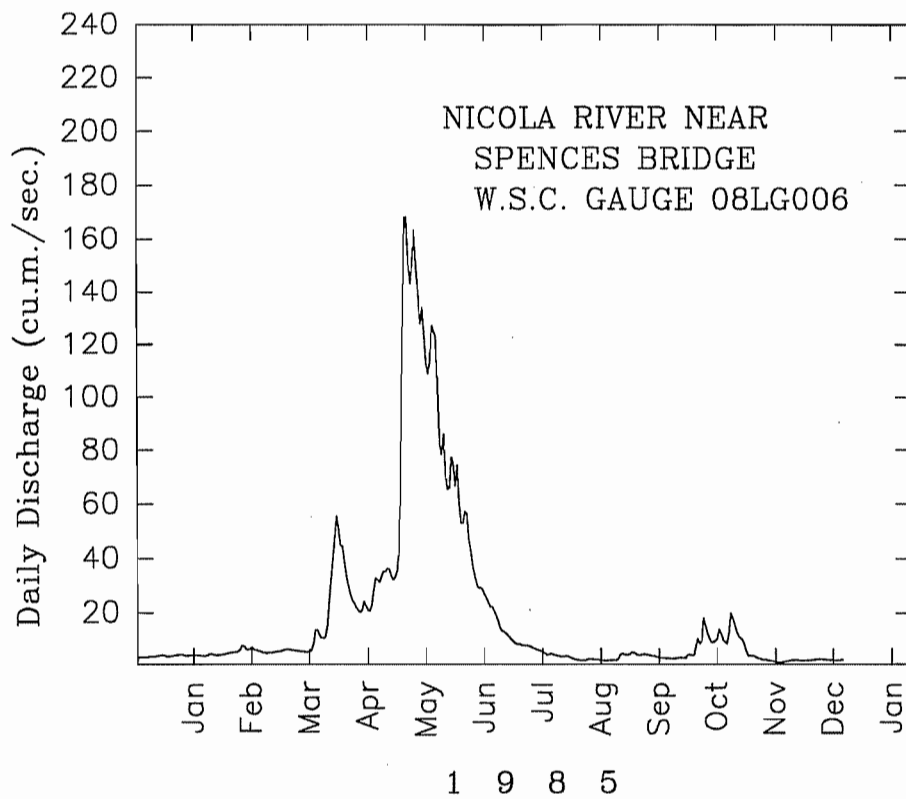


Fig. 2 Hydrographs of the Nicola River near Spences Bridge at Water Survey of Canada Gauge 08LG006 during 1985 and 1986

cover category, which differs from the technique described in the Stream Survey Field Guide. The substrate and cover composition data, given in the results, were mean values of the estimates made at each sample site throughout the sampling period.

Fish sampling methods varied with season and hydraulic conditions. Electrofishing with a battery powered backpack Smith-Root Model 11A was used when turbidity, temperature and hydraulic conditions allowed. The multiple pass and removal method was used along with the Zippin method to compute population estimates (Higgins 1985). The sample sites were usually 30-80 m long and 1-3 m wide, which covered a variety of habitat types as described above. At least three replicate samples were obtained at each sample site. Stop nets were rarely used, as water velocities were often too high, and large boulder substrate at many sites made effective use of them very difficult.

During high freshet flows ( $> 40 \text{ cu m/sec}$ ), the Nicola River was too turbid for effective electrofishing and other fish sampling methods were used. These methods included beach seining and pole seining. Details as to which fish sampling methods were used at particular sites are given elsewhere (Lauzier 1987; Lauzier 1989). The beach seine was 15 m long, with 5 mm wing mesh and 3 mm bunt mesh. The pole seine (3 m long, 1.5 m deep, 3 mm mesh) was used mainly in side channels and back channels, and to a limited extent in mainstem habitats during freshets. Detailed methods on beach seine and pole seine deployment are given elsewhere (Lauzier 1989). As with electrofishing, at least three replicate samples were obtained at each sample site with the beach seine and pole seine. Fish were anaesthetized in a dilute solution of 2-phenoxyethanol (3-4 drops/litre of water), and then fork lengths were measured to the nearest millimetre. Anaesthetized fish were then placed in fresh oxygenated water for recovery, before being released at the same site.

Data were also collected on water temperature, current velocities, depth, cover, conductivity, cover composition, and substrate composition. Water temperatures were measured with a hand-held thermometer. Current velocities and depths were measured with a Marsh-McBirney Model 201D electromagnetic current meter. The velocities were measured at 0.6 of the depth for depths less than 1 m, when water depths were  $>1$  m, velocity at 0.2 and 0.8 of the depth was measured and the average velocity calculated. Five depths and velocities were usually measured where fish were captured or observed in each sample site. Conductivity was measured with a Cole-Parmer Model SJ-1481-50 hand held digital conductivity meter, and was corrected for temperature.

## RESULTS

Juvenile chinook salmon accounted for 36.5% of the total catch ( $n = 5658$ ), followed by rainbow trout (34.1%,  $n = 5300$ ). Cyprinids (Cyprinidae) accounted for 16.7% ( $n = 2595$ ) of the total % ( $n = 650$ ), Dolly Varden char (Salvelinus malma) 0.2% ( $n = 29$ ), and mountain whitefish (Prosopium williamsoni) and all other species comprised of 1.0% each. Marked chinook (adipose clipped) accounted for 0.8% ( $n = 45$ ) of the total chinook catch. A summary of catch composition, number of specimens, and sampling effort by reach and tributary is shown in Table 4. All marked chinook were caught in Reach 4.

**Table 4. Percent (%) species composition, total catch and sampling effort in Nicola River reaches and selected tributaries during 1985 and 1986.**

	Coldwater (Reach 1)	Reach 2	Reach 3	Reach 4	Guichon Creek	Spius Creek
Chinook	7%	39%	25%	35%	54%	19%
Coho	20%	5%	1%	1%	1%	4%
Rainbow	51%	24%	44%	34%	31%	71%
Whitefish	1%	1%	-	-	1%	-
DV Char	6%	-	-	-	-	-
Lamprey	-	2%	6%	6%	1%	5%
Cyprinids	1%	23%	16%	18%	10%	1%
Suckers	1%	4%	7%	5%	2%	-
Others	13%	1%	1%	1%	-	-
No.specimens	393	2201	3528	6235	3001	408
No. samples Electrofished	25	30	51	100	37	9
Beach seined		6	4	14		
Pole seined		22	11	53	26	2

### I. Density estimates

#### a. Chinook

**Reach 1** - In the upper Coldwater River (Station 1 and Station 10), chinook densities were  $< 0.2 \text{ fish} \cdot \text{m}^{-2}$  (Figs. 3-1, 3-2).

**Reach 2** - In the upper Nicola River (Stn. 18, 21) chinook densities were 0.15 to  $10.82 \text{ fish} \cdot \text{m}^{-2}$  in April and May 1985, but decreased in July and August, 1985 ( $0.08$  to  $0.42 \text{ fish} \cdot \text{m}^{-2}$ ) (Figs. 3-3, 3-6). In 1986, the April and May chinook densities ( $0.07$  to  $2.74 \text{ fish} \cdot \text{m}^{-2}$ ) were not as high as those in the spring 1985 (Figs. 3-3, 3-6). In 1985, the highest chinook density ( $10.82 \text{ fish} \cdot \text{m}^{-2}$ ) was in the Nicola River above the mouth of Guichon Creek (Station 21) (Figs. 3-6).

**Guichon Creek** - In 1986, the highest chinook density ( $12 \text{ fish} \cdot \text{m}^{-2}$ ) was in Guichon Creek pools (Station 20) (Figs. 3-5). In 1985, chinook densities decreased from high densities in the spring ( $2.79$  to  $6.74 \text{ fish} \cdot \text{m}^{-2}$ ) to low summer densities ( $0.10$  in riffles and  $0.10$  to  $3.29 \text{ fish} \cdot \text{m}^{-2}$  in pools) (Figs. 3-4, 3-5). In 1986, the spring densities in the pools ( $5.90$  to

