Study of Juvenile Chinook Salmon in the Nechako River, British Columbia 1985 and 1986

by Nechako River Project

Department of Fisheries and Oceans
Pacific and Yukon Region
Nechako River Project
555 West Hastings Street
Vancouver, B.C. V6B 5G3

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152

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STUDIES OF JUVENILE CHINOOK SALMON IN THE NECHAKO RIVER, BRITISH COLUMBIA 1985 and 1986

by

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Department of Fisheries and Oceans

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LIST OF TABLES

LIST OF TABLES

LIST OF FIGURES

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#152

Abstract

Data collected on juvenile chinook salmon rearing in the Nechako River system between August and September 1985 and between May and July 1986 are presented. Seasonal distribution and abundance of juvenile chinook salmon within the river and its tributaries were determined.

Microhabitat criteria for juvenile chinook were studied. Using a variety of sampling techniques, data on fish length, height above bottom, wet weight, water temperature, depth and velocity were collected. A series of marginal and mid-channel dives were conducted to determine the lateral distribution of juvenile chinook in the river. On four occasions sampling was conducted for day and night distribution. Electroshocking in the lower reaches of eight tributaries was conducted to obtain an index of tributary use by juvenile chinook salmon.

Selected microhabitat conditions were found to change significantly with the increasing size of juvenile chinook. Microhabitat characteristics selected by juveniles of the same size varied between reaches of the Nechako River. Day and night distribution of juveniles in the Nechako suggested they redistribute along the shallow river margins at night to feed and reform into loose schools next to wood accumulations for safety during the day.

Key words: juvenile chinook salmon, rearing, distribution, habitat selection, microhabitat

RÉSUMÉ

On présente des données recueillies en août et septembre 1985 et de mai à juillet 1986 sur les saumons quinnats juvéniles du système de la rivière Nechako. On a aussi déterminé la répartition et l'abondance saisonnières des juvéniles dans la rivière et ses tributaires.

Les caractéristiques du microhabitat des quinnats juvéniles ont été étudiées. À l'aide d'une variété de méthodes d'échantillonnage, on a recueilli des données sur la longueur des poissons, la profondeur fréquentée, le poids net, la température de l'eau, la profondeur et la vitesse du courant. On a aussi effectué une série de plongées aux bords et au milieu du chenal afin de déterminer la répartition latérale des quinnats juvéniles. À quatre occasions, l'échantillonnage a été effectué de manière à établir la répartition pendant le jour et la nuit. On a réalisé une pêche par électricité dans les tronçons inférieurs de huit tributaires afin d'obtenir un indice de l'utilisation des tributaires.

On a découvert que les conditions du microhabitat choisi varient nettement en fonction d'une augmentation de la taille des quinnats juvéniles. Les caractéristiques favorisées par des juvéniles de la même taille variaient selon les tronçons de la Nechako. La répartition diurne et nocturne des juvéniles dans la Nechako porte à croire qu'ils se dispersent la nuit dans les eaux peu profondes le long des rives pour s'alimenter et se regroupent en bancs relâchés pendant le jour à proximité d'amoncellements de branches et de troncs où ils se sentent plus en sécurité.

Mots-clés : saumon quinnat juvénile, croissance, répartition, choix d'habitat, microhabitat

INTRODUCTION

This report presents the data collected in 1985 and 1986 on juvenile chinook salmon in the Nechako River system. The purpose of these studies was to determine the habitat conditions used by juvenile chinook salmon while they were rearing in the river. Our goal was to determine where the fish distributed themselves within the river, how and on what basis they selected locations within the river to live, how permanent these locations were, and how the positions changed as the fish grew larger and the seasons changed.

The streamflow in the Nechako River is regulated by the Aluminum Company of Canada (ALCAN) through a dam at Skins Lake spillway. As a consequence of water diversions out of the system the streamflow pattern is very non-normal with lower than the natural streamflow that is relatively steady for long periods of time, and with its largest flow (equivalent to the historical spring runoff flow) delayed by about one month. Because the timing and amount of streamflow in a river are known to be important factors influencing the way fish locate themselves within the environment and cues which they use to initiate some of their important life history patterns, we particularly wanted to record how juvenile chinook salmon occupied habitat in relation to the Nechako's regulated streamflow.

Specific questions which we addressed on the juvenile chinook salmon's habitat were:

1) How are juvenile chinook salmon distributed longitudinally along the river?

2) How are juvenile chinook salmon distributed laterally across the river?

3) How are juvenile chinook salmon distributed between the mainstem of the river and its tributaries?

4) Are deep canyon areas of the river used as habitat by juvenile chinook salmon?

5) Do juvenile chinook salmon use the same habitat at night as they use during the day?

6) What are the specific water depths, water velocities, substrate sizes, light intensities and cover objects that juvenile chinook salmon select and avoid in the river?

and

7) How do these distributions within and along the river change as the fish grow, the water temperature associated with the summer and autumn seasons changes, and the streamflow changes?

METHODS

MICROHABITAT CHARACTERISTICS

Between August 23 and September 15, 1985 and between May 14 and July 17, 1986, microhabitat characteristics occupied by juvenile chinook salmon in the Nechako River system were surveyed. Assuming the fish had emerged April 15 each year, the 1985 studies are for habitat used by fish 4 to 5 months old, and the 1986 studies are for habitat used by fish 1 to 3 months old. In 1985, a total of 36 sites were surveyed sequentially from Cheslatta Falls to Vanderhoof, a distance of approximately 140 km (Fig. 1 and Appendix 1). In 1986, additional sites including 10 tributaries were added for a total of 46 sites (Fig. 1, Appendix 2).

In August and September of 1985, sampling sites were selected systematically irrespective of fish abundance. In 1986, the microhabitat survey reused the most populated sites as determined during field observations in 1985 and 1986. The aim of the microhabitat study was to describe the rearing environment utilized by chinook salmon juveniles and to represent the different river sections in approximate direct proportion to the abundance of juveniles found there during sampling. As a result, as opposed to 1985, sites monitored in 1986 often included beaver lodges, log jams, fallen trees and dock areas since the juvenile chinook salmon tended to concentrate near these structures.

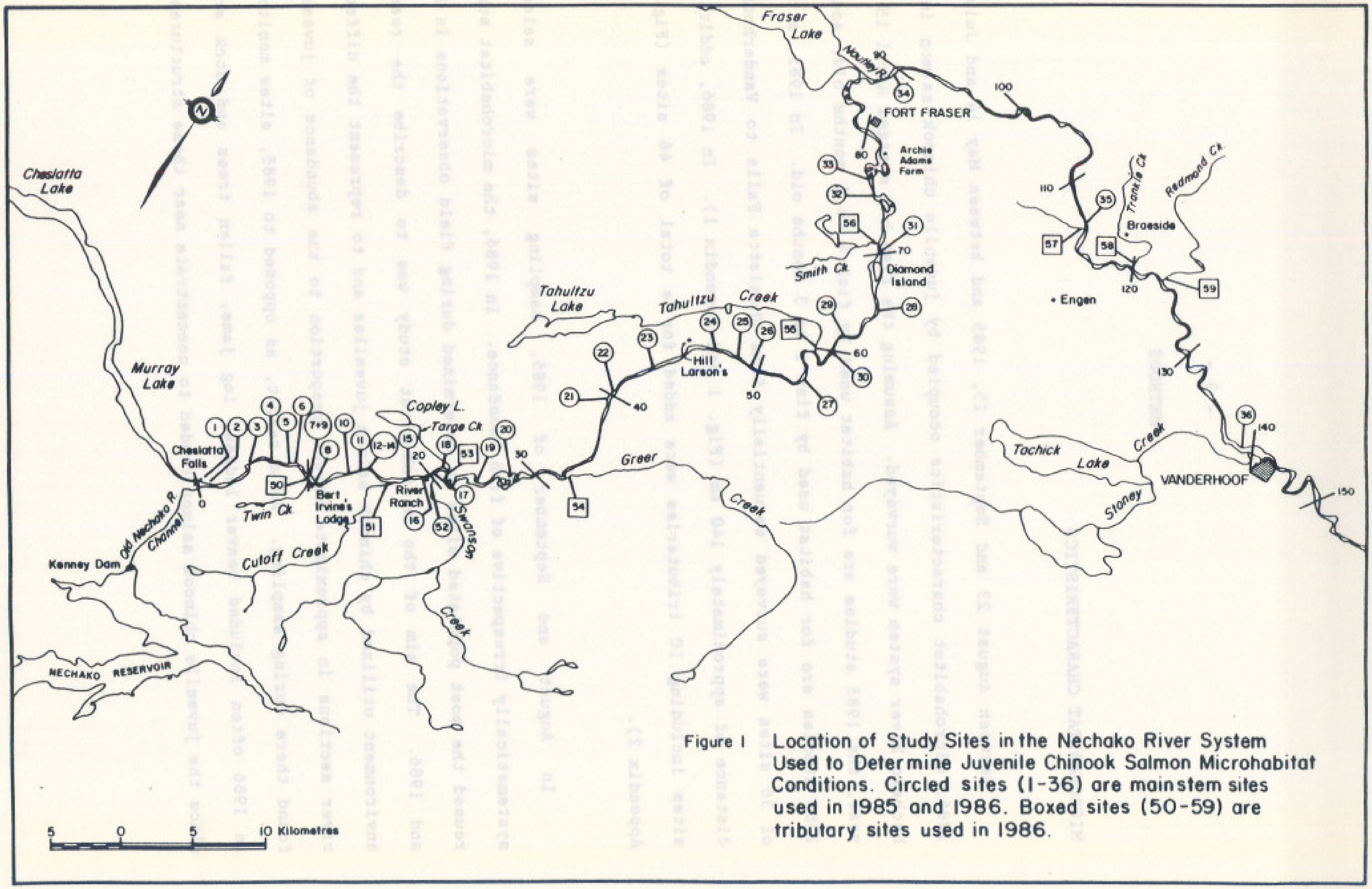

Figure 1 Location of Study Sites in the Nechako River System Used to Determine Juvenile Chinook Salmon Microhabitat Conditions. Circled sites (1-36) are mainstem sites used in 1985 and 1986. Boxed sites (50-59) are tributary sites used in 1986.

In the autumn of 1985, each site was generally surveyed once by snorkeling. In addition, a Smith-Root Electrofisher (model No. 11-A) was used on August 23, 1985. Records were made of the duration of electrofishing and snorkeling, and of the number and species of fish captured or sighted at each location (Appendix 1) in order to obtain an indication of salmonid and non-salmonid presence in the system. During May, 1986, sampling and the effectiveness of fish observation was hampered by high water, turbidity, and schooling behavior of the newly emergent fry which held in tight schools in very shallow water so that snorkeling could not be used to study fish habitat in detail. Instead, observations were made from shore while walking along the river bank and during electrofishing. Snorkeling commenced June 12, 1986 when the water was clearer and the juvenile chinook salmon had moved into sufficiently deep water to allow the use of divers. Two observers collaborated during sampling; a diver made observations while an observer recorded the data and operated the measuring equipment.

The field objective of the microhabitat study was to locate visually a juvenile chinook salmon holding in position in the water column, capture that fish for size measurement, and measure a series of microhabitat parameters at the fish's position. The following information was collected: fish length (fork length mm) and wet weight (g) at the time of capture, water temperature, water depth, fish's height above bottom, water velocity at five locations (1 = water velocity at the fish's position, 2 = velocity 30 cm laterally to the fish's position taken on the faster flowing side, 3 = water velocity 30 cm above the fish's position - or at the surface where water depth was insufficient, 4 =

water velocity at 15 cm above bottom, and 5 = water velocity at 6/10 of the depth from the surface at the fish's position), light intensity at the fish's position and at the surface, distance to the water's edge, and substrate composition. It should be noted that in 1985, velocity measurements were not taken at 15 cm above the stream bottom or at 6/10 of the column depth. Water velocities from these various positions hereinafter will be referred to as nose-velocity, lateral 30 cm velocity, vertical 30 cm velocity, vertical 15 cm velocity and 6/10 column velocity.

Water temperature was measured using a Fisher Scientific No. 15-1403 ASTM 63-C total immersion thermometer. The bulb of the thermometer was held at the fish's position during measurement. Water velocity was measured using an Ott C2 current meter (Kempten W. Germany) with a Z210 impulse counter. Water velocities were measured for 30 seconds and the mean velocity was calculated and expressed as $cm \cdot s^{-1}$.

Light measurements were made using a Li-Cor LI-188 B integrating quantum photometer with underwater sensor model No. LI-212 SB. Light measurements were integrated over 10 second intervals and expressed in thousands of luxs. For measuring light arriving at the water surface, the sensor was held in the air just above the water surface; for measuring light arriving at the fish's eye, the sensor was held at the fish's eye position. Readings at the fish's eye were corrected by an immersion factor (x 1.35). Surface readings could not be used since during measurements, varying amounts of water covered the sensor bulb so that a constant correction factor could not be established for all measurements.

Distance of the fish's position to the water's edge was measured perpendicular from the fish's position to the wetted edge of river bank, paced off in meters by the recorder. Substrate composition involved recording the dominant and sub-dominant substrate types encountered at the fish's position in order of decreasing abundance. Substrate sizes were judged subjectively by the diver underwater. The size ranges of the substrate types followed the modified Wentworth Particle Size Scale (Bovee and Cochnauer (1977): silt-clay (<0.062 mm), sand (0.062 - 2 mm), gravel (2 - 64 mm), cobble (64 - 250 mm) and boulder (250 - 4000 mm). Bedrock, growing plants, and organic sediment (bark, leaves) were also recognized and recorded.

During the 1985 fall snorkeling survey, individual juvenile chinook salmon could not be captured for size measurement since they were too big and swam too fast to be captured by the diver. To compensate for this, a brief sampling program was undertaken at the end of the study on September 17 and 18, 1985 to capture representatively sized individuals. It was assumed that fish captured during these samples were representative of the fish for which the microhabitat characteristics had been measured. Gee minnow traps, a Smith-Root Electrofisher (model No. 11-A), a pole seine and a beach seine were used to sample seven sites between Cheslatta Falls and Greer Creek. The site location, the trapping method used, and the effort expended at each site are given in Appendix 3.

During May 14 to 24, 1986 juvenile chinook salmon were captured by electrofishing for the determination of their microhabitat. In June and July of that year, juveniles were captured primarily by using a spear gun fitted with a specially modified trident spear tip (C. Shirvell, Pacific Biological Station, personal communication). A number of fish were also captured with a net approximately 30 cm in diameter and 25 cm deep, that could be pursed shut to enclose the fish (Morantz et al. 1987).

Once captured the fork length of fish was measured to the nearest 1 mm and the wet weight of fish measured to the nearest 0.1 g using a Sartorius electronic digital scale model No. 1002 MP9. Prior to handling, fish were anaesthetized with 2-phenoxyethanol. A portion of the fish captured by electrofishing or seine nets and all fish captured with the spear gun were preserved in 10% formalin solution and held for subsequent stomach content analysis. The remaining fish were released into the river after size measurements were taken.