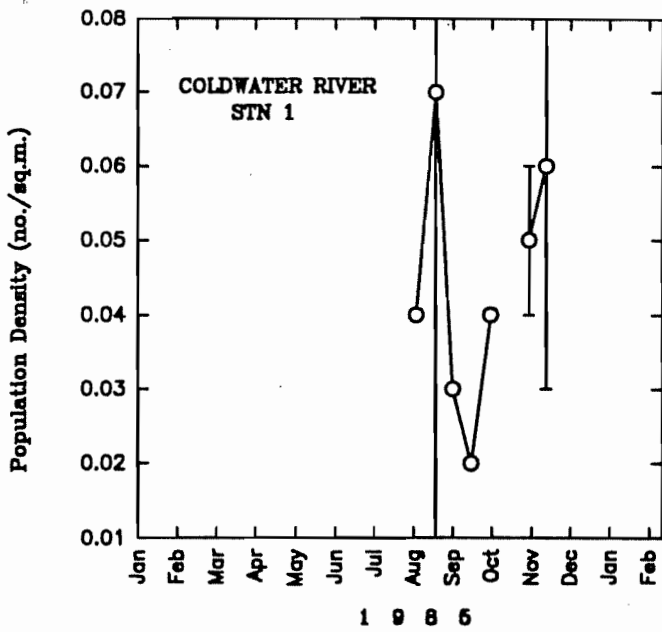


Fig. 3-1 Chinook salmon population density at Station 1, Coldwater River

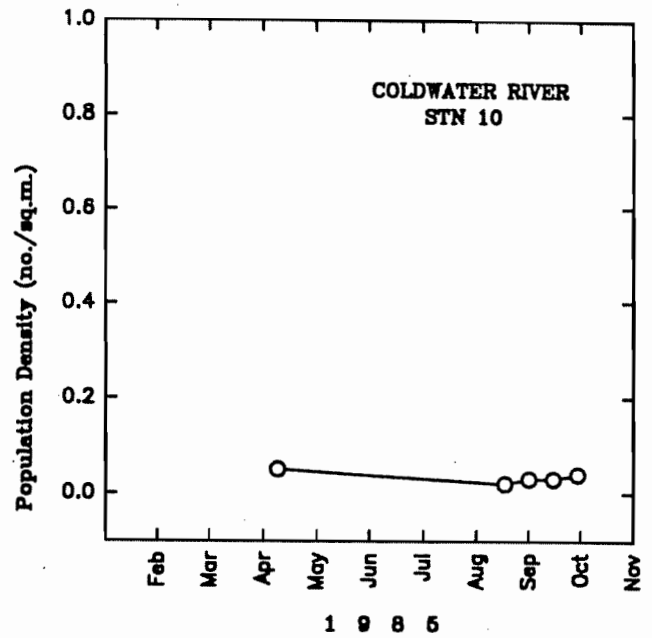


Fig. 3-2 Chinook salmon population density at Station 10, Coldwater River

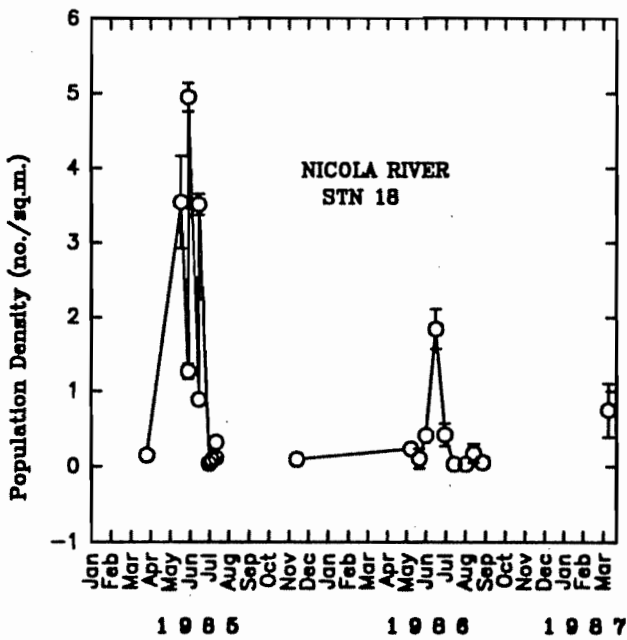


Fig. 3-3 Chinook salmon population density at Station 18, Nicola River

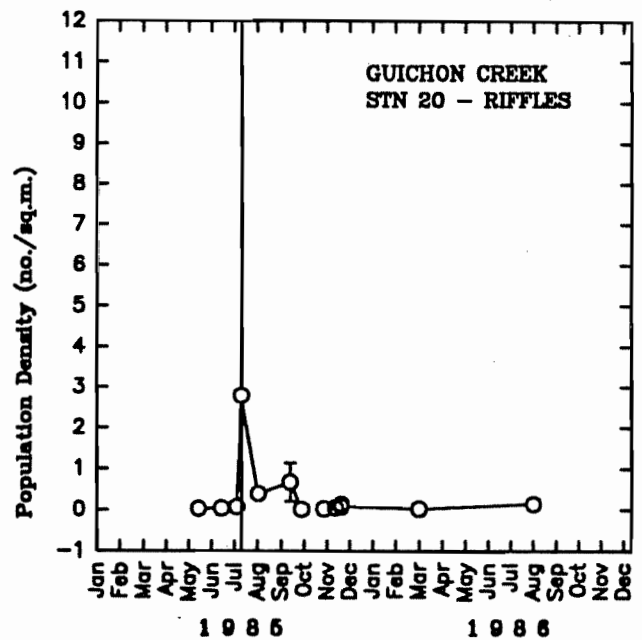


Fig. 3-4 Chinook salmon population density at Station 20, Guichon Ck riffles

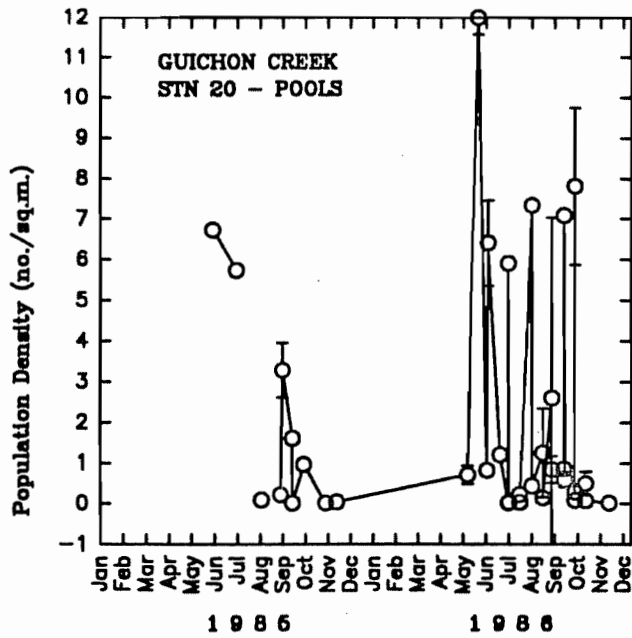


Fig. 3-5 Chinook salmon population density at Station 20, Guichon Ck. pools

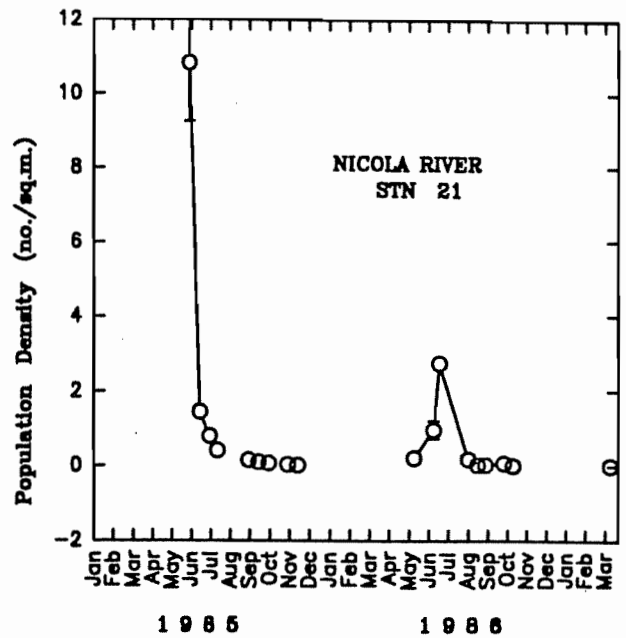


Fig. 3-6 Chinook salmon population density at Station 21, Nicola River

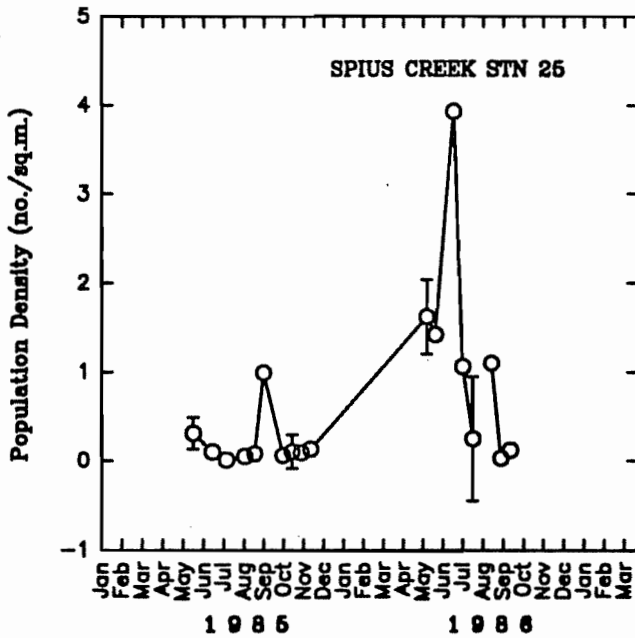


Fig. 3-7 Chinook salmon population density at Station 25, Spius Creek

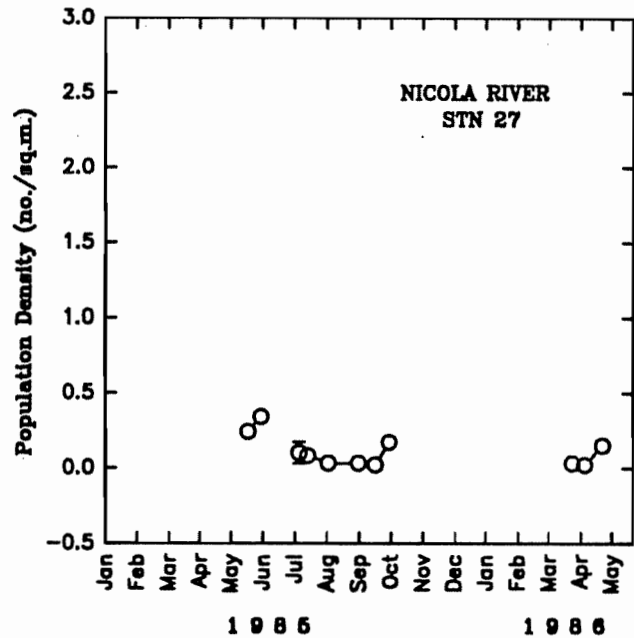


Fig 3-8 Chinook salmon population density at Station 27, Nicola River

12 fish·m<sup>-2</sup>) also decreased (0.03 to 7.33 fish·m<sup>-2</sup>) in summer (Fig. 3-5).

Spilus Creek - Chinook densities were higher in the spring and summer of 1986 (1.42 to 3.93 fish·m<sup>-2</sup> and 0.25 to 1.10 fish·m<sup>-2</sup>, respectively) than in the spring and summer of 1985 (0.10 to 0.31 fish·m<sup>-2</sup> and 0.05 to 0.99 fish·m<sup>-2</sup>, respectively) (Figs. 3-7)

Reach 3 - Chinook densities in the Nicola River were low (< 0.5 fish·m<sup>-2</sup>) immediately below the mouth of Spilus Creek at Station 27 and remained low throughout 1985 and early 1986 (Fig. 3-8). Chinook densities at Station 27 were consistently low (0.24 to 0.34 fish·m<sup>-2</sup>) in comparison to other stations further upstream in the Nicola River (Fig. 3-6) and Spilus Creek (Fig. 3-7). At Station 33, approximately 13 kms downstream of Station 27, chinook densities were 0.33 to 4.31 fish·m<sup>-2</sup> in April and May 1986, and then decreased (0.06 to 0.77 fish·m<sup>-2</sup>) in the summer and fall (Fig. 3-9).

Reach 4 - Chinook densities in spring (0.58 to 3.21 fish·m<sup>-2</sup>) were not as high as those at some of the upper and mid-Nicola River stations (Stn 18, Stn 21)(3.83 to 10.82 fish·m<sup>-2</sup>). Chinook densities in Reach 4 did not decrease as rapidly in the early summer, as was observed in the upper stations, but remained higher (0.06 to 1.40 fish·m<sup>-2</sup>) until late August (Figs. 3-10, 3-11, 3-12, 3-13).