On several occasions during the May electrofishing, fish that were captured were not maintaining any single position but were slowly swimming in slack water near the river's edge. For these fish only size and water temperatures were recorded. When several fish holding in a tight school were captured simultaneously during electrofishing, or where two fish were speared simultaneously during snorkeling, all were measured for size (the measurements were subsequently used in a growth study) but only one location was measured which was assumed to represent the microhabitat of the whole school. Microhabitat parameters were also measured for some fish that escaped capture due to their large size and speed. These fish were denoted as N/A in the "fish number" column in Appendix 12 and lack size data.

FISH DISTRIBUTION ACROSS THE RIVER

During the microhabitat studies in 1985 and 1986, a series of marginal and mid-channel snorkeling dives were conducted at several sites along the Nechako River mainstem to determine the lateral distribution of juvenile chinook salmon in the river. The dives along the river margin were made generally within 4 m of the shoreline and averaged 37 min in duration. The mid-channel dives were made anywhere from 20 m or more from the shoreline and averaged 16 min in duration. All diving was conducted between approximately 1000 hr and 1600 hr, and a mid-channel dive usually followed a dive along the margin so that the sampling was "paired" for the same location.

The diver drifted downstream with the current or with his own propulsion if the current was slow, thereby maintaining comparable search speed in a variety of current velocities, and visually searched for fish from side to side. In this way, the diver could observe a band of water 3-4 m wide, and almost always the entire water column depth since underwater visibility usually exceeded water depth (up to about 4 m).

In addition to the microhabitat snorkeling conducted by the Department of Fisheries and Oceans, the B.C. Provincial Fisheries Branch conducted snorkeling surveys in the Nechako River mainstem during 1985 and 1986, and provided incidental data on the lateral distribution of chinook juveniles (P. Slaney, personal communication). On July 3, 1985 starting at 1530 hr, five B.C. Fish and Wildlife divers snorkeled along Reach #1 for a distance of approximately 5 km starting downstream from Cheslatta Falls (Fig. 2). Each diver covered a lane about 4 m wide, with one diver swimming along each shore lane (0-4 m from shore), one diver along each nearshore lane (4-8 m from shore) and one diver along the mid-section lane (8-12 m from shore). A single count of juvenile chinook salmon was obtained for each lane. No reaches other than Reach 1 were examined at this time due to poor visibility.

During June 17-24, 1986, the Provincial Fisheries Branch surveyed four reaches in the Nechako mainstem including Reach 1 from the previous year (Fig. 2). Wetted width ranged from 52 m - 90 m and the reach length ranged from 3.0 km - 5.5 km (Table 1). Six divers snorkeled along six river lanes (two shore, two nearshore and two mid-channel) for the length of the reach (3.0 km - 5.5 km). The divers worked in pairs, each member of the pair searching an area just ahead and in opposite direction from the other. Visual distance for a given reach ranged from 2 m - 3 m (Table 1) and was based on the distance a representative fish specimen in that reach was visible at. A total of 2-3 counts of juvenile chinook salmon were made for each reach (1 count/day in a given reach) and all diving was conducted between approximately 1100 h and 1600 h.

A final snorkeling survey by the B.C. Provincial Fisheries Branch was conducted during September 9-10, 1986 in Reach 1. Two replicate counts were made in each of the six lanes surveyed, using the same methods as in June of that year (above).

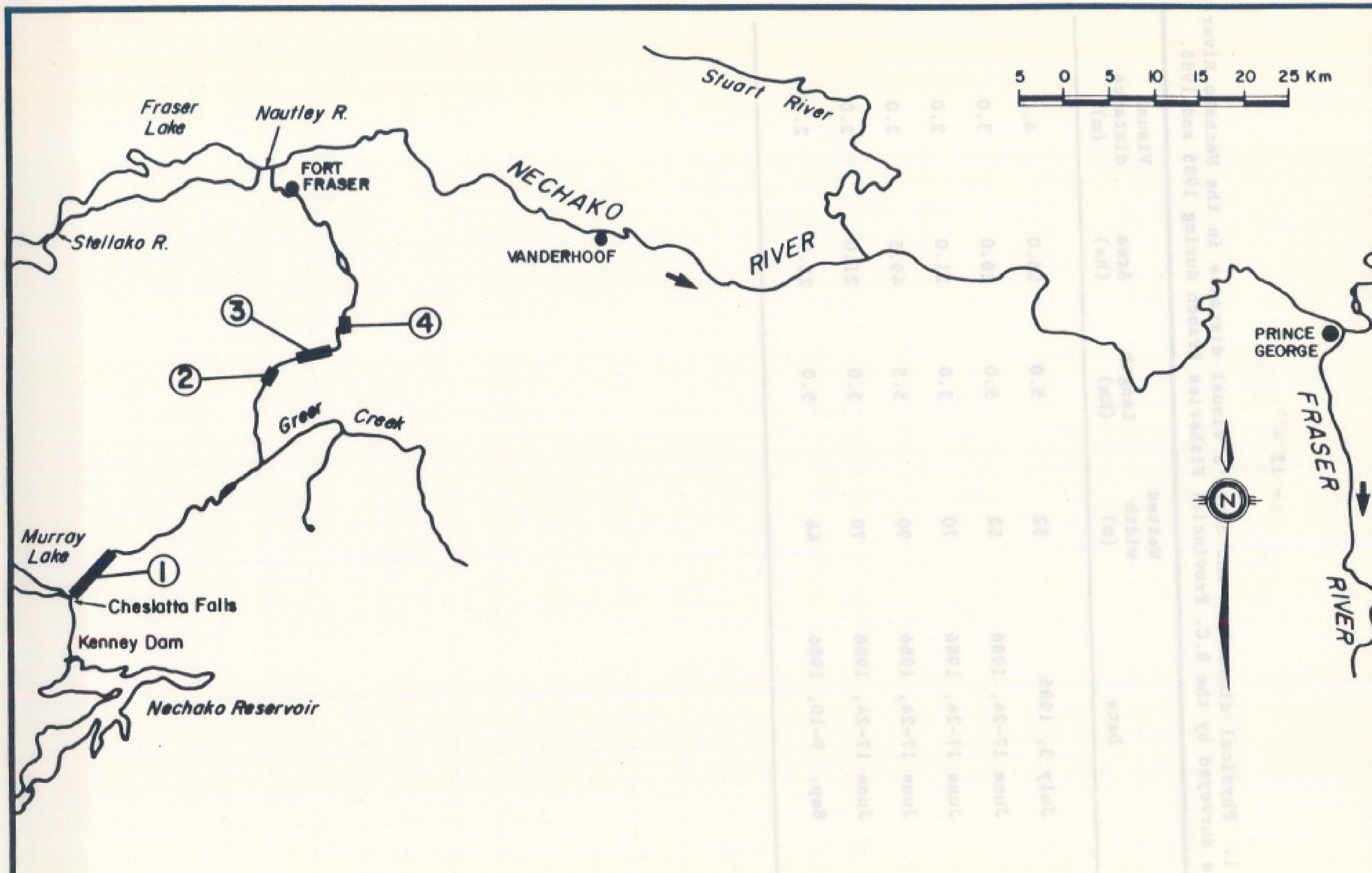

Figure 2 Snorkeling Reaches (1-4, shaded areas) Surveyed for Juvenile Chinook Salmon by the B.C. Provincial Fisheries Branch, Nechako River, 1985, 1986
(adapted from Envirocon 1983 by P. Slaney, personal communication)

Table 1. Physical dimensions and diver's visual distance in the Nechako River reaches surveyed by the B.C. Provincial Fisheries Branch during 1985 and 1986.

Reach	Date	Wetted width (m)	Length (Km)	Area (ha)	Visual distance (m)
1	July 3, 1985	52	5.0	26.0	4.0
1	June 17-24, 1986	52	5.0	26.0	3.0
2	June 17-24, 1986	70	3.0	21.0	2.0
3	June 17-24, 1986	90	5.5	49.5	2.0
4	June 17-24, 1986	70	3.0	21.0	2.0
1	Sep. 9-10, 1986	44	5.0	22.0	2.0

DAY vs NIGHT DISTRIBUTION

June-July 1986 sampling

Juvenile chinook salmon were sampled in the Nechako mainstem for day and night distribution on four occasions in 1986: June 30, July 4, 9 and 17. Sampling locations were at river kilometre 10.5 (Bert Irvines'), river kilometre 46 (Hill Larson's), and river kilometre 142 (the Vanderhoof bridge) (Fig. 1). At each site, four quadrats each measuring 1 m^2, were set in pairs along the river margin with the upstream and downstream pairs about 40 m apart. The four quadrats were placed in specific microhabitats so that each grid pair consisted of one shallow quadrat located close to shore and one deeper quadrat further offshore. Each 1 m^2 quadrat was formed by driving four spikes into the substrate and attaching white string to each spike head to delineate the enclosed area. (Note that grids at Vanderhoof bridge were positioned at similar but not identical locations on the two sampling dates, July 4 and 17).

At specified times during day and night, two observers approached each quadrat group (one observer per pair) from a downstream direction so as not to disturb the fish, and counted the fish in each quadrat. Generally, 2-6 replicate counts were made at each quadrat. Individual counts lasted 2 minutes and were followed by 3 minutes of no disturbance prior to the next count. A regular 6 volt lantern was used during the night counts since the fish were not disturbed by the 2 minute period of illumination. Lights were extinguished during the "rest" periods. Day counts occurred between 09:04 and 16:59; night counts occurred between 23:36 and 00:57.

In addition to day and night quadrat counts, two observers conducted day and night walks along the shoreline between the paired quadrats and sometimes beyond, for a distance of 36-100 m, and counted the number of chinook observed in a band of water along the shoreline 2-3 m wide. Counts of juvenile chinook salmon along the shoreline lasted 3-30 minutes and generally occurred a few minutes after the last quadrat count. This was considered to be an adequate separation period between counts since at night fish were observed not to be disturbed by the lights while in the daytime no chinook were observed in the quadrats.

On each sampling date, a series of physical parameters was measured at each quadrat. The parameters included water temperature, water depth, 6/10 of the depth water velocity, distance to wetted shore edge, light intensity at the surface, and substrate composition. The measurements were taken at the center of each quadrat between 09:22 and 17:17, except on July 17 when depths and velocities were measured at around 21:00. Physical measurements were not taken from the areas between the quadrats along the shoreline since it was assumed that the four quadrats represented subsamples of the larger area. However, the area of streambed along the shoreline counted for fish between the quadrats was calculated for each sample.

August-September 1986 sampling

In addition to the above observations during June and July, night quadrat counts were obtained at the Vanderhoof bridge in August. Also, during August and September, day and night (or dusk) beach seining and snorkeling were conducted at selected sites (See Table 14 and Fig. 5) along the upper Nechako River mainstem as part of the day and night distribution study on chinook salmon juveniles. Sites used for these samples were selected on the basis of their accessibility in the dark and the size of chinook salmon catches in the daytime.

On August 12, five 1 m^2 quadrats were installed around midnight at the Vanderhoof bridge site in water depth of 30 cm or less, and three replicate counts were made between 2345 h and 0005 h. This area was also counted and beach seined in the daytime on August 15 at 1420 h and beach seined in the evening on September 25 between 1800-1830 h. On October 9 at 2300 h, approximately 30 m of shoreline were counted upstream and downstream of the Vanderhoof bridge, and visual observations made using a spotlight.

USE OF DEEP WATER BY JUVENILE CHINOOK SALMON

The purpose of these observations was to evaluate the use of deep water by juvenile chinook salmon. The area studied was a deep canyon located approximately 1 km downstream from Cheslatta Falls. The canyon is approximately 500-600 m long, has an average width of 27 m, and mean and maximum observed water depth of 6.1 m and 17.2 m respectively; water flow at the time of these measurements was approximately 30 $m^3 \cdot s^{-1}$ (1000 cfs) (K. Rood, Reid Crowther Co., personal communication). This canyon represents the deepest water in the Nechako River mainstem.

The study was conducted in two parts. On September 17, 1985, three Gee minnow traps baited with salmon roe were lowered into the canyon to approximately a 6 m depth for a period of 24 h. At the end of that interval, the traps were removed and the captured fish counted.

On June 26, 1986 two scuba divers made a total of four replicate dives along the canyon length. Dives 1 and 2 were generally bottom dives along the centre of the canyon; dives 3 and 4 started on opposite canyon banks but converged as the river constricted in the deeper water about half-way down the canyon. During each dive, two divers swam parallel to each other, each surveying his side of the travelled route. The dives were conducted between 10:55 and 13:23 and each lasted 7-20 min. The information recorded included the number and species of fish observed, water temperature, estimated water depth and velocity, and substrate composition in each area where fish were sighted.

On July 3, 1985 the B.C. Provincial Fisheries Branch conducted limited scuba diving along 250 m of the same canyon (P. Slaney, personal communication).

USE OF NECHAKO RIVER TRIBUTARIES BY JUVENILE CHINOOK SALMON, MAY 1986, AUGUST 1986, SEPTEMBER 1985

Between May 14 and 24, 1986, electrofishing was conducted in the lower reaches of eight Nechako River tributaries (Table 2, Figure 1). The purpose of these samples was to obtain an index of tributary use by juvenile chinook salmon in the spring, as opposed to the 1985 samples which were collected in the

Table 2. Tributaries of the Nechako River sampled for juvenile chinook salmon in the spring 1986.

Date	Site No. (see Fig. 1)	Approx. km below Cheslatta Falls	Electrofishing period (sec)
	Creeks		
May 20	50 (Twin Cr.)	10	47
May 20/24	51 (Cutoff Cr.)	17	439
May 24	52 (Swanson Cr.)	19.5	145
May 19	53 (Targe Cr.)	21	222
May 23	56 (Smith Cr.)	71	48
May 23	57 (Leech Cr.)	114	196
May 23	58 (Trankle Cr.)	120	52
May 23	59 (Redmond Cr.)	122	96
	TOTAL TRIBUTARIES		1,245

autumn. Fish were captured using a Smith-Root Electrofisher model No. 11-A. Sampling was conducted by fishing in an upstream direction from the mouth of the tributary for a set time period. The duration that electrical current was applied (as an index of sampling effort) was recorded for each tributary (Table 2).

During August 12 - 14, 1986, four Nechako River tributaries (Smith Creek, Swanson Creek, Cutoff Creek, and Greer Creek) were sampled for juvenile chinook salmon using a Smith Root electroshocker (Table 3). Sampling in each tributary was limited to one stream section (30 m or less). Smith and Swanson Creeks were sampled near their confluences with the Nechako River while Cutoff and Greer Creeks were sampled about 0.5 and 3.0 km upstream of their confluences respectively and were accessed from the Nechako River road. The number of juvenile chinook salmon captured was recorded. The fish were anasthesized, their lengths and weights measured, and after recovery they were released back into their capture locations.

During September 13-18, 1985, seven Nechako River tributaries were sampled for fish using pole seining, beach seining and electrofishing to determine the extent of tributary use by juvenile chinook salmon for rearing in autumn. All tributary sampling was conducted upstream of Diamond Island and included the original Nechako River channel upstream of Cheslatta Falls (it was considered a tributary for this study), Twin Creek, Cutoff Creek, Swanson Creek, Targe Creek, Greer Creek and Tahultzu Creek (Fig. 3). Table 3 lists by date the survey method used and the catch effort expended in each tributary.

Table 3. Sampling Of Nechako River Tributaries for Juvenile Chinook Salmon, May 1986, August 1986, and September 1985.

Date	Tributary	Site	Survey Method	Survey Effort Interval/(s)	Survey Effort Area/Distance
May 19	Targe Ck.	Creek channel	electrofishing	222	-
May 20	Twin Ck.	Creek channel	electrofishing	47	-
May 20/24	Cutoff Ck.	Creek channel	electrofishing	439	-
May 23	Smith Ck.	Creek channel	electrofishing	48	-
May 23	Leech Ck.	Creek channel	electrofishing	196	-
May 23	Trankle Ck.	Creek channel	electrofishing	52	-
May 23	Redmond Ck.	Creek channel	electrofishing	96	-
May 24	Swanson Ck.	Creek channel	electrofishing	145	-
Aug 12	Smith Ck.	Creek mouth small side channel	electrofishing	-	-
Aug 14	Swanson Ck.	Creek channel pool/riffle sequence	electrofishing	-	75m
Aug 15	Cutoff Ck.	Creek channel 0.5 km upstream from mouth	electrofishing	-	25m
Aug 15	Greer Ck.	Creek channel 3.0 km upstream from mouth	electrofishing	-	30m
Sep 13	Tahultzu Ck.	Creek channel	visual observation	-	-
Sep 17	Targe Ck.	Creek channel	pole seining	50	100m^2
	Targe Ck.	A cutoff pool (27m x 3m)	pole seining	15	15m
	Targe Ck.	3 upper cutoff pools	electrofishing	244	70m^2
Sep 17	Swanson Ck.	Upstream from mouth	pole seining	90	105m^2
	Swanson Ck.	A cutoff pool (29m x 2m)	electrofishing	110	-
Sep 17	Cutoff Ck.	Creek channel	visual observation	-	-
	Cutoff Ck.	Cutoff pool A (30m x 5m)	pole seining	45	-
	Cutoff Ck.	Cutoff pool B	electrofishing	122	-
Sep 17	Twin Ck.	Creek channel	electrofishing	207	-
Sep 18	Twin Ck.	Creek mouth	beach seining	-	900m^2
Sep 18	Greer Ck.	Creek channel	visual observation	-	-
	Greer Ck.	Pool downstream of bridge	pole seining	40	60m^2
	Greer Ck.	Other lower pools	Electrofishing	322	100m^2
Sep 18	"Old" Nechako Channel	Channel	pole seining (set #1)	45	75m^2
	"Old" Nechako Channel	Channel	pole seining (set #2)	90	75m^2
	"Old" Nechako Channel	Channel	electrofishing	205	240m^2

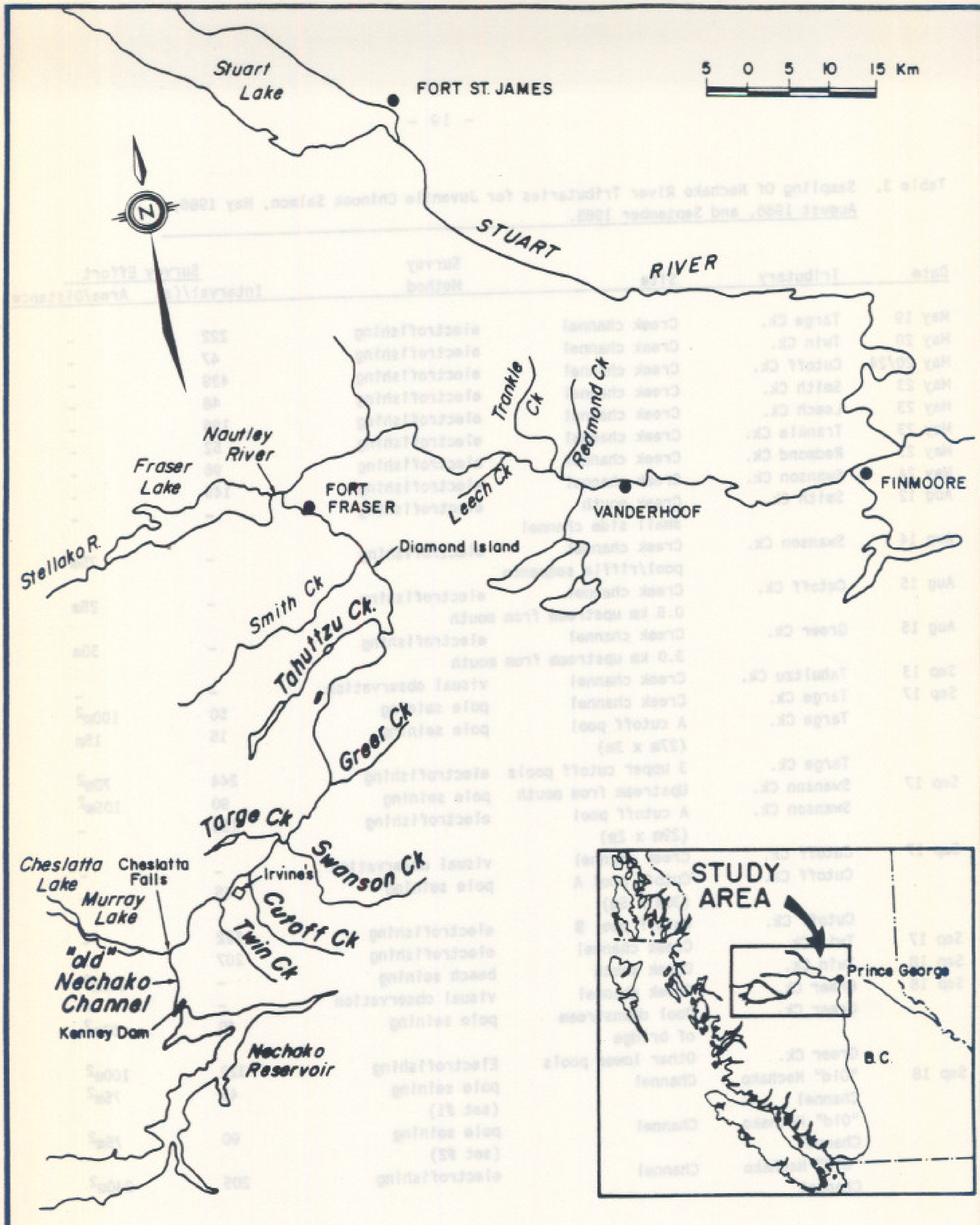

Figure 3 Nechako River Tributaries Investigated for Use by Juvenile Chinook Salmon, September, 1985

LONGITUDINAL DISTRIBUTION OF JUVENILE CHINOOK SALMON IN THE NECHAKO RIVER AND THEIR GENERAL HABITAT USE

Electroshocking, May 1986

Between May 14 and 24, 1986, electrofishing was conducted from sites 3-26 on the Nechako mainstem (Appendix 12) in order to obtain an index of abundance and distribution of chinook juveniles soon after their emergence from the gravel. A Smith Root Electrofisher model No. 11-A was used during the survey. The effectiveness of this capture method (ie. probability of fish capture) varies with the intensity of voltage which is a function of water temperature and water conductivity. Water conductivity and output current strength was recorded for each sample. For these samples it was determined that the equipment performance was the same throughout the sampling program.

Beach seining and snorkeling, August-October 1986

Beach seining and snorkeling programs were conducted during August 11-14 and September 25 - October 1, 1986. A total of 34 sites were sampled in the Nechako River between Cheslatta Falls and Vanderhoof (Fig. 4, Appendix 4). These sites represented the upper Nechako River (sites 1-16, km 2 to km 18 below Cheslatta Falls); the middle Nechako River including the vicinity of Larson's Ranch (sites 17-19, km 45 to km 47) and Diamond Island/Fort Fraser areas (sites 20-25, km 68 to km 82); and the Nechako River in the vicinity of Vanderhoof (sites 26-34, km 137 to km 144). It should be noted that in general, similar areas were sampled in August-October 1986 as during the May-July 1986 microhabitat study but the sites and site numbers differ.

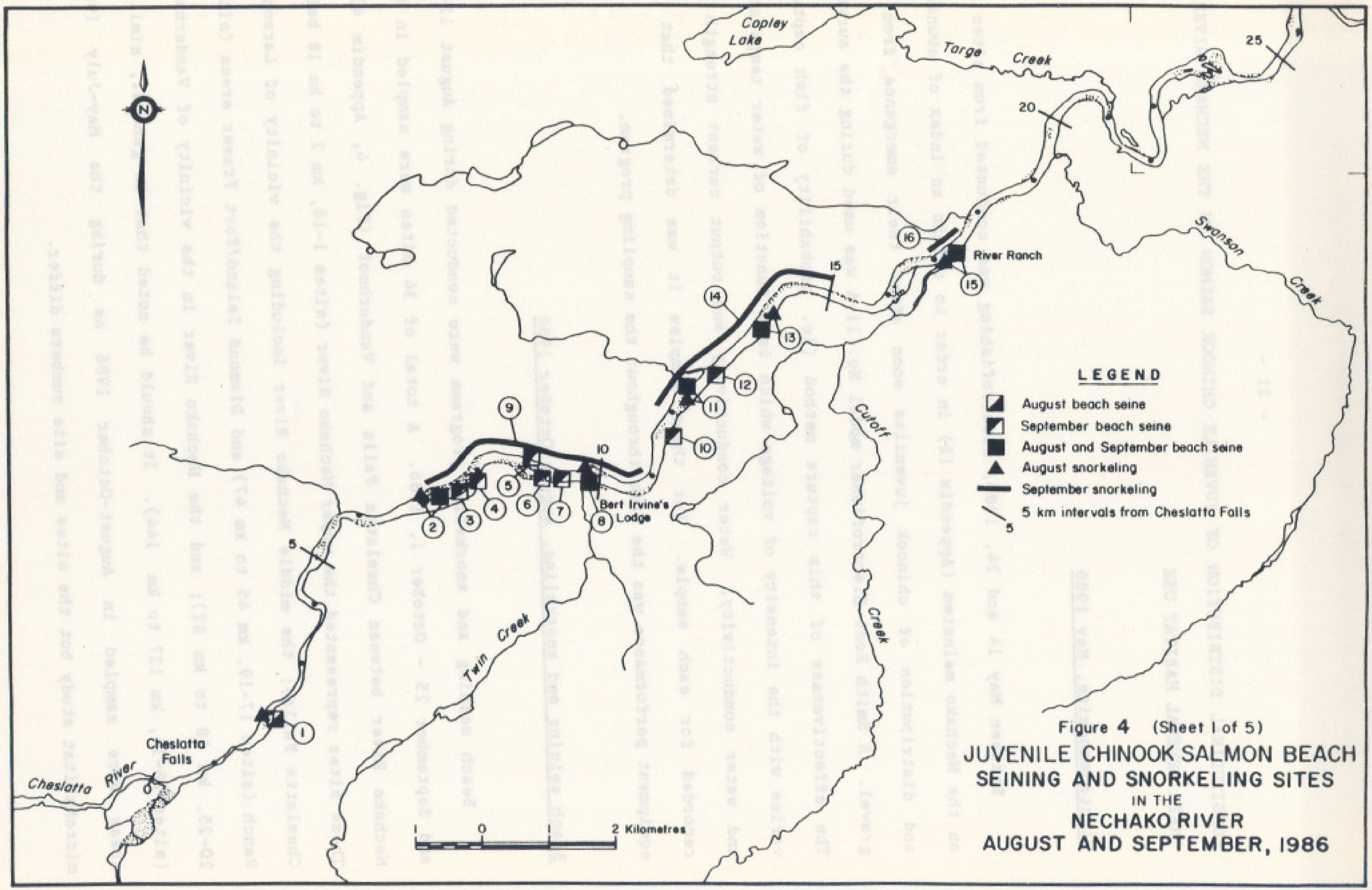

Figure 4 (Sheet 1 of 5)
JUVENILE CHINOOK SALMON BEACH SEINING AND SNORKELING SITES IN THE NECHAKO RIVER AUGUST AND SEPTEMBER, 1986