## b. Rainbow trout

Rainbow trout fry were observed in July and August, and during all other months, rainbow trout juveniles were categorized to be parr. The population densities of juvenile rainbow trout are depicted in Figure 4.

Reach 1 - Rainbow trout densities in the upper Coldwater River (Stn. 1) Fig. 4-1) were the lowest (0.01 to 0.23 fish·m<sup>-2</sup>) in the study area. At Station 10 (Fig. 4-2), rainbow trout densities were initially high (0.92 fish·m<sup>-2</sup>) in early April 1985, but decreased (0.01 - 0.02 fish·m<sup>-2</sup>) in July. Rainbow trout densities increased from late July to late September (0.31 to 0.61 fish·m<sup>-2</sup>), and then decreased to 0.08 fish·m<sup>-2</sup> in early November.

Reach 2 - In the Nicola River, at Station 18 (Fig. 4-3), rainbow trout densities were highest (0.61 to 0.72 fish·m<sup>-2</sup>) from late August until mid-October 1985. In August 1986, rainbow trout densities were much lower (0.29 fish·m<sup>-2</sup>) at this site. At Station 21, the maximum density of rainbow trout (3.05 fish·m<sup>-2</sup>) (Fig. 4-6) was observed in early July 1985. In late summer and fall, densities ranged from 0.27 fish·m<sup>-2</sup> to 0.99 fish·m<sup>-2</sup> in 1985, and ranged from 0.10 to 0.78 fish·m<sup>-2</sup> in late summer and fall of 1986.

Guichon Creek - In late summer 1985, rainbow trout densities ranged from 0.95 to 3.68 fish·m<sup>-2</sup> in the riffle habitat, and from 0.102 to 2.03 fish·m<sup>-2</sup> in the pool habitat Figs. 4-4, 4-5). In late summer 1986, densities in the pool habitat were slightly lower (0.02 to 1.33 fish·m<sup>-2</sup>) than in 1985.

Spilus Creek - In summer and fall 1985, rainbow trout densities showed two pronounced peaks; 1.75 fish·m<sup>-2</sup> in mid-July, and 1.99 fish·m<sup>-2</sup> in early October (Figs. 4-7). In 1986, maximum rainbow trout densities were observed at this station in early August (1.12 fish·m<sup>-2</sup>).

Reach 3 - At Station 27, immediately below the mouth of Spilus Creek, rainbow trout densities were approximately 0.01 to 0.06 fish·m<sup>-2</sup> until early July 1985, and then increased to 2.50 fish·m<sup>-2</sup> in early August 1985. By late October, rainbow trout densities had