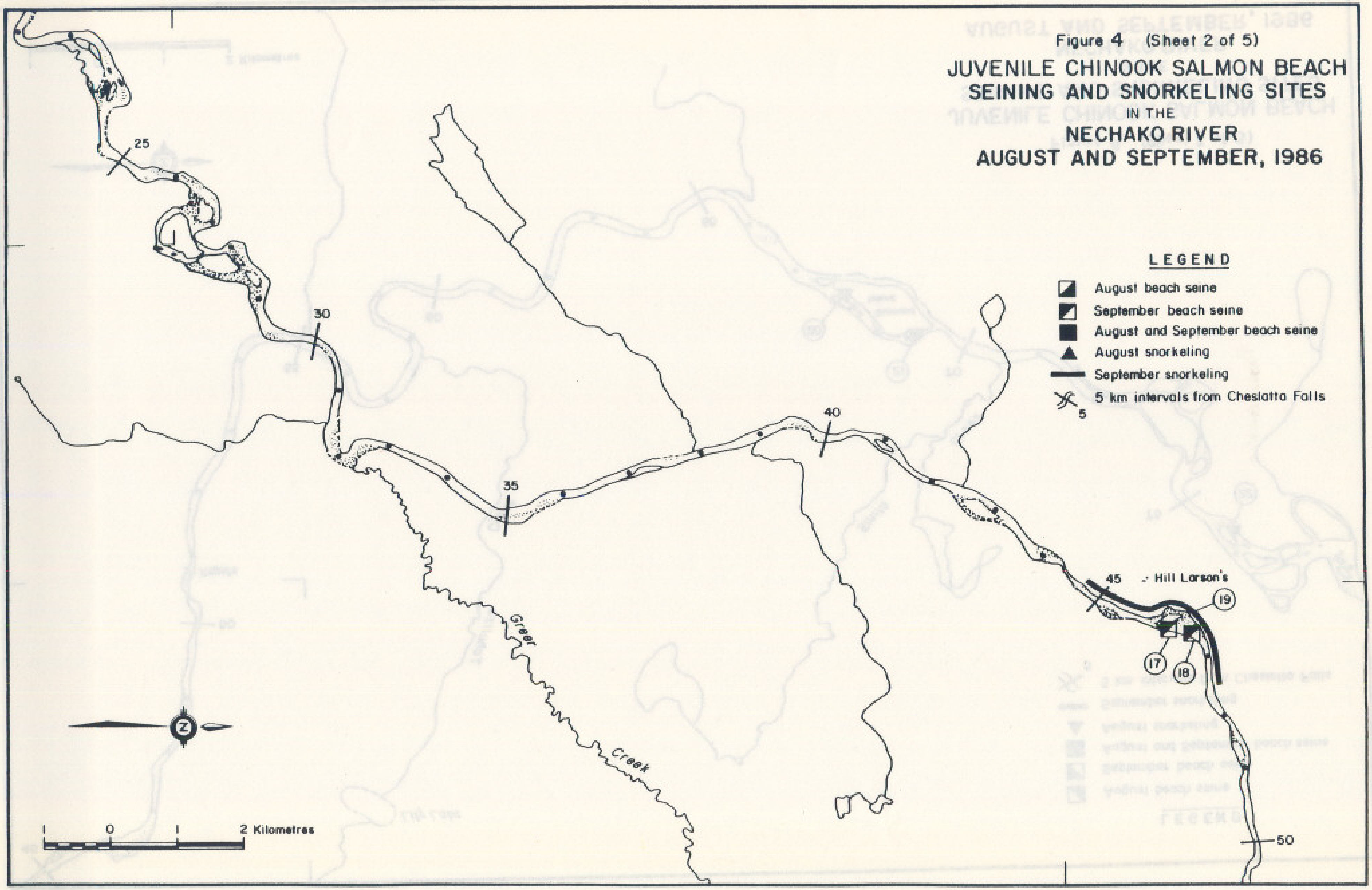
Figure 4 (Sheet 2 of 5)
JUVENILE CHINOOK SALMON BEACH SEINING AND SNORKELING SITES IN THE NECHAKO RIVER AUGUST AND SEPTEMBER, 1986
LEGEND
August beach seine
September beach seine
August and September beach seine
August snorkeling
September snorkeling
5 km intervals from Cheslatta Falls
25
30
35
40
45
50
Hill Larson's
17
18
19
Greer Creek
1 0 1 2 Kilometres

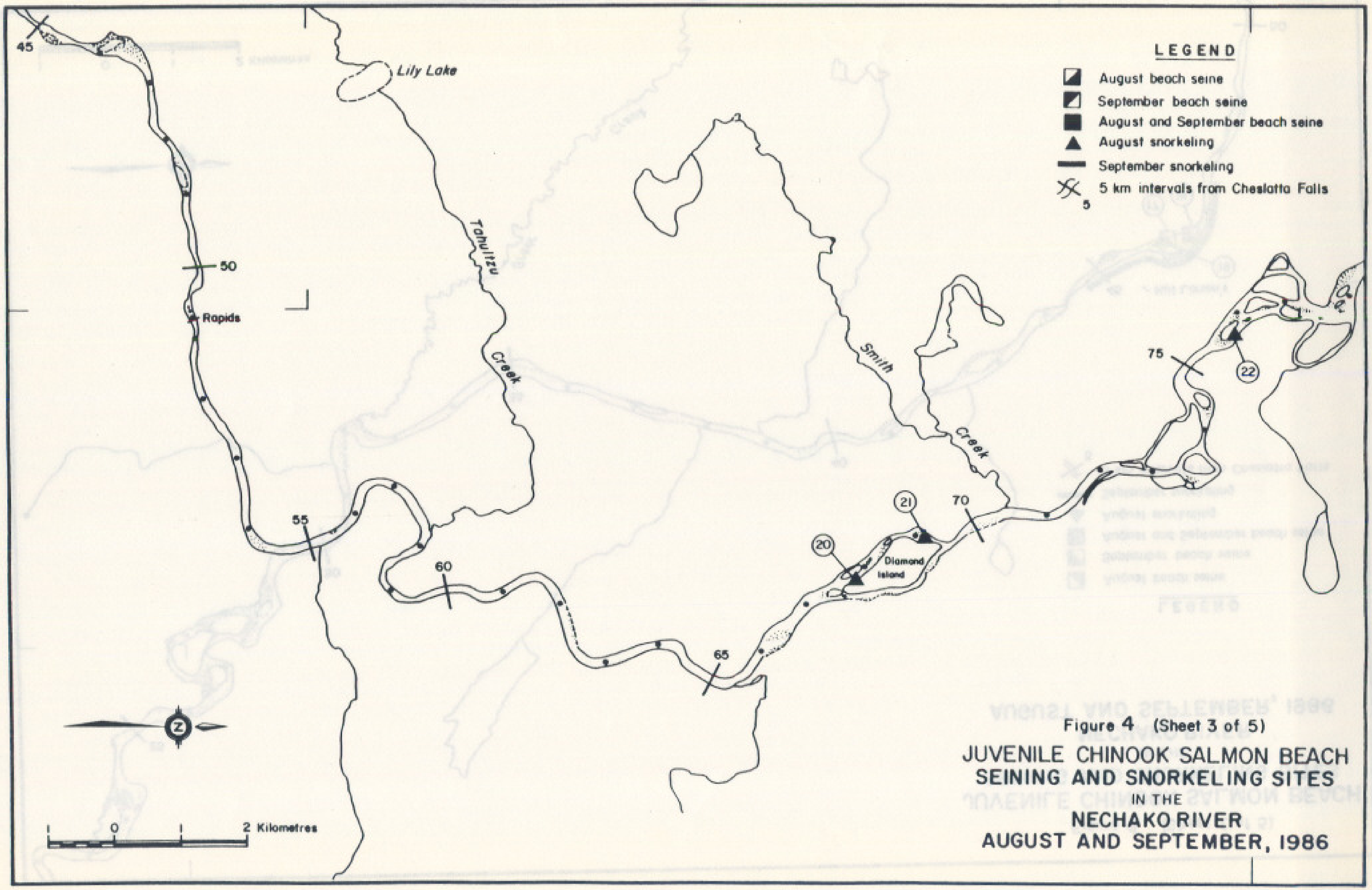

Figure 4 (Sheet 3 of 5)
JUVENILE CHINOOK SALMON BEACH SEINING AND SNORKELING SITES IN THE NECHAKO RIVER AUGUST AND SEPTEMBER, 1986

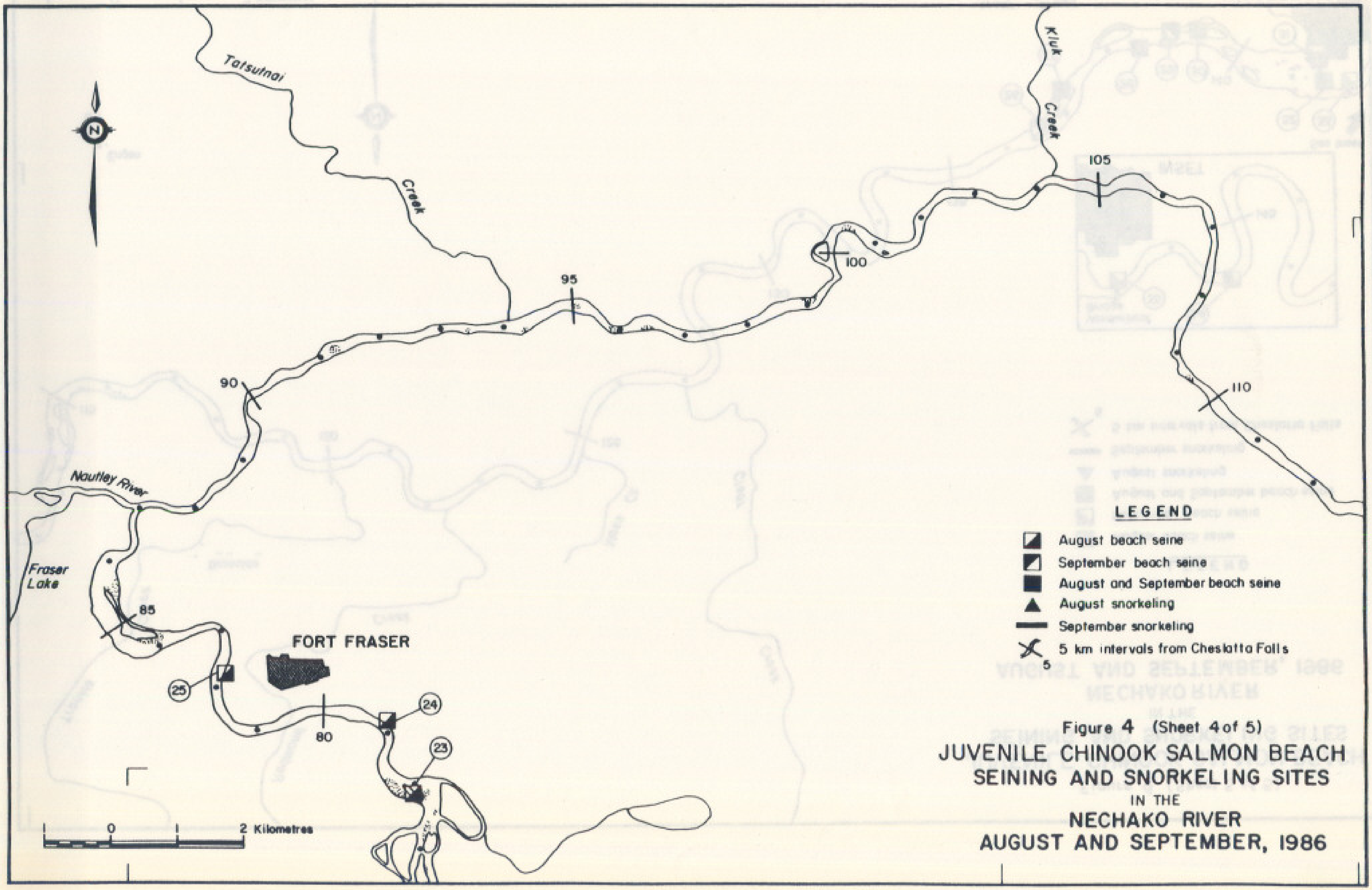

Figure 4 (Sheet 4 of 5)
JUVENILE CHINOOK SALMON BEACH SEINING AND SNORKELING SITES IN THE NECHAKO RIVER AUGUST AND SEPTEMBER, 1986

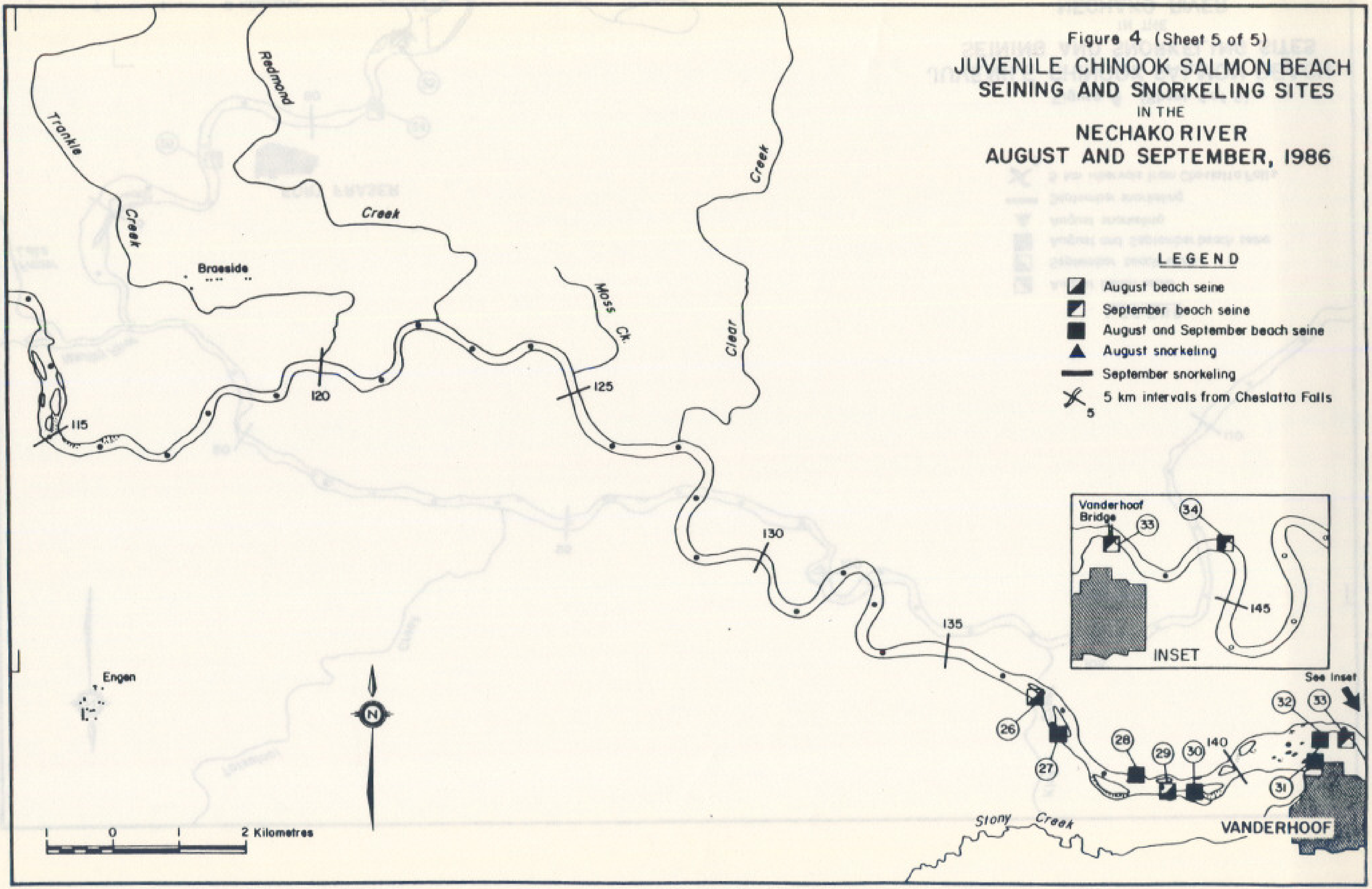

Figure 4 (Sheet 5 of 5)
JUVENILE CHINOOK SALMON BEACH SEINING AND SNORKELING SITES IN THE NECHAKO RIVER AUGUST AND SEPTEMBER, 1986

Selected sites were seined using a 15 m beach seine. In most cases, the seine was walked along the river margin in shallow water. Where the water was too deep for wading, the seine was set by boat and those occasions are marked as "boat seine" in Appendices 5 and 6. At most sites, three sets were made generally covering about 100 m of shoreline. In addition, replicate day and evening beach seining was conducted at selected sites (see day and night distribution study). When possible, similar sites were sampled in August and September; however, additional sites were sampled in September as more sites suitable for beach seining became available at the lower flows in autumn (Appendix 6). Other sites could not be sampled since the reduced streamflows left them dry.

Snorkeling surveys were also conducted in August and September 1986, to observe general chinook salmon distribution and habitat use and to supplement the beach seining program. Snorkeling sites were generally selected to include beach seining sampling sites (Appendix 4). Between August 12-14, a total of nine sites were snorkeled: 6 sites in the first 17 km of the upper Nechako River above River Ranch (river kilometer 17.5, Figure 4), and 3 sites between km 68 and km 76 in the vicinity of Diamond Island (Fig. 4, Appendix 7). Most of the sites were located along the mainstem but several included side channels. A number of sites in the upper river were snorkeled both during the day and evening (see day/night distribution study).

The snorkeling drifts made in August, were usually less than 500 m long. Generally two divers, one on each side of the river, floated along within 4 m of the river margins and carefully inspected log debris, beaver lodges and vegetation that was flooded during August. All chinook observed during these dives were recorded and general comments regarding their habitat use were made. No physical measurements of the microhabitat were taken during the snorkeling survey.

Between September 30 and October 1, a total of four sites were sampled (No. 9, 14, 16 and 19, Fig. 4, Appendix 8). As in August, the September/October snorkeling effort was concentrated in the upper Nechako River (km 7-18), although several kilometers were also sampled in the vicinity of Larson's Ranch (km 45-47). Because of the low flows in September (approximately 28 $m^3 \cdot s^{-1}$), the water's edge had receded from the shoreline vegetation and very little log debris or other physical features the chinook salmon could use for cover was wetted. The divers, therefore, drifted for much longer distances (several kilometers) compared to the August survey, with one diver close to shore and the other 2-3 m further out into the midstream. The distance from shore varied depending on the depth of water and was generally within 8 metres.

During the beach seining and snorkeling programs, spot temperatures were measured at selected sites using a hand thermometer.

GROWTH OF JUVENILE CHINOOK SALMON, 1986

Growth of chinook juveniles in the Nechako system was monitored between May and October 1986. Sampling methods primarily consisted of electroshocking in May, spearfishing in June and July, and beach seining in August and October. The electroshocking and spearfishing methods are described in the methods for the microhabitat investigations. During beach seining, the 15 m seine was operated from a boat or was walked along the shore.

Generally, from 5-15 mainstem sites were sampled each month between May 14 and October 1. In addition, eight tributaries were sampled within 0.5 km of their confluences with the Nechako River in May and one tributary (Swanson Creek) was sampled in August. Monthly sample size per site ranged from 1-35 fish depending on the fishing effort and chinook salmon abundance at each site. During August to October, a target sample size of 35 juvenile chinook salmon was set for each of the 3 areas sampled; the upper, middle and lower Nechako. Appendix 10 lists by month the sampling dates and sample sizes for each site.

Juveniles were anaesthetized and measured individually for fork length to the nearest 1 mm using a fish measuring board, and for wet weight to the nearest 0.1 g using a Sartorius electronic digital scale model No. 1002 MP9 or an Ohaus electronic balance.

RESULTS AND DISCUSSION

BEHAVIOUR OF JUVENILE CHINOOK SALMON

The following description of juvenile chinook salmon behavior is based on observations of young fish in the river shallows during shoreline counts, during electrofishing in May 1986, and during snorkeling in the spring and summer of 1986, and the fall of 1985.

The newly emergent fry leave the gravel of the redds where they have lived for several months and as they drift downstream move towards the river margins seeking out shallow, (< 15 cm deep) sheltered areas with little or no current. At this stage, the juveniles measure approximately 35-40 mm and may still have unabsorbed yolk sac attached to their belly. Initially, for 10-14 days the fry live off the remains of their yolk and do not feed or swim. They exhibit strong schooling behavior, each school presumably representing siblings that emerged from the same redd. Also, at this stage, they display a very strong affinity for the gravel substrate and will hide in the gravel if disturbed, as by a diver or predator. It is likely that the juveniles also enter the gravel substrate at night.

After approximately 10-20 days of this transition from the gravel to free swimming behavior, and having attained a size of approximately 45 mm, the behavior of the fry changes dramatically. This change corresponds to a major development in the young fish i.e. its yolk supply is now completely exhausted.

At this stage, the juveniles must now find a suitable feeding area. They compete for food items, become aggressive and begin to defend territories. Their habitat use shifts from the shallow, stagnant, nearshore areas to deeper offshore waters where the current is slow and there they learn to swim and pick off small floating particles. At this stage, the behaviour of juvenile chinook salmon gradually changes from a schooling to a territorial and more aggressive behavior. Their body shape, because of the consumption of the yolk sac, changes from a rounded shape to a longer, more streamlined shape, making it possible for them to more easily maintain a position in moving water.

Older juvenile chinook salmon observed in the Nechako River during summer of 1986 were frequently found during the daytime in schools of a few to several hundred fish. They were almost always associated with beaver dams, log jams, fallen trees, or other structures in the water like boats and docks. At night, juveniles were dispersed individually in the shallows where they were apparently feeding. Chinook salmon became progressively more scarce in the river during the late summer and autumn months and by mid-October were very difficult to find using beach seining and snorkeling techniques.

MICROHABITAT CHARACTERISTICS USED BY JUVENILE CHINOOK SALMON

The microhabitat conditions utilized by 0+ juvenile chinook salmon in the Nechako River were studied for three rearing periods: spring (derived from the May 1986 data), summer (derived from the June - July 1986 data), and autumn (derived from the late August - September 1985 data). Detailed results are presented for the period August 24 - September 15, 1985 in Appendix 11 and for the period May 14 - July 17, 1986 in Appendix 12. Observations are listed chronologically by sampling date and include the sampling site, fish's length and weight, water temperature, water depth, fish's height above the bottom, water velocity at the fish's position, water velocity 30 cm lateral to the fish's position, water velocity 15 cm above the stream bed, water velocity 30 cm above the fish's position, water velocity at 6/10 of the depth from the surface, light intensity at the fish's position, distance from the fish's position to the water's edge, and the dominant substrate type.

Table 4 lists chronologically the number of microhabitat observations made at each site sampled during spring and summer 1986 and fall 1985. Of the total 333 observations, which include incomplete sets of data, 27 (8%) were made in the spring, 195 (59%) in the summer and 111 (33%) in the autumn. Most of the summer observations were concentrated in areas heavily utilized by juveniles, as in log jams (sites No. 3, 9, 13, 20B), at beaver lodges (sites No. 13, 15D, 20B, 24, 25) and in dock and boat areas (site No. 9). Therefore, the microhabitat observations represent the proportional use of the river sections by chinook juveniles. Also, the microhabitat data in Appendices 11 and 12 represent habitat conditions and behavior of approximately 95% of the juvenile chinook population in the Nechako River during the daytime. The remaining 5% during the daytime inhabited deeper water and escaped capture and determination of their specific microhabitat. It should be noted that the microhabitat data obtained during electrofishing in May 1986 (fish numbers 1-112, Appendix 12) represent only approximate or general habitat conditions utilized by recently emerged

Table 4. Number of microhabitat observations listed in chronological order made at each sampling site, and estimated number of juvenile chinook salmon associated with each fish position sampled for spring, summer and autumn periods in the Nechako system, 1985 - 1986.

Site No.[a]	Sampling date	Survey method[b]	No. microhab. obs.[c]	Est. chinook associated with position sampled
		SPRING	May 1986	
4	May 24	EL	1	5
9	May 14	SN	1	1
	May 16	EL	6	27
13	May 14	SN	1	30
	May 18	EL	1	approx 20
15	May 18	EL	1	5
19	May 19	EL	2	6
21	May 19	EL	1	5
24	May 21	EL	1	5
25	May 21	EL	1	5
31	May 23	EL	1	6
35	May 23	EL	1	5
50	May 20	EL	1	5+
51	May 24	EL	1	5
52	May 24	EL	1	5
53	May 19	EL	1	1
56	May 23	EL	1	5
57	May 23	EL	2	9
58	May 23	EL	1	approx 30
59	May 23	EL	1	5
TOTAL SPRING			27	
	SUMMER	June - July 1986		
3	June 27	SN	3	N/A[d]
	July 7	SN	7	approx 300
	July 15	SN	4	approx 260
4	June 25	SN	7	N/A
	June 26	SN	1	N/A
	July 7	SN	1	20
9	June 14	SN	3	230+
	June 25	SN	3	4+
	June 26	SN	4	N/A
	June 27	SN	2	300+
	July 8	SN	5	approx 500
	July 9	SN	4	N/A
	July 15	SN	2	approx 400
	July 16	SN	5	30+

Site No.[a]	Sampling date	Survey method[b]	No. microhab. obs.[c]	Est. chinook associated with position sampled
		SUMMER (cont'd.)		
13	June 12	SN	2	approx. 100
	June 13	SN	2	N/A
	June 14	SN	2	N/A
	June 27	SN	5	N/A
	July 8	SN	1	N/A
	July 9	SN	1	N/A
	July 17	SN	4	34
15	June 27	SN	1	1
15A	June 27	SN	2	8+
	June 28	SN	2	50
15B	June 27	SN	1	N/A
	July 11	SN	1	5
15C	June 29	SN	1	20
	July 11	SN	1	50
15D	June 29	SN	2	80
	July 11	SN	1	50
19	June 15	SN	3	N/A
	June 16	SN	1	10
	July 11	SN	2	30
19A	June 16	SN	2	N/A
	July 11	SN	1	10
20A	June 16	SN	1	10
	June 27	SN	1	30
20B	June 16	SN	1	25
	June 28	SN	3	100
21	July 1	SN	4	9
	July 10	SN	2	2
21D	June 29	SN	4	4
23	July 1	SN	2	15+
24	June 17	SN	7	100+
25	June 30	SN	3	27
	July 13	SN	6	40+
28	July 2	SN	5	8+
	July 13	SN	1	N/A
28A	July 13	SN	1	N/A
30	July 2	SN	1	7
31	June 18	SN	10	approx 60
	July 13	SN	1	N/A

Table 4. (cont'd.)

Site No.[a]	Sampling date	Survey method[b]	No. microhab. obs.[c]	Est. chinook associated with position sampled
SUMMER (cont'd.)				
35	June 19	SN	11	26+
	July 3	SN	11	approx 80
	July 14	SN	1	10
36	July 4	SN	11	30+
	July 14	SN	6	36
	July 15	SN	3	10+
TOTAL SUMMER			195	
FALL Aug. 24 - Sep. 15, 1985				
4	Aug. 24	SN	20	N/A
9	Aug. 25	SN	20	24
12	Aug. 27	SN	1	1
13	Aug. 27	SN	7	18
14	Aug. 27	SN	2	8
15	Aug. 27	SN	1	N/A
	Aug. 28	SN	6	29
16	Aug. 28	SN	1	N/A
17	Aug. 28	SN	2	N/A
19	Aug. 29	SN	6	15
20	Aug. 29	SN	2	N/A
21	Sep. 10	SN	4	9
22	Sep. 10	SN	1	1
24	Sep. 11	SN	7	12
25	Sep. 11	SN	5	N/A
27	Sep. 13	SN	4	11
30	Sep. 13	SN	3	3
31	Sep. 14	SN	5	17
32	Sep. 14	SN	1	3
33	Sep. 14	SN	3	N/A
34	Sep. 14	SN	1	1
35	Sep. 15	SN	6	15
36	Sep. 15	SN	3	19
TOTAL FALL			111	

[a] No microhabitat data obtained from unlisted sites.
[b] SN - snorkeling, EL - electroshocking.
[c] Includes incomplete sets of microhabitat measurements.
[d] N/A - not available.

fish. The reason is that recently emerged juveniles studied in May exhibited strong schooling behavior and darted away or into the gravel during electroshocking so that the microhabitat measurements were taken at the general location of the school rather than at a specific location of an individual fish. From June 12 onwards (fish number 113, Appendix 12), juveniles were territorial and spread out so that individual fish could be singled out readily during snorkeling and accurate microhabitat measurements specific to a particular fish could be obtained.

Microhabitat Characteristics Used by Juvenile Chinook Salmon in the Spring, Summer and Autumn

Average microhabitat characteristics for juvenile chinook salmon in the Nechako River system are shown for spring, summer and autumn in Figure 5 and Table 5. The May electroshocking data included juveniles that were hiding in the substrate during capture as well as those holding freely in the water column; these two sets of data are discussed separately below. Newly emergent chinook salmon fry hiding in the substrate during the May sampling program had a mean size of 39.4 mm and weighed 0.5 g and were positioned approximately 2.0 m from the shore in 24.3 cm deep water. Mean water temperature was 8.5°C and gravel was the dominant substrate used. Newly emergent chinook salmon fry swimming in the water column measured on the average 39.2 mm and weighed 0.5 g, and were positioned about 2.4 m from the shore in 28.8 cm deep water. Water temperature averaged 7.6°C and gravel was the dominant substrate used. The fish sizes and habitat values used by chinook salmon fry hiding in the substrate are