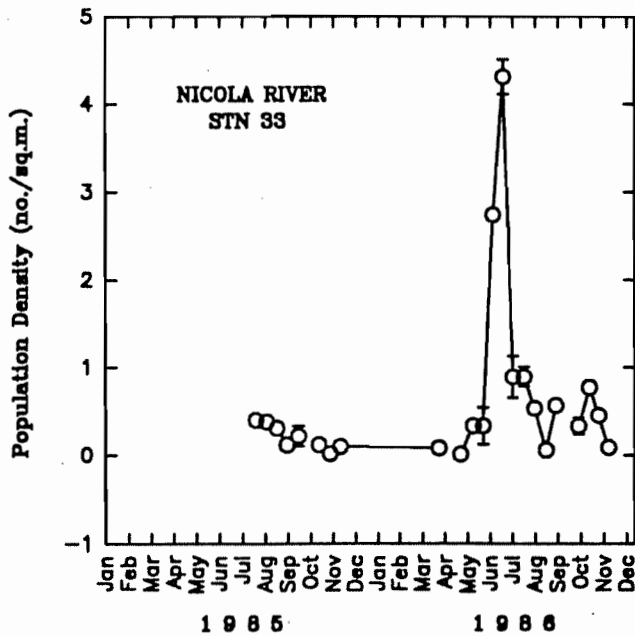


Fig. 3-9 Chinook salmon population density at Station 33, Nicola River

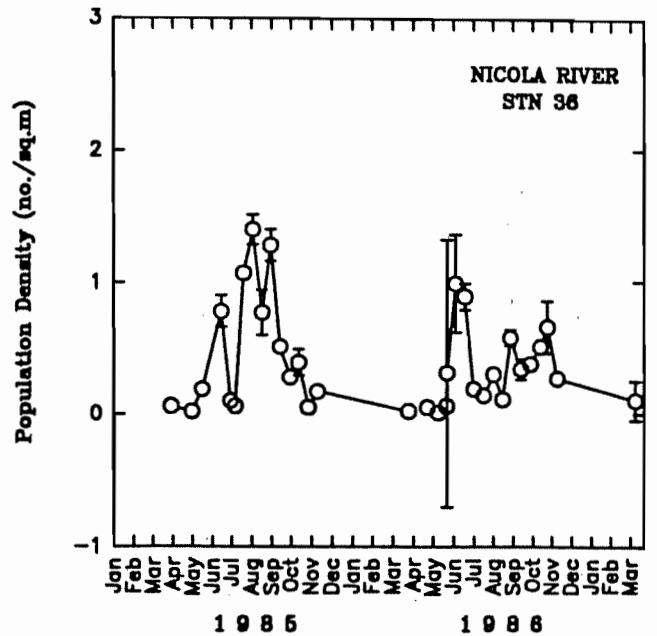


Fig. 3-10 Chinook salmon population density at Station 36, Nicola River

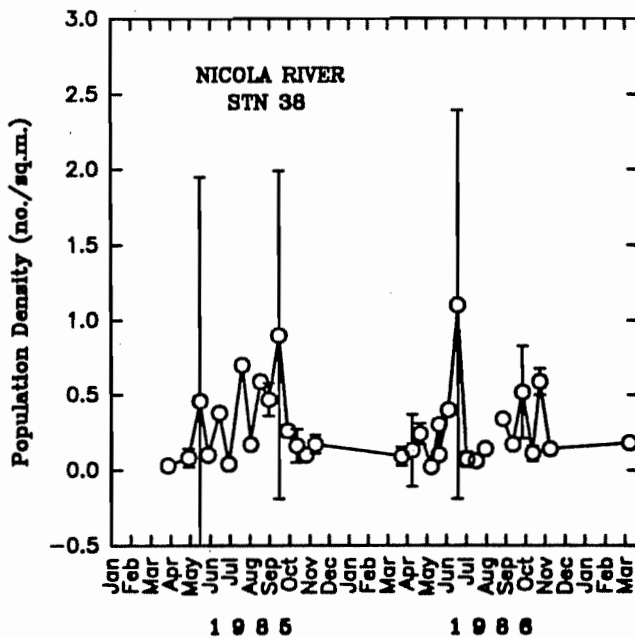


Fig. 3-11 Chinook salmon population density at Station 38, Nicola River

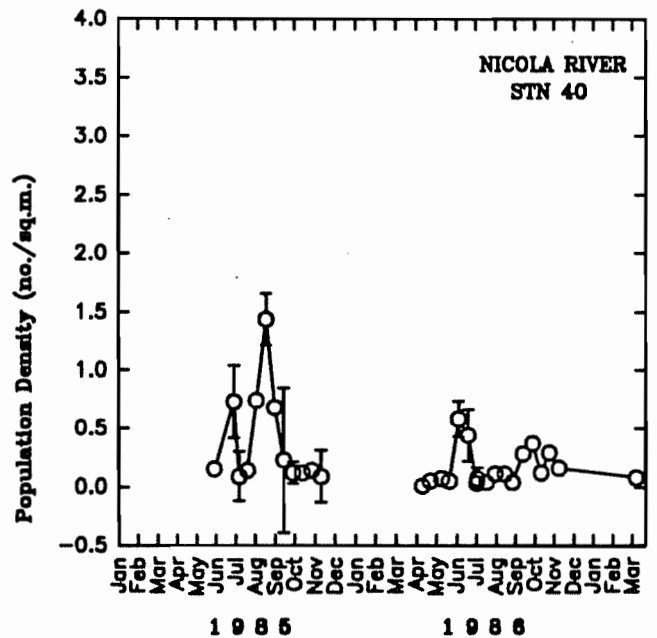


Fig. 3-12 Chinook salmon population density at Station 40, Nicola River



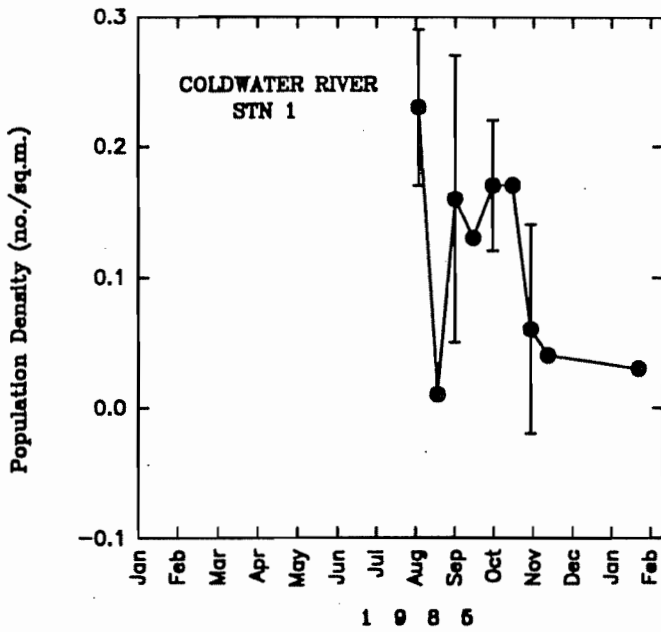


Fig. 4-1 Rainbow trout population density at Station 1, Coldwater River

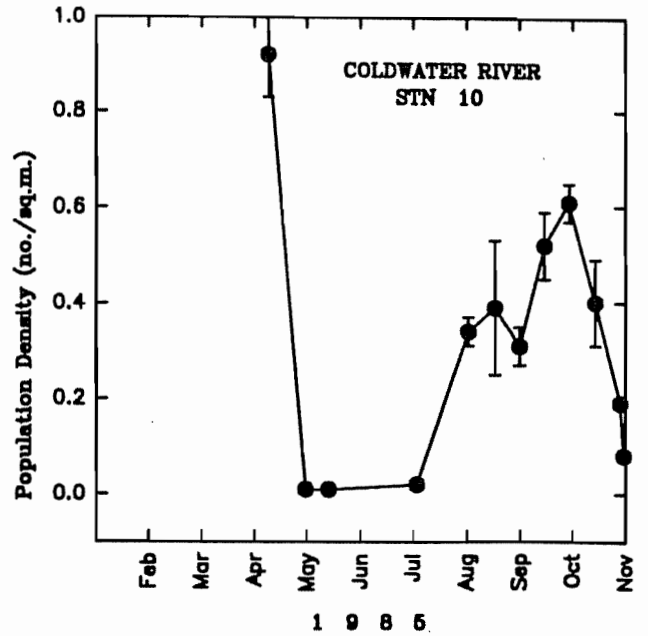


Fig. 4-2 Rainbow trout population density at Station 10, Coldwater River

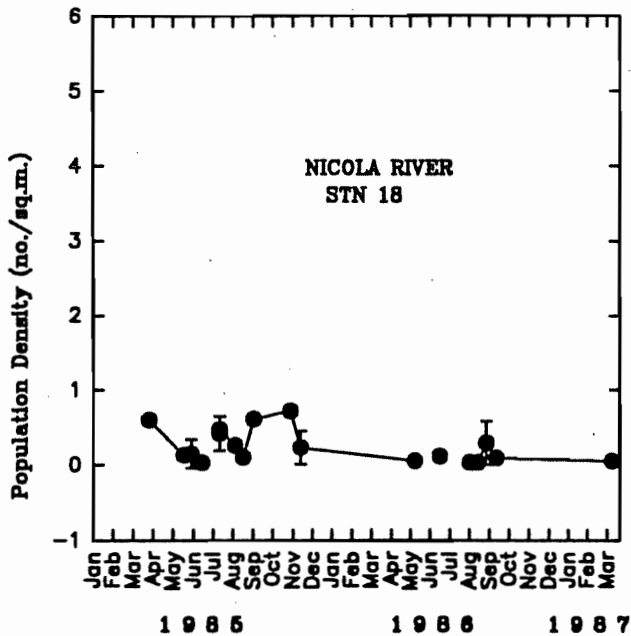


Fig. 4-3 Rainbow trout population density at Station 18, Nicola River

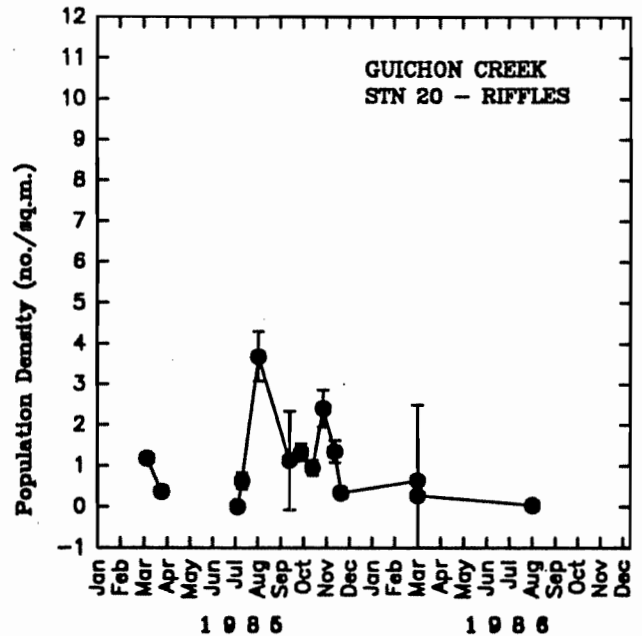


Fig. 4-4 Rainbow trout population density at Station 20, Guichon Ck. riffles

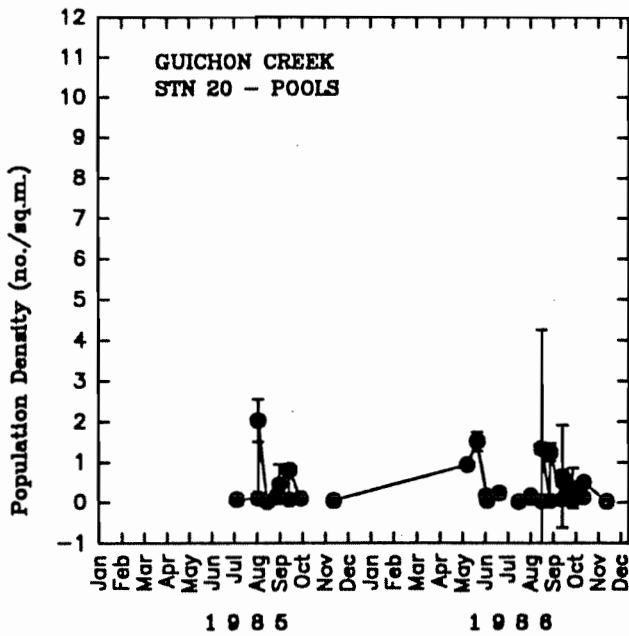


Fig. 4-5 Rainbow trout population density at Station 20, Guichon Ck. pools

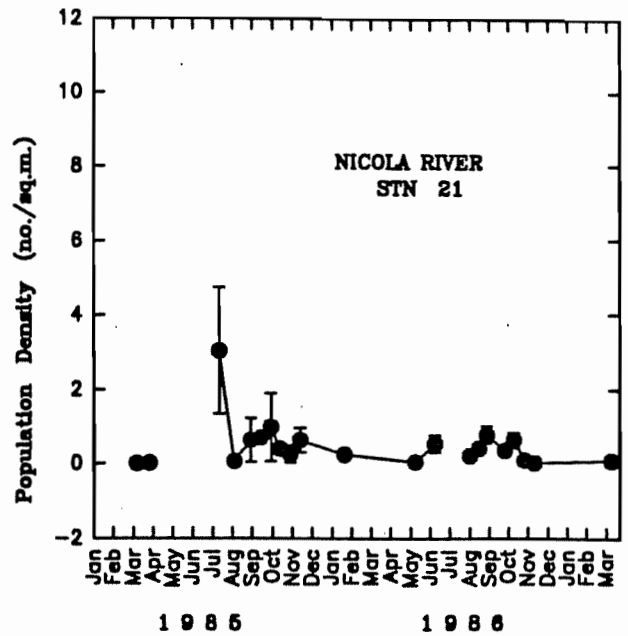


Fig. 4-6 Rainbow trout population density at Station 21, Nicola River

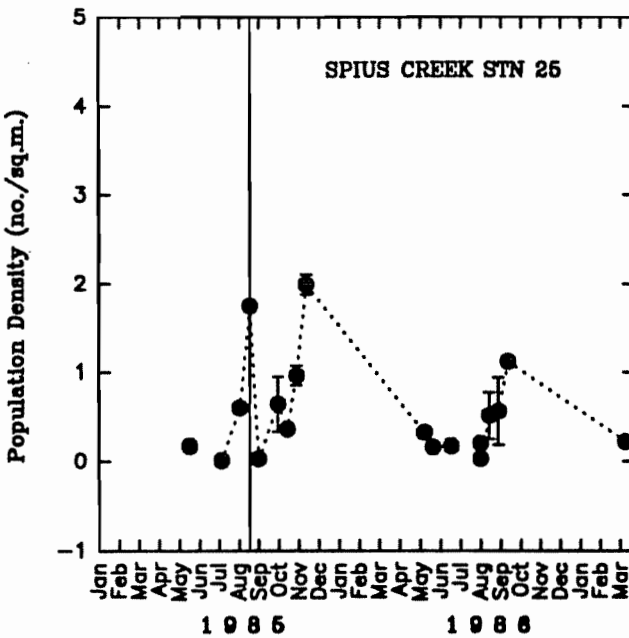


Fig. 4-7 Rainbow trout population density at Station 25, Spius Creek

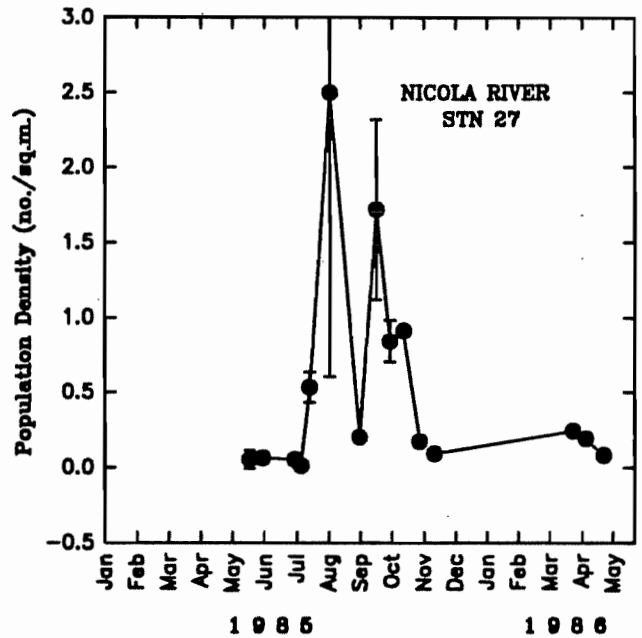


Fig. 4-8 Rainbow trout population density at Station 27, Nicola River

decreased to 0.09 fish·m<sup>-2</sup>. At Station 33, rainbow trout densities increased from 0.03 fish·m<sup>-2</sup> in June 1985, to 2.31 fish·m<sup>-2</sup> in mid-September (Figs. 4-9). With the exception of a peak density of 1.90 fish·m<sup>-2</sup> in mid-August 1986, rainbow trout densities in 1986 were lower than rainbow trout densities observed at this station in the previous year (Figs. 4-9).

Reach 4 - Two population density patterns were observed. In 1985 at Station 38 (Fig. 4-10), rainbow trout densities were less than 0.5 fish·m<sup>-2</sup> until early August, when densities began to increase towards summer and fall. At Station 40, a similar pattern was seen in 1985, except that densities were slightly higher (0.61 fish·m<sup>-2</sup>) in late May (Fig. 4-11). In 1986, a different pattern was observed. At Station 36, peak density was observed in mid-April, but at Stations 38 and 40, maxima were observed in late May. Late summer densities ranged between 0.13 and 0.47 fish·m<sup>-2</sup> in this reach.