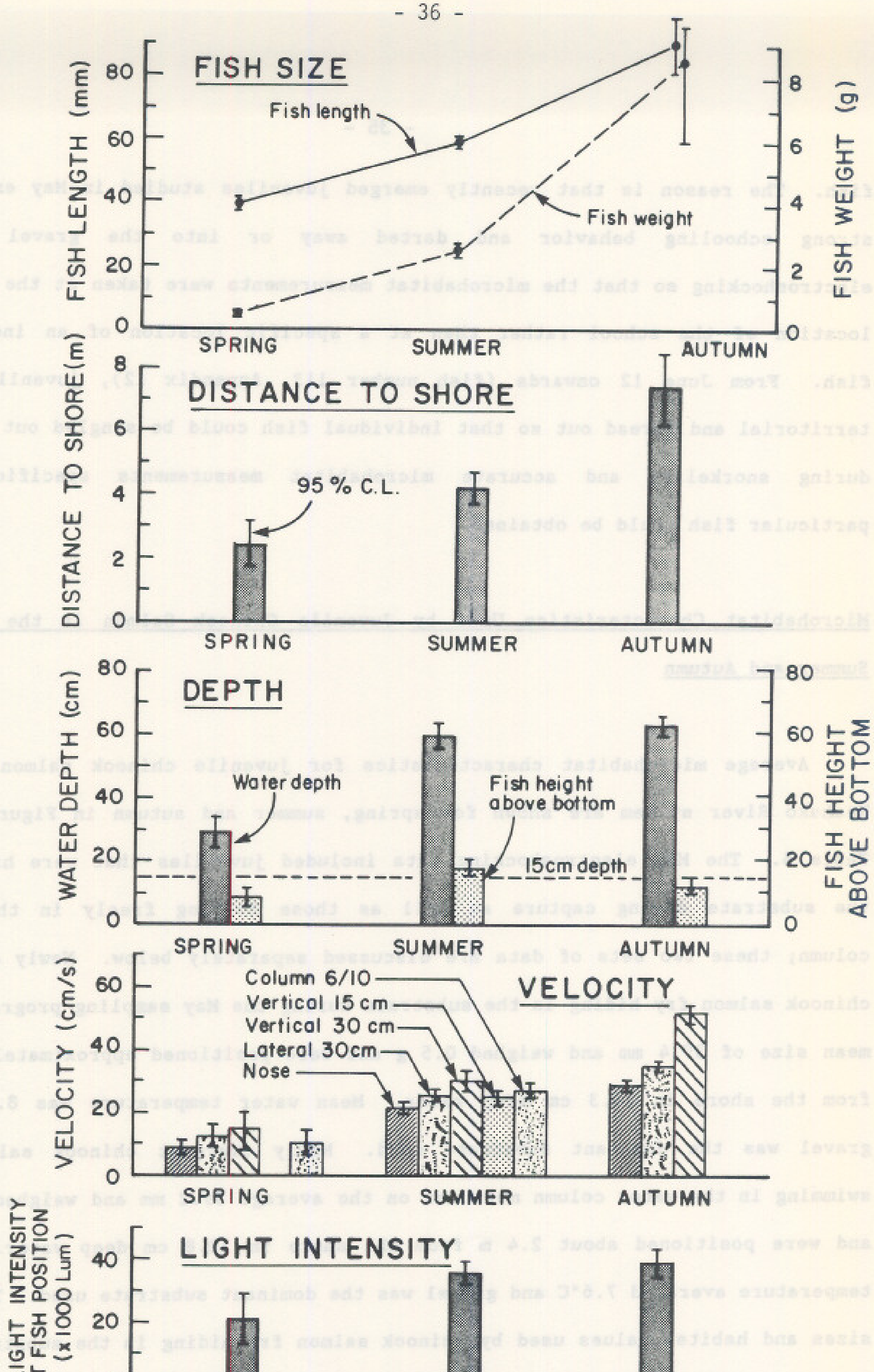

Figure 5 Seasonal Microhabitat Conditions for Juvenile Chinook Salmon in the Nechako River System, 1985, 1986

Table 5. Seasonal microhabitat characteristics for juvenile chinook salmon in the Nechako River system, 1985, 1986 (sample size and 95% C.L. given in parenthesis).

Season	Fish length (mm)	Fish weight (g)	Water Temp. (°C)	Water depth (cm)	Fish ht above bottom (cm)	Velocity (cm/sec): Nose	Velocity (cm/sec): Lateral 30 cm	Velocity (cm/sec): Vertical 30 cm	Velocity (cm/sec): Vertical 15 cm	Velocity (cm/sec): Column 6/10	Light (X1000 lux) at fish position	Distance to Shore (m)	Dominant Substrate
	Mean±1S.E.	Mean±1S.E.	Mean±1S.E.	Mean±1S.E.	Mean±1S.E.	Mean±1S.E.	Mean±1S.E.	Mean±1S.E.	Mean±1S.E.	Mean±1S.E.	Mean±1S.E.	Mean±1S.E.	
SPRING					FISH HIDING IN SUBSTRATE								
May 18-24, 1986	39.4±1.0 (8) (37.1-41.7)	0.5±0.07 (8) (0.3-0.7)	8.5±0.3 (8) (7.7-9.3)	24.3±1.5 (7) (20.7-27.9)	0	-	-	-	-	-	- -	2.0±0.5 (4) (0.3-3.7)	Gravel
SPRING					FISH IN WATER COLUMN								
May 14-24, 1986	39.2±0.9 (18) (37.4-41.0)	0.5±0.06 (18) (0.4-0.6)	7.6±0.3 (17) (6.9-8.3)	28.8±2.2 (12) (24.0-33.7)	8.7±1.3 (9) (5.7-11.6)	8.7±1.0 (9) (6.4-10.9)	12.8±1.7 (9) (8.9-16.8)	14.7±2.5 (9) (8.8-20.6)	-	10.4±1.8 (9) (6.3-14.5)	21.0±3.5 (9) (13.0-29.1)	2.4±0.3 (11) (1.7-3.2)	Gravel
SUMMER													
June 12-July 17, 1986	59.1±08 (126) (57.5-60.7)	2.5±0.1 (129) (2.3-2.7)	14.9±0.2 (184) (14.5-15.4)	59.5±2.0 (185) (56.6-63.4)	17.7 ±1.5 (185) (14.9-20.6)	21.4±0.9 (185) (19.7-23.3)	25.6±1.1 (183) (23.5-27.8)	30.2±1.5(182) (27.3-33.1)	25.2±1.2 (183) (22.8-27.5)	27.4±1.3 (184) (24.8-30.0)	35.7±1.9 (181) (32.0-39.5)	4.2±0.3 (166) (3.7-4.7)	Gravel
AUTUMN													
Aug 24-Sep 15, 1985	90.1±3.5 (8) (81.9-98.3)	8.6±1.1 (8) (6.0-11.2)	-	62.1±1.5 (111) (59.1-65.0)	11.8±1.1 (111) (9.6-14.0)	29.0±0.7 (111) (27.5-30.4)	35.0±0.9 (111) (33.3-36.7)	51.6±1.6 (108) (48.5-54.7)	-	-	38.7±2.3 (94) (34.2-43.2)	7.4±0.6 (107) (6.2-8.5)	Gravel

not significantly different ($p<0.05$) than the fish sizes or microhabitat characteristics used during the same period by chinook salmon fry holding in the water column. It seems likely that the fry captured in the substrate are the same age and exhibiting the same behavior as the fry captured above the substrate, just that they were occupying different phases of their normal habitat at that time. It might be safely assumed then that chinook salmon alevins changing behavior from complete substrate residence to complete free-swimming residence may initially use water velocities that were measured above the substrate they were hiding in.

In the following comparison of chinook microhabitats in spring, summer and autumn, the limited data obtained from chinook salmon fry hiding in the substrate in May were excluded, and only those data obtained for chinook fry holding in position in the water column were considered.

During the study period, the mean size of the fry increased from 39.2 mm, and 0.5 g in the spring to 59.1 mm, and 2.5 g in the summer, to 90.1 mm, and 8.6 g in the autumn (Fig. 5). Unfortunately, since only eight juvenile chinook salmon were captured during the autumn microhabitat study period, all in the vicinity of the Twin Creek outlet, the autumn data may not accurately represent the mean size of juvenile chinook salmon during that season. However, for a much larger sample size collected in the autumn of 1986 for growth studies, the mean lengths of juvenile chinook salmon in both years in the autumn was similar (n=89; mean length = 90.7 mm, mean weight = 8.28 g, Table 19).

Juvenile Chinook Salmon Distance from Shore and Water Depths Utilized

As the season progressed, juvenile chinook salmon occupied positions progressively further from shore (2.4 m in spring, 4.2 m in summer, and 7.4 m in autumn) and utilized deeper water (28.8 cm in spring, 59.5 cm in summer, and 62.1 cm in the fall). Their height above the stream bottom increased from 8.7 cm in spring to 17.7 cm in summer, then declined to 11.8 cm during autumn. Their higher height above the bottom in summer may be an artifact of interaction of habitat variables selected for in that in general chinook fry would reside higher in the water column the slower the water velocity was, and in summer the juvenile chinook salmon selected areas of lower velocity relative to later in the summer. Therefore, during the three respective seasons, chinook were positioned at 30.1%, 29.8% and 19.0% of the column depth from the bottom.

Water Velocities Selected by Juvenile Chinook Salmon

Mean water velocities at different positions relative to the fish's position ranged from 8.7 $cm{\cdot}s^{-1}$ to 51.6 $cm{\cdot}s^{-1}$ and increased from spring to autumn by up to 3.5 times for a given velocity position (Table 6). For any particular season (spring, summer, autumn), velocities were lowest at the fish's position (seasonal range 8.7-29.0 $cm{\cdot}s^{-1}$), higher laterally 30 cm to the fish's position (seasonal range 12.8-35.0 $cm{\cdot}s^{-1}$), and highest 30 cm above the fish's position (seasonal range 14.7-51.6 $cm{\cdot}s^{-1}$). In a given season, water velocities 30 cm lateral to the fish's position was 1.20-1.47 times greater, and vertical water velocity 30 cm above the fish's position was 1.41-1.78 times

Table 6. Seasonal change in water velocity of microhabitat positions used by juvenile chinook salmon in the summer and autumn relative to those in the spring for velocities at the fish's position, 30 cm lateral to the fish's position, 30 cm above the fish's position, 15 cm above the streambed at the fish's position, and at 6/10 of the depth at the fish's position in the Nechako River, 1986.

Ratio of water velocity used in the spring relative to water velocities used in the summer and autumn.

Season	Nose	Lateral 30 cm	Vertical 30 cm	Vertical 15 cm	Column 6/10
Spring	1	1	1	-	1
Summer	2.46	2.00	2.05	-	2.63
Autumn	3.33	2.73	3.51	-	-

Table 7. Ratio of water velocities at the fish's position relative to other velocities used in summer and autumn. Microhabitat data are for juvenile chinook salmon in Nechako River system, 1986.

Season	Nose	Nose/ Lateral 30 cm	Nose/ Vertical 30 cm	Nose/ Vertical 15 cm	Nose/ Column 6/10
Spring	1	1.47	1.69	-	1.20
Summer	1	1.20	1.41	1.18	1.28
Autumn	1	1.21	1.78	-	-

greater than nose velocity (Table 7). This strongly suggests the juvenile chinook salmon were selecting specific positions protected from the main current.

The measurement of water velocities lateral and vertical to the positions used by juvenile chinook salmon served to clarify whether they were selecting preferred water velocities per se or were selecting water velocity gradients. Measuring water velocities above and to the side of positions selected by juvenile chinook salmon tested the hypothesis that the behavior of these fish optimized energy gain by feeding from energy-saving protected locations on the streambed. The distance of 30 cm was used to test for these gradients because Fausch (1984) had shown that for feeding, juvenile coho salmon (Oncorhynchus kisutch) would not move more than two body lengths for their initial position to intercept food items drifting in the current. The 30 cm distance, therefore, represented approximately three body lengths of the longest juvenile chinook salmon we expected to encounter.

During the summer and fall, mean water velocities at the fish's position were significantly lower ($p < 0.05$) than the water velocities 30 cm lateral and vertical to the positions selected by the fish. This suggests that in the presence of lateral and vertical velocity gradients, chinook juveniles select a position with distinctly lower velocity. The data from spring also showed a lower water velocity at the fish's position compared to 30 cm lateral or vertical to the fish's position. However, the differences were not significant ($p < 0.05$) probably because in May fry were holding in shallow, near-stagnant areas where all water velocities were low.

Water velocity 15 cm above the streambed was available only for the summer period (June 12 - July 17, 1986) and averaged 25.2 $cm \cdot s^{-1}$. The 15 cm velocity measurement was chosen to test an assumption frequently made by users of physical habitat models that juvenile salmonids selectively inhabit this particular position above the stream bed. Also, the depth of 15 cm above the streambed is often assumed to be the water velocities experienced and selected for by adult spawning salmon. Indeed, the summer and fall microhabitat data indicate that the mean height above the bottom of juvenile chinook salmon was in the range of 12-18 cm (but 9 cm during spring). Mean water velocity at 18 cm above the streambed was 21.4 $cm \cdot s^{-1}$ and did not differ significantly ($p < 0.05$) from the water velocity 15 cm above the streambed of 25.2 $cm \cdot s^{-1}$ (Table 5; only summer data are available for this comparison). This suggests that the depth of 15 cm above the bottom and the water velocities there may be representative of the microhabitat selected by juvenile chinook salmon while rearing during summer. In contrast, the preferred height above the bottom selected by juvenile chinook salmon for rearing during spring is considerably less in slower water velocities (9 cm, and 8.7 $cm \cdot s^{-1}$).

The conclusion that water velocities 15 cm above the streambed may be representative of the position occupied by juvenile chinook salmon in the Nechako River may be valid only for fish living in all locations taken together. During the mid-June to mid-July period most juvenile chinook salmon in the Nechako River were in close proximity to submerged logs and trees during the daytime. These trees obstruct the full force of the current, and the juvenile chinook salmon often positioned themselves in the slower water behind these obstructions. Because these trees and logs were often near the water's surface, juvenile chinook salmon selecting these positions were often high up in the water column. Individuals not associated with woody debris were often much nearer the streambed (<15 cm) because close to the streambed was the only location that gave them protection from the full force of the current equivalent to that provided by the trees. There tended to be an inverse relationship between the fish's height above the bottom and the mean column water velocity so that at low water velocities the fish were higher up in the water and as water velocity increased the fish were increasingly closer to the streambed (Figure 7). If this trend is real, water velocities 15 cm above the streambed may be representative of conditions experienced by the juvenile chinook salmon only in slow areas of the river (pools), while in riffles the conditions experienced by the fish are much closer to the streambed (see Figure 9).

Mean water velocity at 6/10 of the depth averaged 10.4 $cm \cdot s^{-1}$ in spring and 27.4 $cm \cdot s^{-1}$ in summer. The 6/10 water velocity measurement represents the mean velocity of the entire water column. This velocity is generally used in official water surveys, and is frequently applied in modelling to simulate fish habitat. Compared to the water velocity at the fish's position, the mean column water velocity was 1.20 and 1.28 times greater in spring and summer respectively (Table 7). This difference is significant ($p < 0.05$) for the summer data but not for the spring data; autumn data were not available for this comparison.