## II. Length distributions of chinook

Reach 1 - In spring 1985, chinook fry lengths in the Coldwater River (Fig. 5-1) were less than 40 mm, except for large presmolts observed in early April. There was a slight decrease in mean lengths, from 57 mm to 53 mm, in late July, indicating a possible outmigration of smaller fish.

Reach 2 - The maximum mean length (74 mm) was attained in late September 1985 (Fig. 5-3). This was followed by decreases in mean length to 69 mm and 67 mm in the late fall and early winter. In 1986, there was a steady increase in mean lengths, with the exception of mid-June, throughout the spring, summer and fall. There was no decrease in mean lengths, as seen in the previous year at this reach.

Reach 3 - There was a slight decrease, from 39 mm to 35 mm, in June 1985 (Fig. 5-4). This was followed by a rapid increase in mean lengths from early July until September, (36 mm to 69 mm). In 1986, the mean lengths rapidly increased from early August to mid-October. Maximum mean length in this reach was 78 mm, attained in mid-February 1987.

Reach 4 - Marked hatchery chinook were measured in May 1985 (Fig. 5-5). The mean lengths of the marked fish were higher (77 mm) than unmarked chinook (68 mm) measured at the same time. The maximum mean length of the marked chinooks, 93 mm, was reached in early June. From June to October 1985, there was a steady increase (Fig. 5-5) in mean lengths (38 mm to 72 mm, followed by a slower increase (72 mm to 80 mm). In May 1986, (Fig. 5-6) there were two high mean lengths (52 mm and 63 mm) at a time when mean lengths ranged from 36 mm to 41 mm. This was likely due to chinook which had overwintered from the fall of 1985 (1984 brood), or may be due to unmarked hatchery fish. Mean lengths increased (36 mm to 76 mm) from May until September 1986, with a slight decrease in August from 59 mm to 53 mm. In October, mean lengths decreased slightly from 76 mm to 71 mm; the mean length of marked hatchery chinooks was 82 mm.

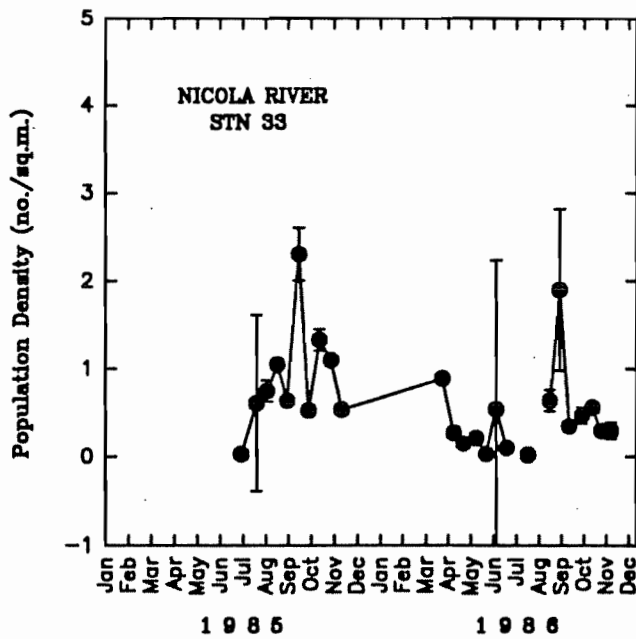


Fig. 4-9 Rainbow trout population density at Station 33, Nicola River

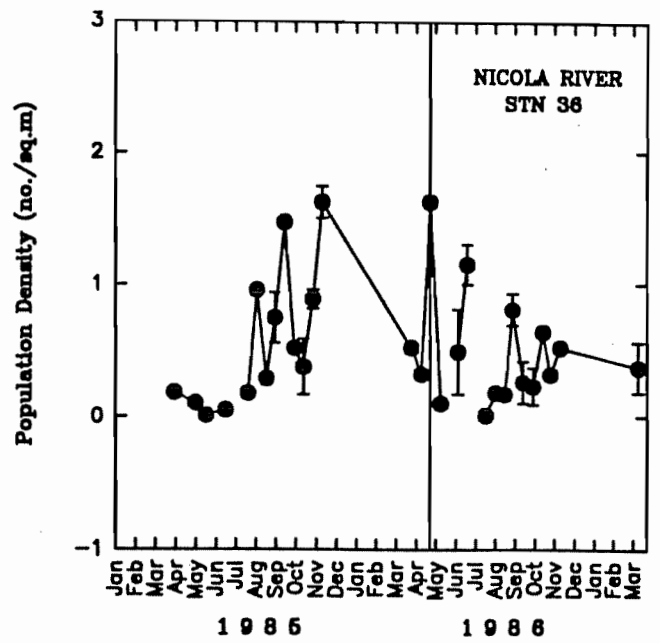


Fig. 4-10 Rainbow trout population density at Station 36, Nicola River

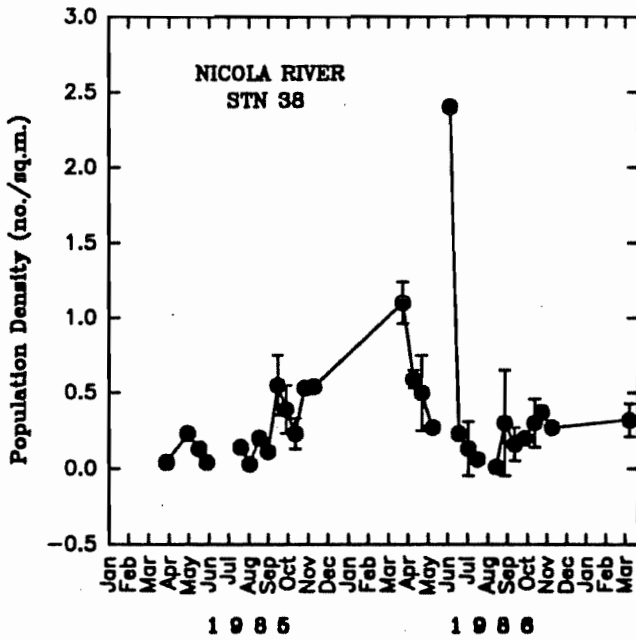


Fig. 4-11 Rainbow trout population density at Station 38, Nicola River

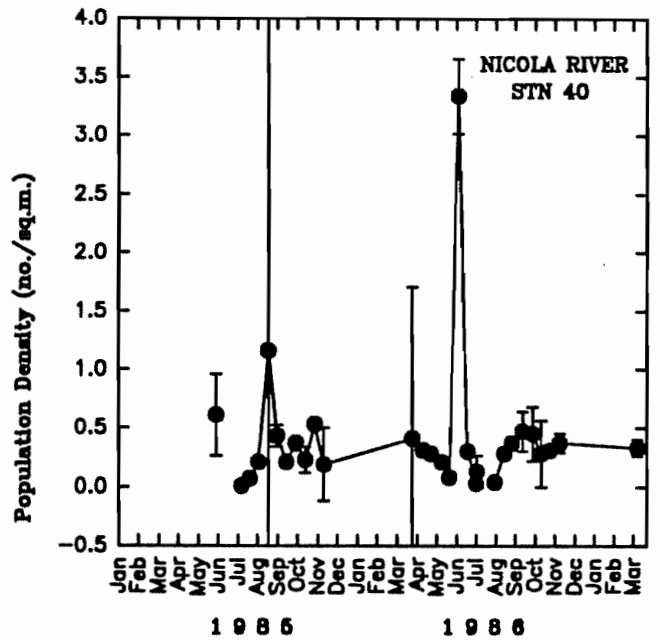


Fig. 4-12 Rainbow trout population density at Station 40, Nicola River

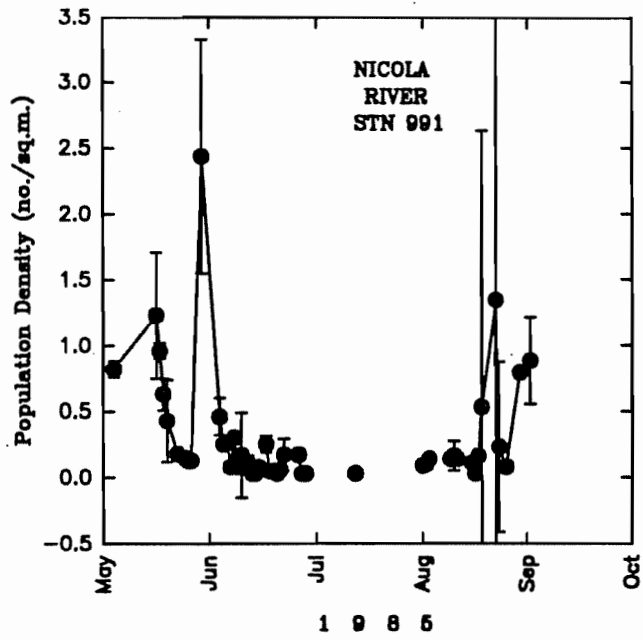


Fig. 4-13 Rainbow trout population density at Station 991, Nicola River

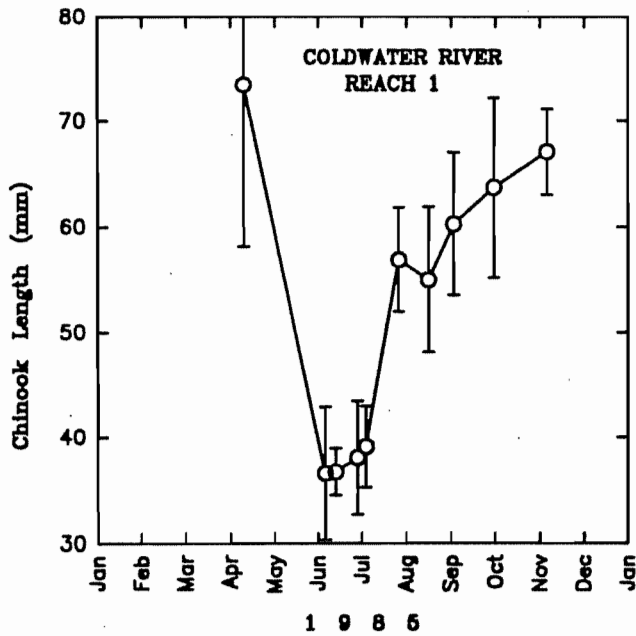


Fig. 5-1 Chinook salmon fork lengths (mm) in Reach 1, Coldwater River

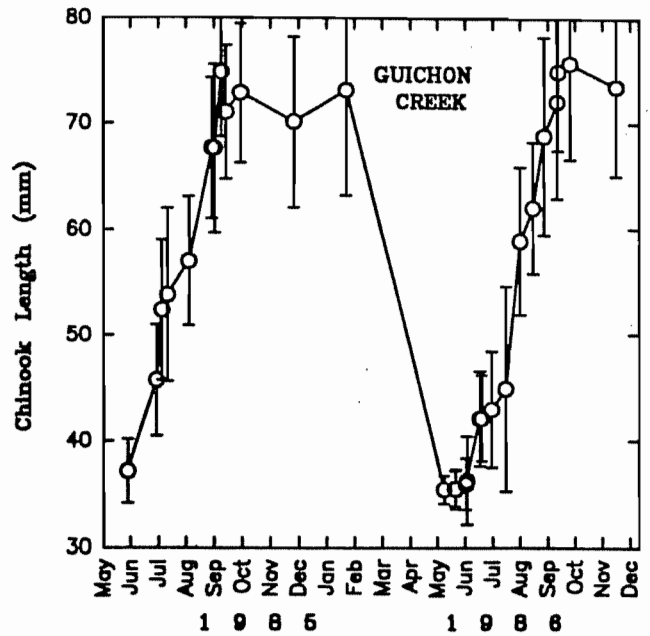


Fig. 5-2 Chinook salmon fork lengths (mm) in Guichon Creek

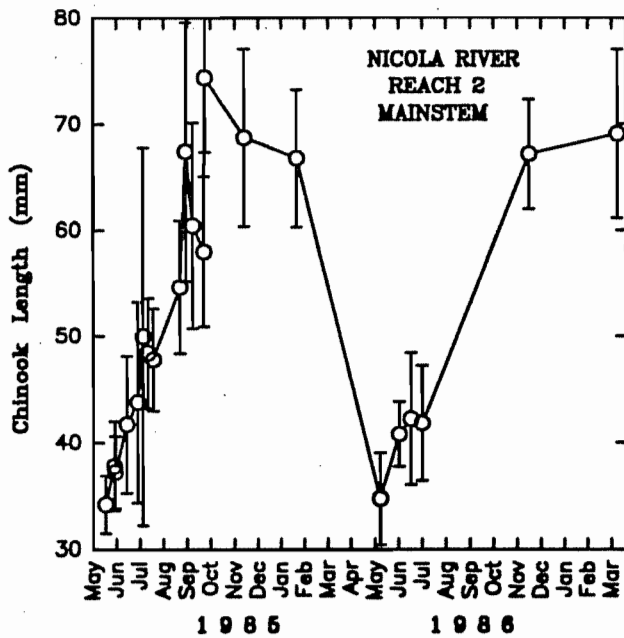


Fig. 5-3 Chinook salmon fork lengths (mm) in Reach 2, Nicola River

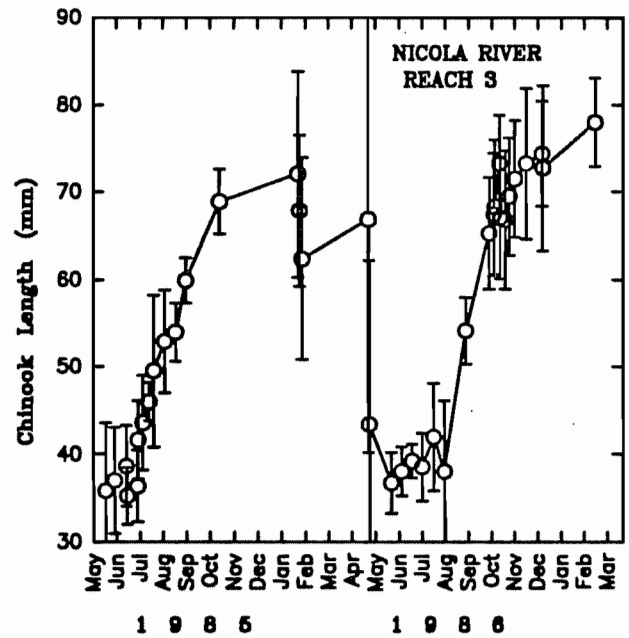


Fig. 5-4 Chinook salmon fork lengths (mm) in Reach 3, Nicola River

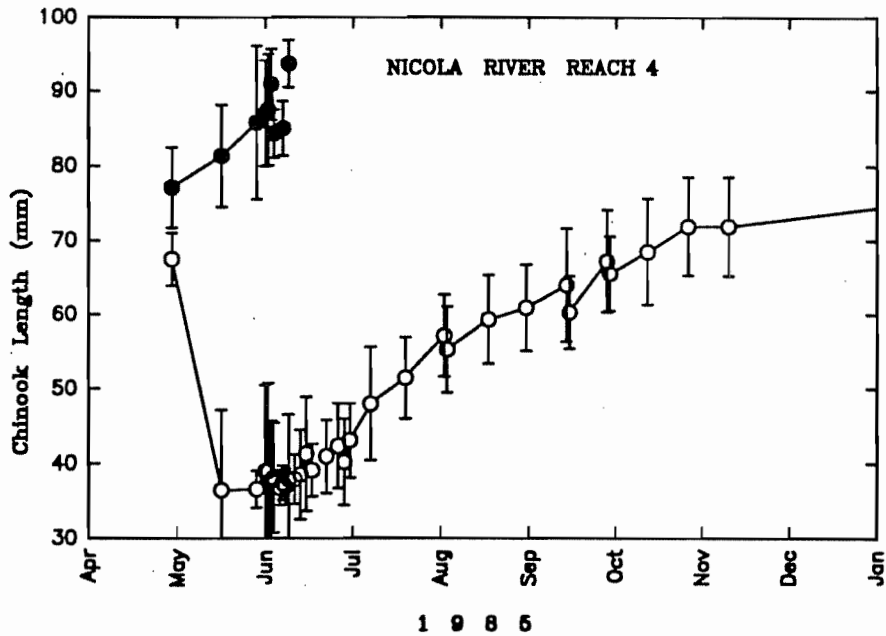


Fig. 5-5 Chinook salmon fork lengths (mm) in Reach 4, Nicola River during 1985. ○.....Unmarked Chinooks  
●.....Marked Chinooks

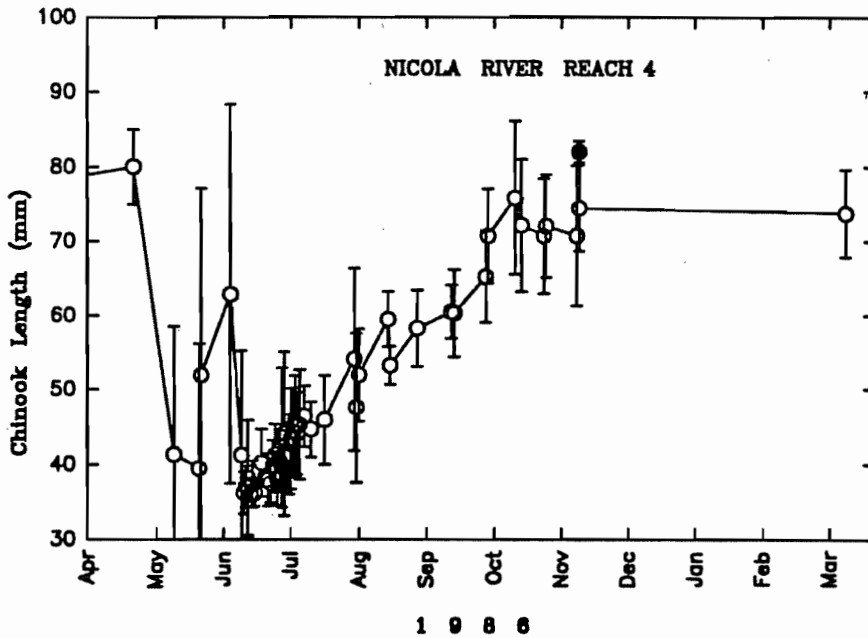


Fig. 5-6 Chinook salmon fork lengths (mm) in Reach 4, Nicola River during 1986. ○.....Unmarked Chinooks  
●.....Marked Chinooks

### III. PHYSICAL FACTORS

#### a. Velocities and depths

The mean velocities and mean depths of stations from the reaches sampled in this study and Guichon Creek are shown in Appendix 2, and the ranges are listed in Table 5.

**Table 5. Ranges of mean velocities (cm/sec) and depths (cm) in Nicola River reaches during freshet and post-freshet conditions.**

	Velocities (cm/sec)		Depth (cm)	
	Main freshet	Post-freshet	Main freshet	Post-freshet
Reach 1	45-76	5-20	29-37	30-40
Reach 2	51-80	8-39	29-44	17-44
Reach 3 1985	25-39	5-34	41-42	11-29
Reach 3 1986	29-47	10-39		18-32
Reach 4 1985	21-44	9-27	27-44	15-30
Reach 4 1986	8-50	16-28	13-51	22-44

#### b. Temperature

Reach 1 - The Coldwater River (Fig. 7-1) had a maximum daily mean temperature of 16.5 C in late July 1985. Water temperatures in summer in the Coldwater River were generally cooler than in Guichon Creek or the Nicola River.

Reach 2 - The maximum mean temperatures were 24.0 C in July 1985, and 22.0 C in July 1986 (Fig. 7-2).

Guichon Creek - The maximum mean temperatures were 20 C in June 1985, and 21 C in July 1986 (Fig. 7-3).

Reach 3 - The maximum mean temperatures were 18.5 C in August 1985, and 21.0 C in August 1986 (Fig. 7-4).

Reach 4 - The maximum mean temperatures were 21.0 C in July 1985 and 25.0 in July 1986 (Fig. 7-5).

#### c. Conductivity

The mean conductivity and standard deviation of the Coldwater River was 54.78 microsiemens  $\pm$ 45.19. In the Nicola River, the mean conductivity of Reach 2 was 269.67 microsiemens  $\pm$ 44.93, the mean conductivity of Reach 3 was 184.31 microsiemens  $\pm$ 66.34,

and the mean conductivity of Reach 4 was 222.86 microsiemens  $\pm$ 59.69. Guichon Creek had the highest conductivities in the study area, with a mean conductivity of 475.0 microsiemens  $\pm$ 80.60. Spius Creek had a mean conductivity of 255.67 microsiemens  $\pm$ 62.42.