In summary, the above velocity relationships clearly indicate that in the presence of the lateral and vertical velocity gradients observed in this study

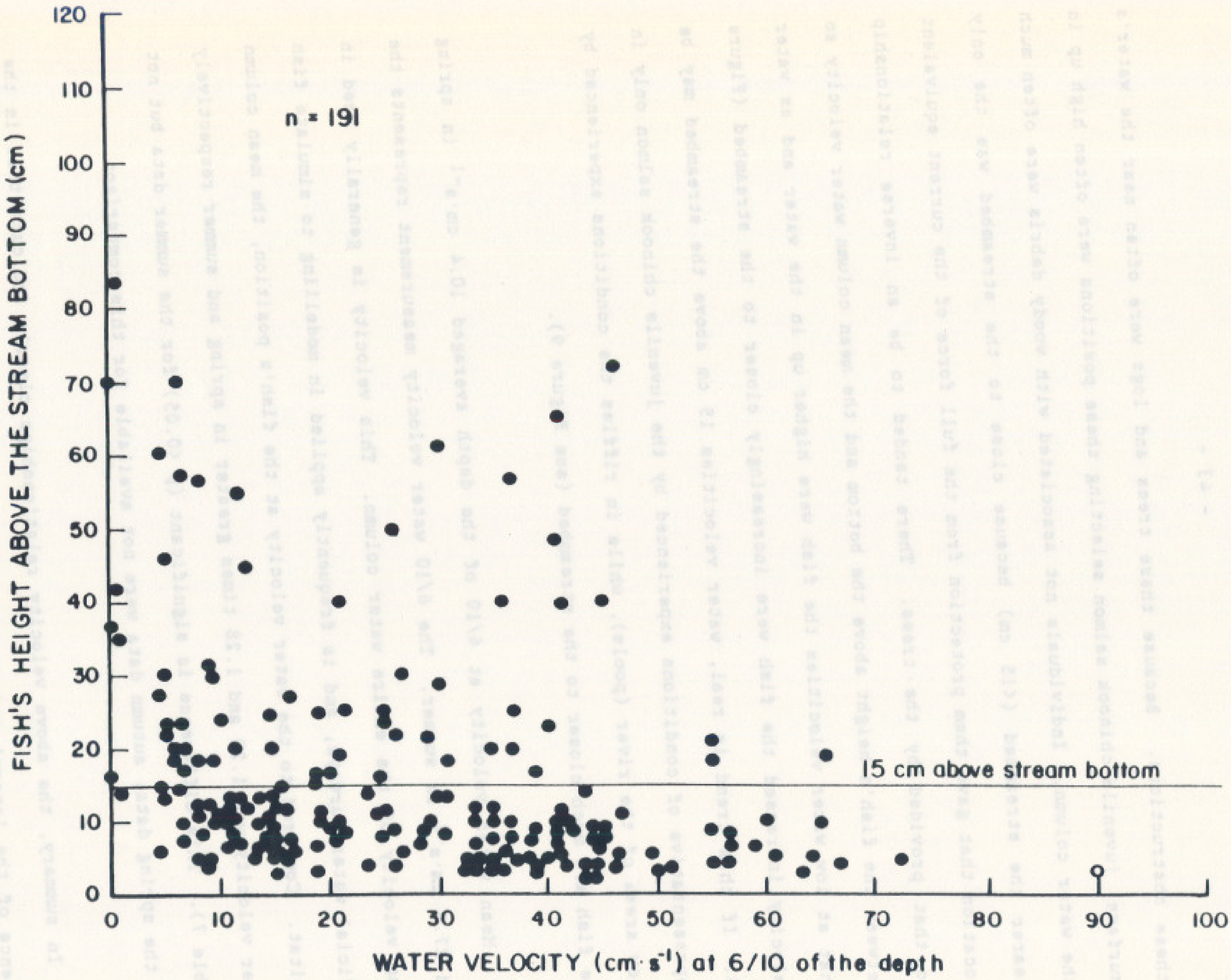

Figure 6 Height Above the Streambed Selected by Juvenile Chinook Salmon in the Nechako River at Different Water Velocities. Data are for June 12 to July 17, 1986

in the Nechako River, rearing juvenile chinook salmon selected a position with a distinctly lower water velocity compared to the mean column water velocity and to water velocities at the maximum distance they might move to capture food (30 cm laterally and vertically from their position). This tendency by juvenile chinook salmon to utilize lower velocity microhabitats may be considered an energy saving strategy. By selecting a position in slower water, the juveniles conserve energy which otherwise would be expended on holding their position against the current while at the same time occupying a position near a good source of food (the faster velocities nearby). (This is currently a hypothesis in salmonid ecology. For a discussion see Fausch 1984).

The above conclusions regarding velocity preference by juvenile chinook salmon in the Nechako River were developed during the period when the daily river discharge was relatively low and stable (approximately 30-110 m^3/sec or 1,000-4,000 cfs; Table 8).

Light Intensity at Positions Selected by Juvenile Chinook Salmon

Light intensity at the fish's position averaged 21.0 x 1000 lux in spring, and was significantly lower ($p < 0.05$) than the summer and fall values of 35.7 x 1000 lux and 38.7 x 1000 lux respectively (Fig. 5, Table 5). Only general conclusions can be drawn from the light intensity data since surface readings were not available for comparison. In addition, individual light measurements were affected by an array of external conditions including cloud movement, the angle of the sun relative to water surface, and shadows from foliage, fallen

Table 8. Seasonal ranges of daily discharge in the Nechako River at the Water Survey of Canada gauging station 08JA017.[a]

MICROHABITAT STUDY PERIOD	DAILY DISCHARGE (approx. r[illegible]) $(m^3 \cdot s^{-1})$	(cfs)
Spring 1986 (May 14 - 24)	65 - 110	2,000 - [illegible]
Summer 1986 (June 12 - July 17)	60	2,000
Fall 1985 (Aug 24 - Sep 15)	64 - 115	1,000 - 3,000

[a] Approximately 10 km below Cheslatta Falls.

[b] cfs = cubic feet per second.

trees and other debris. These inconsistencies make it difficult to interpret comparisons between light readings for different seasons or fish of different sizes.

It is generally believed that young fish avoid bright light partly to reduce detection from predators. The present data indicate that the smallest chinook fry occupied positions with light intensities lower than they experienced later in the summer. However, it is unclear whether this is a result of position selection (i.e. light avoidance) or simply lower seasonal light intensities in the river associated with higher turbidity. During the June-July snorkeling survey in the Nechako River, the majority of juvenile chinook salmon were sighted in the vicinity of beaver lodges, in log jams, under fallen trees, and under overhanging vegetation. All of these locations provided protection from direct sunlight. However the available evidence is insufficient to differentiate between the selection by juveniles of microhabitats with reduced light intensity compared to a preference for microhabitats affording physical protection.

The day and night distribution study further suggested that light intensity plays a role in microhabitat selection. During the day/night sampling in June and July 1986, juvenile chinook salmon were absent from the shallow margins during the daytime. However at night, when light intensity was near zero, these near shore areas became the preferred microhabitat of the juvenile chinook salmon.

Substrate Composition Selected by Juvenile Chinook Salmon

On the average, gravel was the dominant substrate at the positions occupied by juvenile chinook salmon during spring, summer and autumn (seasonal range of gravel utilization was 48-70%), followed by cobble (seasonal range of cobble utilization was 20-25%) and silt (seasonal range of silt utilization was 1-14%) (Fig. 7, Appendix 13). Silt was observed to occur more frequently at positions selected by younger fish, possibly as a correlate of the lower water velocities they selected for.

Water Temperature at Positions Occupied by Juvenile Chinook Salmon

Mean water temperatures at positions occupied by juvenile chinook salmon increased from 7.6°C during spring to 14.9°C during summer 1986 (autumn 1985 temperatures were not available). The maximum water temperature occupied by any juvenile chinook salmon was 19.9°C. Water temperatures at the sampled microhabitats showed a considerable variation of up to 10°C in the same general area (Appendix 12). This variation may be attributed to flows from tributaries, groundwater seepage, and shadow effects among others.

Summary

In summary, the microhabitat parameters measured (distance to shore, water depth, fish's height above the bottom, water velocities at different positions relative to the fish, and light intensity at fish's position) showed significant

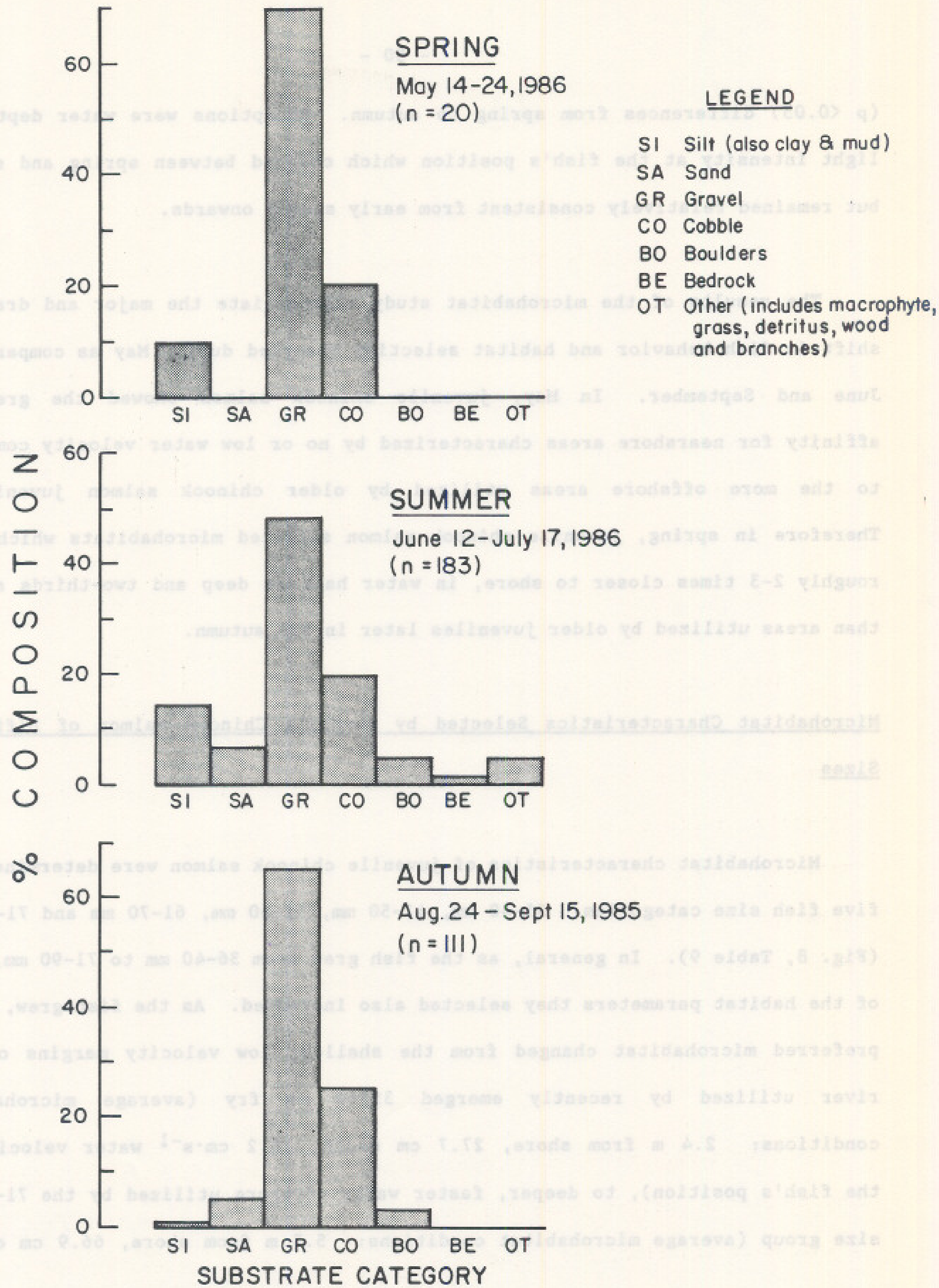

Figure 7 Dominant Substrate at Positions Selected by Juvenile Chinook Salmon in the Nechako River During Spring, Summer and Autumn, 1985 - 1986

($p < 0.05$) differences from spring to autumn. Exceptions were water depth and light intensity at the fish's position which changed between spring and summer but remained relatively consistent from early summer onwards.

The results of the microhabitat study substantiate the major and dramatic shift in fish behavior and habitat selection observed during May as compared to June and September. In May, juvenile chinook salmon showed the greatest affinity for nearshore areas characterized by no or low water velocity compared to the more offshore areas utilized by older chinook salmon juveniles. Therefore in spring, juvenile chinook salmon selected microhabitats which were roughly 2-3 times closer to shore, in water half as deep and two-thirds slower than areas utilized by older juveniles later in the autumn.

Microhabitat Characteristics Selected by Juvenile Chinook Salmon of Different Sizes

Microhabitat characteristics of juvenile chinook salmon were determined for five fish size categories: 35-40 mm, 41-50 mm, 51-60 mm, 61-70 mm and 71-90 mm (Fig. 8, Table 9). In general, as the fish grew from 36-40 mm to 71-90 mm, each of the habitat parameters they selected also increased. As the fish grew, their preferred microhabitat changed from the shallow, low velocity margins of the river utilized by recently emerged 35-40 mm fry (average microhabitat conditions: 2.4 m from shore, 27.7 cm depth, 10.2 $cm \cdot s^{-1}$ water velocity at the fish's position), to deeper, faster water offshore utilized by the 71-90 mm size group (average microhabitat conditions: 5.7 m from shore, 66.9 cm depth,

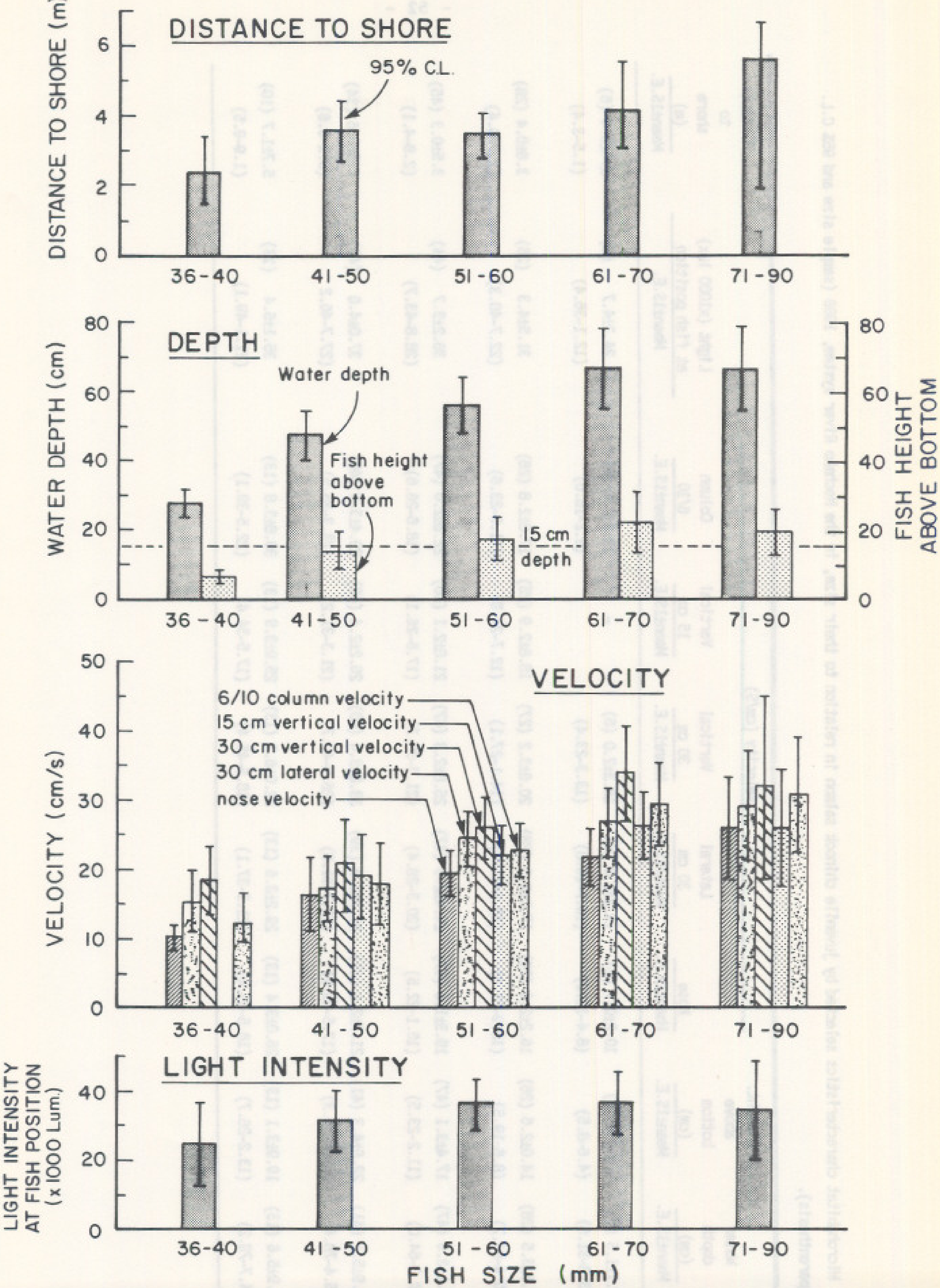

Figure 8 Microhabitat Conditions Selected by Juvenile Chinook Salmon in Relation to Their Size, in the Nechako River System, 1986

Table 9. Microhabitat characteristics selected by juvenile chinook salmon in relation to their size, in the Nechako River system, 1986 (sample size and 95% C.L. given in parenthesis).