#### d. Substrate and cover

A summary of the substrate and cover composition by reach and tributary is given in Table 6. These data are mean values of all sites within a reach or tributary, calculated over the sampling period. Guichon Creek was divided into riffle (R) and pool (P) habitats.

**Table 6. Percent mean substrate composition and mean cover composition in Nicola River reaches and selected tributaries during 1985 and 1986.**

	Coldwater (Reach 1)	Reach 2	Reach 3	Reach 4	Guichon Ck. P R		Spius Creek
<b><u>SUBSTRATE:</u></b>							
Boulder	15	6	18	37	22	1	11
Cobble	19	32	38	23	40	2	53
Gravel	41	24	14	8	36	0	17
Sand	22	17	16	5	1	73	12
Silt	2	19	13	28	0	22	8
Hardpan	0	0	1	0	0	0	0
<b><u>COVER:</u></b>							
Boulder	11	4	10	23	11	0	8
Cobble	6	9	14	7	9	0	10
Gravel	0	3	1	1	3	0	1
Cut bank	8	1	4	3	9	20	4
Log debris	18	4	5	1	5	14	3
Overstream vegetation	3	4	4	2	4	0	4
Instream vegetation	2	4	10	8	20	0	4

## DISCUSSION

The highest population densities of juvenile chinook salmon were found in Guichon Creek pools (Fig. 3-5), and in the Nicola River at the mouth of Guichon Creek (Stn. 21, Fig. 3-6). Guichon Creek was cooler than the adjacent reaches of the Nicola River by 2-5 C (Figs. 7-2, 7-3) and may have provided temperature refugia from the higher summer temperatures. Summer water temperatures in Reach 2 were close to the upper tolerance limits (24.5-25 C) for juvenile chinook salmon (Brett 1952).

Another factor which may have affected chinook distribution was cover composition. In Guichon Creek pools the total mean cover was 34%, and the mean cover provided by cutbank was 20% and by log debris was 14%. Cutbank, therefore, provided 59 % of the total cover and log debris provided 41% of total cover. Cutbank cover was highest in Guichon Creek pools, in comparison to other reaches and tributaries. Brusven et al. (1986) showed over 80% of 0+ chinook in an artificial channel were found in simulated cutbank cover during the summer. At Station 21, the total mean cover was 15%, and the mean cover provided by log debris was 6%. Log debris provided 40% of the total cover at Station 21. The only other area where log debris provided a high proportion of the total cover was Station 1 in the Coldwater River. The total mean cover at Station 1 was 47% and log debris provided 27% cover, resulting in log debris providing 57% of the total cover. Station 1, however, was consistently the coldest station and had the lowest conductivity. When sampling sites with heterogeneous habitats which included log debris or brush piles, it was observed that the majority of fish were captured in the wood debris. In flooded areas during the 1985 spring freshet, high densities (7.46 fish m<sup>-2</sup>) of chinook fry were observed in reconnaissance sampling among the bushes and willow saplings at an infrequently sampled station in Reach 3 (Lauzier 1987). The importance of woody debris as cover for juvenile salmonids is well documented (Hartman 1965; Chapman and Bjornn 1969; Bryant 1983).

Another factor which may have influenced chinook rearing in Guichon Creek were the higher conductivities in this tributary, in comparison to other areas. Conductivity is an indicator of secondary production, and possibly increased food production. Guichon Creek also had deep (~1 m deep) pools, which were rarely seen on the mainstem of the Nicola River. A combination of temperature regime, cover composition and stability, conductivity and pool habitat, may have provided ideal rearing conditions for chinook salmon in this tributary. An examination of the length data showed an earlier increase in mean lengths in Guichon Creek in 1985, in comparison to Reach 2 (Figs. 5-2, 5-3). In the fall of 1985, mean lengths in Guichon Creek levelled off, but in Reach 2, mean lengths decreased approximately 10 mm. This indicates possible emigration from Reach 2, with little or no growth in the remaining fish. In 1986, mean lengths were higher in Guichon Creek, than mean lengths in Reach 2, indicating better rearing conditions in Guichon Creek. Chinook spawning occurs sporadically in Guichon Creek (Kosakoski Pers. Comm.), so the chinook we observed may have originated in Guichon Creek, rather than have migrated from the Nicola River.

In Guichon Creek riffle habitat, rainbow trout densities (Fig. 4-4) surpassed chinook densities (Fig. 3-4) in 1985 and early 1986. In the adjoining pool habitat, chinook densities (Fig. 3-5) surpassed rainbow trout densities throughout most of 1985 and 1986. Peak

rainbow trout densities in riffle habitat in the late summer and fall of 1985 were close to chinook densities in adjoining pool habitat at the same time. This is similar to the habitat segregation found between age 0+ steelhead and age 0+ chinook by Everest and Chapman (1972). A comparison of chinook length date from Guichon Creek (Fig. 5-2) and Reach 2 (Fig. 5-3) shows Guichon Creek chinook were not likely adversely affected by intraspecific or interspecific competition. Bjornn (1978) found a decline in production of 0+ rainbow trout which were sympatric with chinook in the Lemhi River (Idaho).

Most of the upper and mid-Nicola River sites (Stn. 18, 21, 33) Figs. 3-3, 4-3, 3-6, 4-6, 3-9, 4-9) showed somewhat similar seasonal changes in chinook salmon and rainbow trout population densities. Chinook population densities characteristically exceeded rainbow trout densities in April, May and June. In July, chinook population densities decreased and were surpassed by rainbow trout densities in August and September. This was a result of the differing emergence times and subsequent downstream migration of chinook salmon and rainbow trout. Chinook fry typically emerged in April and May, and rainbow trout typically emerged in July and August (Lauzier and MacPherson 1987). The potential for chinook and rainbow interspecific competition is likely minimized by temporal segregation in the upper and mid-Nicola reaches.

Chinook salmon and rainbow trout population density patterns in the lower Nicola River (Reach 4)(Figs. 3-10, 4-10, 3-11, 4-11, 3-12, 4-12, 3-12, 4-13) were different than the upper and mid-Nicola River. The chinook densities in spring were initially lower, but densities remained higher throughout the summer and early fall, until October, when rainbow trout densities surpassed the chinook densities. Chinook were likely emigrating to the Thompson River, as recent evidence shows that this major river provided winter rearing habitat (Levings and Lauzier 1991). An examination of the site descriptions, with substrate and cover composition, showed that the mean boulder cover was higher in reach 4 than any of the other areas (Table 6). Some winter rearing also occurred in this reach, judging from early winter catches (Figs. 3-10 to 3-12, 4-10 to 4-12). It appears that the greatest potential for interspecific competition between chinook and rainbow would occur in Reach 4 in the fall and winter. However, Chapman and Bjornn (1969) found minimal competition during late fall and winter in Idaho streams, due to reduced digestive rates, and an adequate food supply for the reduced digestive rates.

Conductivity generally increased from the headwaters of the Coldwater River to the mouth of the Nicola River, suggesting more food may have been available in the lower reaches. However, the maximum mean conductivity in the Nicola River mainstem was in Reach 2, possibly due to the influence of the Merritt sewage outfall. The Merritt sewage treatment plant provides tertiary treatment, with the effluent discharged to infiltration lagoons. However, during high freshet flows, a portion of the effluent from the tertiary process is discharged into the Nicola River. The highest conductivities in the study were observed in Guichon Creek, likely due to a number of factors, such as agricultural runoff, and runoff from nearby community of Lower Nicola.

In conclusion, newly emerged chinook fry were found in riparian vegetation and brush piles during freshet. As the young of the year juveniles grew (> 40 mm) in the late spring and early summer, they were found in the margins, associated with cutbanks and other available cover. In the late summer and early fall, chinook juveniles were found in habitats

with cobble and boulder substrates with faster streamflows. Juvenile chinook salmon appeared to be emigrating from the Nicola throughout the year.

Newly emerged rainbow fry were found in quiet margin areas during the summer, but as they grew (> 40 mm), they were found mainly in the riffle areas, closely associated with gravel, cobble and boulder substrates. Rainbow trout juveniles were found in similar habitats as chinook salmon, however, temporal separation was evident throughout the study area. Spatial separation was observed in a small tributary with pool habitats (utilized by chinooks) and riffle habitat (utilized by rainbow trout) in close proximity.

It appears there was minimal intraspecific and interspecific competition between chinook salmon and rainbow trout juveniles in most of the study area throughout the year. The greatest potential for competition would occur when both species occupy the same habitats in the lower reaches during the winter. However, evidence in the scientific literature indicates competition during the winter is likely minimal.

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## APPENDIX 1 SITE DESCRIPTIONS

Site 1: This site, at Km 75 on the Coldwater River, was approximately 50 m downstream of the log bridge crossing of the Coldwater Forest Access Road. This bridge was 2 km upstream of the Henning Bridge on the Coquihalla Highway, close to the Coquihalla Summit. The substrate was mainly small gravel (54%) with pockets of sand (27%) and silt (5%) in the shallow pools. Boulder (9%) and cobble (5%) substrate were in the upstream section of the site. There was extensive cover provided by log debris (27%), cutbanks (15%) and low overhanging trees (5%).

Site 10: This site was immediately downstream of the log bridge crossing the Coldwater River at Kingsvale (Km 35). The substrate was mainly gravel (32%) and cobble (29%), with some mid-stream boulders (25%) in fast water (>30 cm/sec), and pockets of sand (14%) in the slow water sidechannels. Cover was provided by boulder (14%), cobble (9%), instream vegetation (4%) and log debris (1.5%).

Site 18: This site was located at Nicola River Km 65, approximately 3 km downstream of Merritt. The substrate was mainly gravel (36%), cobble (24%), and boulder (4%) in the fast water mid-stream, with sand (15%) and silt (17%) in the backwater pools half-way down the site. Cover was provided by large gravel (7%), cobble (6%), instream vegetation (4%), log debris (3%), and overhanging vegetation (2%). This site was usually sampled along both banks, but during freshet flows, access was restricted to the left downstream bank.

Site 20: This site was located in Guichon Creek adjacent to the Craigmont Mines property in the community of Lower Nicola. The substrate was mainly cobble (44%) and gravel (18%) in a riffle section about 10 m upstream from the confluence with the Nicola River. There was sand (15%) and silt (11%) in the deep pools at the upstream end of the site (estimated 60 m from the mouth). Boulders (13%) were found between two sections. In the upper pool, cover was log debris (11%), large overhanging trees (4%), streambank vegetation (7%), and cutbanks (3%), with instream cobble (9%) and gravel (8%) in the lower riffle area.

Site 21: This site was located in the Nicola River at Km 60, above and below the mouth of Guichon Creek, along the right downstream bank. The substrate close to the bank was mainly silt (28%) and sand (23%) with pockets of gravel and cobble. In the mid-stream riffle, the substrate was cobble (33%), gravel (10%), and boulder (5%). The upstream section of this site was characterized by low banks with log debris (6%), instream vegetation (5%) and overhanging vegetation (4%) cover. The lower section, downstream of Guichon Creek, was characterized by rip-rap banks (13%) bordering a deep (2-3m) pool.

Site 25: This site was located on Spius Creek at the hatchery effluent outlet on the right downstream bank, approximately 400 m upstream of the confluence with the Nicola River. The substrate was cobble (39%), boulder (21%), and gravel (17%), with pockets of sand (18%) and silt (6%). Cover was provided by cobble (14%), boulder (12%), cutbanks (7%), overhanging vegetation (7%), and instream vegetation (2%).

Site 27: This site was located immediately downstream of the Nicola/Spius confluence along the left downstream bank at Nicola River Km 46. The upstream boundary of the site was the CP Rail bridge. The substrate was cobble (42%), gravel (22%), and boulder

(18%), with a sandy beach (19%) reaching out to the mid-stream. Cover was provided by boulder (16%), cobble (16%) and a small cutbank (5%).

Site 33: This site was located immediately upstream of the Manning Creek Forest Access Road bridge on the Nicola River at Km 33 on the left downstream bank. The site was riffle habitat, with cobble (61%), boulder (20%), gravel (12%) substrate and pockets of sand (5%) and silt (2%). Cover was provided by cobble (23%), boulder (11%), and instream vegetation (10%).

Site 34: This site was located on the right downstream bank of the mainstem Nicola River across from Site 33. This site was characterized by riffle/pool habitat with cobble (51%), boulder (16%), and gravel (13%) substrate in the riffles and small gravel (13%) and sand (5%) in the pool. Cover consisted of cobble (15%), instream vegetation (11%), boulder (9%), cutbank (7%) and gravel (1%).

Site 35: This site was 0.4 km downstream of Site 34, on the right downstream bank. The site consisted of fast-moving water through a boulder field. Substrates were mostly boulder (41%), with some cobble (24%) and small areas of gravel (5%). There were large pockets of sand (26%) behind the large boulders on the margin, and small areas of exposed hardpan (4%). Cover was provided by boulders (11%), instream vegetation (11%) along the margins, cobble (8%), and gravel (1%).

Site 36: This site was approximately 0.8 km downstream of 13 Mile Ranch on the Nicola River along the right downstream bank at river Km 15. This site was riffle habitat with a mixed substrate of boulder (44%) and cobble (28%) in the fast water, and silt (16%), sand (7%), and gravel (4%) in the slow water along the margins. Instream vegetation (9%), cutbanks (2%), and overhanging vegetation (2%) provided cover along the margins. Boulders (23%) and cobble (7%) provided cover in the fast water.

Site 38: This site was located adjacent to Hwy. 8, along the right downstream bank, approximately 0.6 km upstream of Jeffries Garden at river km 5. The substrate was boulder (56%) and cobble (28%) in the fast water, with some pockets of silt (12%), sand (5%), and gravel (4%) behind the largest boulders. Mid-stream cover was provided by boulders (28%) and cobble (5%). Cover along the margins was provided by instream vegetation (8%), cutbank (2%), and log debris (1%).

Site 40: This site was located on the right downstream bank, 0.2 km downstream of the lower Rattlesnake Bridge crossing the Nicola River at river Km 2.5. The substrate was boulder (48%) and cobble (29%) in the fast water, and gravel (10%), silt (9%), and sand (3%) along the margin. The mid-stream cover was provided by boulder (28%) and cobble (9%). The cover along the margins was provided by cutbank (6%), instream vegetation (3%), gravel (2%) and overhanging vegetation (2%).

Site 991: This site was located approximately 0.2 km upstream of the Nicola/Thompson confluence along the left downstream bank. The substrate was cobble (18%), boulder (15%), and gravel (11%), with silt (55%) along the margin. Cover was provided by boulders (17%) and cobble (9%) in the fast water. During freshet conditions, instream vegetation (5%) provided cover along the margin.

**APPENDIX 2**  
**WATER DEPTHS AND VELOCITIES**

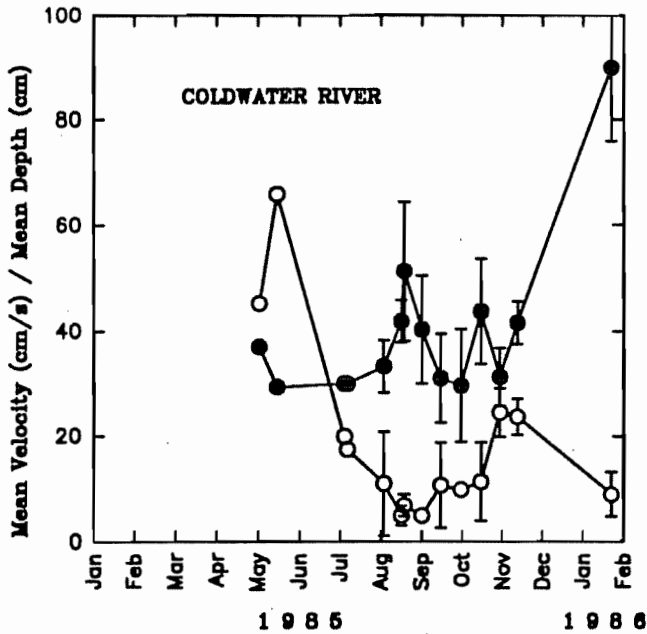


Fig. A2-1 Mean depths and mean velocities in the Coldwater River

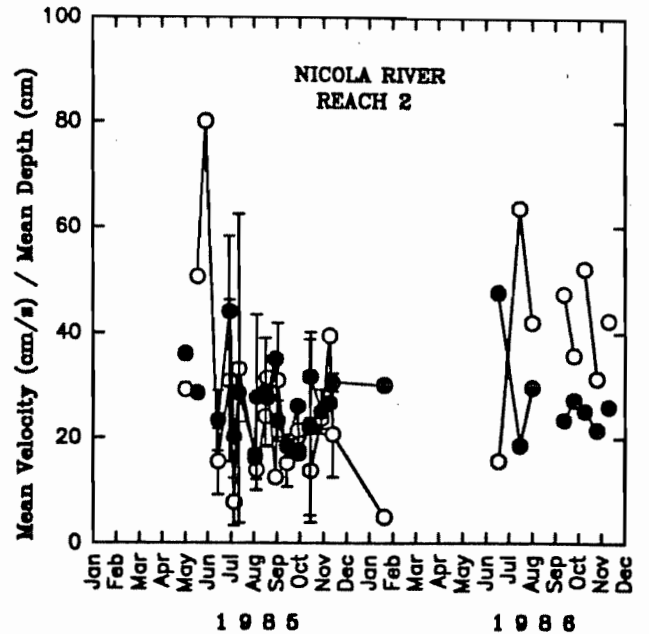


Fig. A2-2 Mean depths and mean velocities in Reach 2, Nicola River

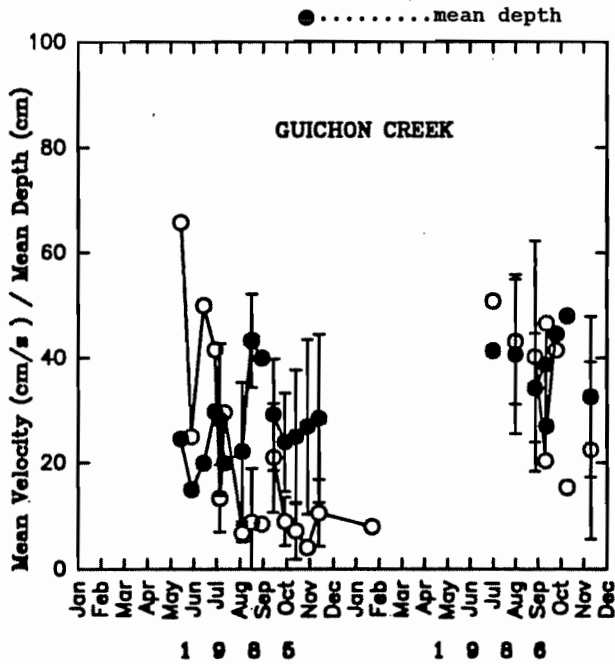


Fig. A2-3 Mean depths and mean velocities in Guichon Creek

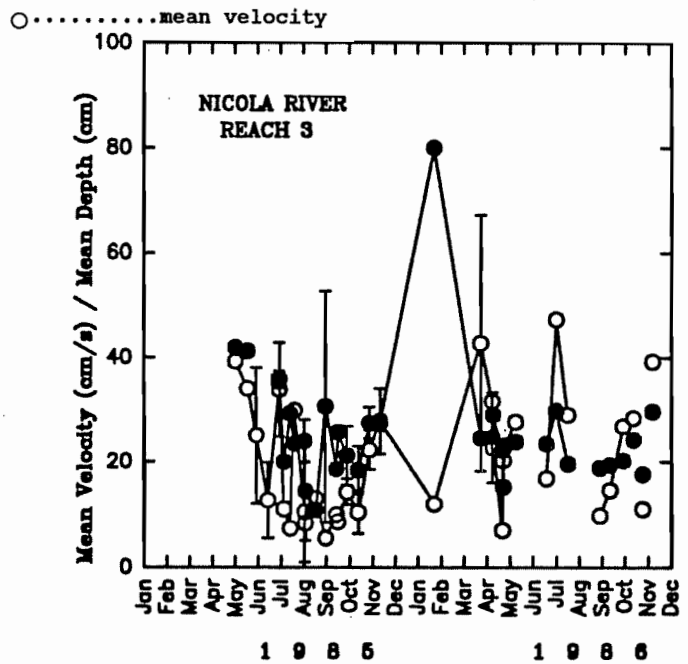


Fig. A2-4 Mean depths and mean velocities in Reach 3, Nicola River

●.....mean depth

○.....mean velocity

●.....mean depth

○.....mean velocity