Fish size (mm)	Water depth (cm)	Fish ht. above bottom (cm)	Velocity (cm/S) Nose	Lateral 30 cm	Vertical 30 cm	Vertical 15 cm	Column 6/10	Light (x1000 lux) at fish position	Distance to shore (m)
	Mean±1S.E.	Mean±1S.E.	Mean±1S.E.	Mean±1S.E.	Mean±1S.E.	Mean±1S.E.	Mean±1S.E.	Mean±1S.E.	Mean±1S.E.
36-40	27.7±1.5 (6)	6.5±0.8 (6)	10.2±0.7 (6)	15.3±1.8 (6)	18.3±2.0 (6)	-	12.9±1.4 (6)	24.3±4.7 (6)	2.4±0.4 (6)
	(23.8-31.6)	(4.6-8.5)	(8.4-12.0)	(10.7-19.8)	(13.3-23.4)		(9.2-16.6)	(12.1-36.4)	(1.5-3.4)
41-50	47.6±3.5 (28)	14.0±2.6 (28)	16.2±2.6 (28)	17.0±2.3 (28)	20.6±3.2 (27)	18.8±2.9 (25)	17.8±2.8 (28)	31.5±4.3 (28)	3.6±0.4 (28)
	(40.4-54.7)	(8.6-19.5)	(10.9-21.4)	(12.2-21.8)	(14.1-27.1)	(12.7-24.9)	(11.9-23.6)	(22.7-40.3)	(2.7-4.4)
51-60	56.1±3.9 (47)	17.4±3.1 (47)	19.3±1.6 (47)	24.4±2.0 (47)	25.8±2.3 (47)	21.8±2.1 (46)	22.6±2.0 (47)	36.2±3.7 (44)	3.5±0.3 (45)
	(48.2-64.0)	(11.2-23.5)	(16.1-22.5)	(20.3-28.4)	(21.3-30.3)	(17.6-26.1)	(18.6-26.6)	(28.8-43.7)	(2.8-4.1)
61-70	66.9±5.7 (41)	22.6±4.3 (41)	21.7±2.1 (41)	26.7±2.5 (39)	33.8±3.4 (40)	26.2±2.4 (40)	29.4±3.0 (40)	37.0±4.6 (40)	4.3±0.6 (34)
	(55.4-78.4)	(13.8-31.3)	(17.5-25.9)	(21.7-31.6)	(26.9-40.7)	(21.3-31.2)	(23.3-35.5)	(27.7-46.2	(3.1-5.6)
71-90	66.9±5.6 (13)	19.9±3.1 (13)	26.0±3.4 (13)	29.2±3.6 (13)	32.0±6.2 (13)	25.9±3.9 (13)	30.8±3.8 (13)	35.1±6.4 (13)	5.7±1.7 (10)
	(54.7-79.2)	(13.2-26.7)	(18.5-33.4)	(21.3-37.1)	(18.5-45.4)	(17.5-34.4)	(22.5-39.1)	(21.1-49.1)	(1.9-9.5)

26.0 $cm \cdot s^{-1}$ water velocity at the fish's position). Light intensity at the fish's position also increased from 24.3 x 1000 lux for the 35-40 mm fry to 37.0 x 1000 lux for the 61-70 mm juveniles. Except for the 35-40 mm size group which selected significantly shallower water ($p<0.05$) and held closer to the stream bottom than the larger juveniles, the preferred microhabitat altered gradually as the fish grew, with no abrupt or significant ($p<0.05$) changes observed from one size group to the next. This gradual change in habitat choice contrasts with the abrupt change in habitat selection which occurred when the chinook fry altered their behavior from schooling to aggressive territoriality.

Height above the stream bottom occupied by the 41-90 mm juveniles ranged from 3.0 cm to 150.0 cm depending on the size of the individual fish (Figure 6), but the mean height above the stream bottom for each size group did not differ significantly from the 15 cm depth ($p<0.05$). However, height above bottom occupied by the newly emerged 35-40 mm fry was only 6.5 cm above bottom which was significantly less than the 15 cm depth ($p<0.05$).

Water velocities at different positions relative to the fish's position showed a similar trend for all size groups with the lowest velocity observed at the fish's position, and the highest water velocity 30 cm above the fish's position. As the juvenile chinook salmon grew the water velocities at the positions they selected continued to increase. However, once they were selecting positions with water velocities greater than 20 $cm \cdot s^{-1}$, they were in deep enough and fast enough water that the water velocities at the other positions no longer increased as the fish grew (Figure 8).

The changes in microhabitat conditions selected by the juvenile chinook salmon as they grew parallelled the changes associated with the different seasons (Figs. 5 vs 8). Just as distance from shore, water depth and velocity at the fish's position increased as the fish grew so did the same parameters increase from spring to fall. The similarity of the relationships between microhabitat and season, and microhabitat and fish size is expected since the size of the juvenile chinook salmon increased steadily as the season progressed (Fig. 5). Consequently it is uncertain whether juvenile chinook salmon altered their choice of microhabitat as a result of changes in seasonal availability of certain habitat types or as a result of their increased size altering their habitat needs.

<u>Microhabitat Characteristics Selected by Juvenile Chinook Salmon in Different Areas of the Nechako River</u>

Microhabitat conditions selected by juvenile chinook salmon of similar size were compared for locations from the upper, middle and lower Nechako River mainstem to investigate whether similar sized juveniles select the same habitat conditions throughout the river. Three size ranges of fish were considered: 41-50 mm, 51-60 mm and 61-70 mm. Redistribution of juvenile chinook salmon over the summer resulted in insufficient data to use identical upper-river and middle-river reaches for each of the size groups. As a result, the upper section was represented by sites 9 and 13 for the 41-50 mm size group, by site 9 for the 51-60 mm size group, and by sites 3, 4 and 9 for the 61-70 mm size group (Table 10). The middle section of the river was represented by sites 19, 19A, 21D, 23 and 24 for the 41-50 mm size group, by sites 15A, 15C, 15D, 19, 20A and 20B for the 51-60 mm size group, and by sites 21, 24 and 25 for the 61-70 mm size group. The lower section of the river was represented by sites 35 and 36 for all size groups.

The approximate distance below Cheslatta Falls for the different river sections was 5-14 km for the upper section, 19-48 km for the middle section, and 114-139 for the lower section (Table 10) (see Figure 1 for the location of the study sites).

The mean microhabitat conditions selected by juvenile chinook salmon of the same size varied greatly between river sections (Fig. 9, Table 10). This indicates that juvenile chinook salmon at the same phase of their lives do not use the same habitat conditions throughout the river but that the habitat conditions they use are partly determined by what is available in that part of the river. Thus for a given size group, habitat conditions used in the middle section of the river often differed considerably from habitat conditions used in the upper and lower sections of the river. Juvenile chinook salmon in the middle section occupied deeper water, experienced lower water velocities at all positions measured and were higher above the stream bottom, and compared to juveniles in the upper and lower sections of the river. Although pronounced, these differences were generally not mathematically significant ($p < 0.05$) due to large variations selected by individuals within the same section of the river.

Table 10. Microhabitat conditions selected by juvenile chinook salmon of similar size in the upper, middle and lower sections of the Nechako River, 1986 (mean ± 1S.E., 95% C.L. given in parenthesis).

Nechako River Section	Approx. km below Cheslatta Falls	Sites	Sampling period	Sample size	Fish length (cm)	Fish weight (g)	Water depth (cm)	Fish Ht. above bottom (cm)	Velocity ($cm \cdot s^{-1}$): Nose	Velocity ($cm \cdot s^{-1}$): Lateral 30 cm	Velocity ($cm \cdot s^{-1}$): Vertical 30 cm	Velocity ($cm \cdot s^{-1}$): Vertical 15 cm	Velocity ($cm \cdot s^{-1}$): Column 6/10	Light (x1000 lux): at fish position	Distance to shore (m)
								41-50 mm							
Upper	9-14	9,13	May 14-June 27	13	46.3± 0.9	1.1±0.1	40.6± 3.5	9.9± 0.9	17.2± 4.4	18.2± 2.8	13.8± 2.8	20.1± 5.0[a]	15.6± 4.3	31.7± 6.6	3.0± 0.2
					(44.4-48.25)	(0.9-1.3)	(33.0- 48.3)	(7.9-11.9)	(7.7-26.7)	(12.1-24.3)	(7.7-19.9)	(8.7-31.5)	(6.3-24.8)	(17.4-46.1)	(2.6- 3.5)
Middle	22-47	19,19A,21D, 23,24	June 15-July 1	8	46.3± 1.1	1.1±0.1	57.1± 8.1	19.5± 7.6	6.6± 2.7	6.1± 2.7	15.5± 6.9	7.9± 4.0	10.2± 4.8	33.3± 9.9	3.2± 0.8
					(43.7-48.9)	(0.9-1.3)	(37.9- 76.4)	(1.5-37.5)	(0.1-13.1)	(-0.3-12.5)	(-0.7-31.8)	(-1.5-17.2)	(-1.2-21.7)	(9.8-56.7)	(1.2- 5.2)
Lower	114-139	35,36	June 19-July 4	5	49.2± 0.4	1.2±0.1	42.2± 2.8	10.0± 1.6	24.4± 3.3	26.1± 6.1	37.8± 4.1	30.1± 2.6	30.1± 3.6	33.4± 6.4	6.0± 1.5
					(48.2-50.2)	(1.1-1.4)	(34.3- 50.1)	(5.5-14.5)	(15.3-33.5)	(9.3-43.0)	(26.5-49.0)	(22.9-37.3)	(20.0-40.1)	(15.6-51.1)	(1.8-10.2)
								51-60 mm							
Upper	9-10	9	June 14-July 16	12	56.1± 0.9	2.0±0.1	38.0± 3.1	8.3± 1.2	21.7± 2.3	34.4± 2.9	26.9± 3.5	27.1± 3.4	27.4± 3.7	45.9± 7.7[b]	3.5± 0.3
					(54.0-58.1)	(1.8-2.2)	(31.2- 44.8)	(5.5-11.0)	(16.7-26.8)	(28.2-40.7)	(19.3-34.6)	(19.7-34.5)	(19.2-35.5)	(28.7-63.0)	(2.9- 4.1)
Middle	19-28	15A,15C,15D, 19,20A,20B	June 15-29	10	53.7± 0.8	1.7±0.1	79.7± 11.1	31.5±11.0	10.7± 2.5	10.0± 2.3	17.0± 4.6	9.7± 3.1	13.1± 3.6	30.1± 7.9	2.8± 0.4
					(51.9-55.5)	(1.5-1.9)	(54.6-104.8)	(6.7-56.3)	(5.0-16.5)	(4.7- 1.52)	(6.6-27.3)	(2.7-16.8)	(5.1-21.2)	(11.8-48.4)[c]	(1.9- 3.7)
Lower	114-139	35,36	June 19-July 4	12	55.4± 0.9	2.0±0.1	40.4± 2.4	9.2± 2.1	27.0± 2.7	27.1± 3.2	34.2± 4.5	29.4± 3.3	28.1± 3.2	44.1± 6.1	5.0± 1.0
					(53.4-57.4)	(1.6-2.3)	(35.1- 45.8)	(4.6-13.7)	(21.1-32.9)	(20.0-34.2)	(24.2-44.2)	(22.0-36.7)	(21.1-35.1)	(30.6-57.7)	(2.7- 7.3)
								61-70 mm							
Upper	5-10	3,4,9	June 25-July 16	12	65.6± 0.9	3.2±0.2	63.6± 7.3	18.3± 7.1	27.4± 2.2	32.8± 3.1	43.8± 3.6	36.0± 2.9	41.2± 4.0	54.7±10.3[d]	4.4± 1.6
					(63.5-67.7)	(2.9-3.6)	(47.6- 79.3)	(2.7-33.9)	(22.6-32.2)	(25.9-39.7)	(36.0-51.6)	(29.8-42.3)	(32.4-50.1)	(31.8-77.7)	(0.6- 8.1)
Middle	39-48	21,24,25	June 17-July 13	8	64.1± 0.8	3.1±0.2	103.5± 22.0	46.0±16.9	13.1± 2.1	17.5± 4.0[g]	13.1± 4.1[g]	12.5± 3.7[g]	13.5± 3.4[g]	17.2± 5.4	4.1± 1.0[f]
					(62.2-66.1)	(2.6-3.5)	(51.6-155.4)	(6.1-85.9)	(8.2-18.0)	(7.8-27.2)	(3.1-23.0)	(3.5-21.5)	(5.2-21.8)	(4.5-30.0)	(1.6- 6.6)
Lower	114-139	35,36	June 19-July 15	12	65.5± 0.8	3.4±0.1	52.0± 3.2	11.6± 1.7	32.0± 4.0	34.6± 3.8	51.2± 5.0	34.4± 3.9	40.5± 5.0	27.7± 4.4	5.6± 1.1
					(63.7-67.3)	(3.1-3.7)	(45.0- 59.0)	(7.8-15.2)	(23.1-40.9)	(26.2-43.0)	(40.2-62.2)	(25.9-42.9)	(29.6-51.5)	(18.1-37.3)	(3.3- 7.9)

[a] Sample size (n) = 10
[b] n = 11
[c] n = 9
[d] n = 11
[e] n = 9
[f] n = 6

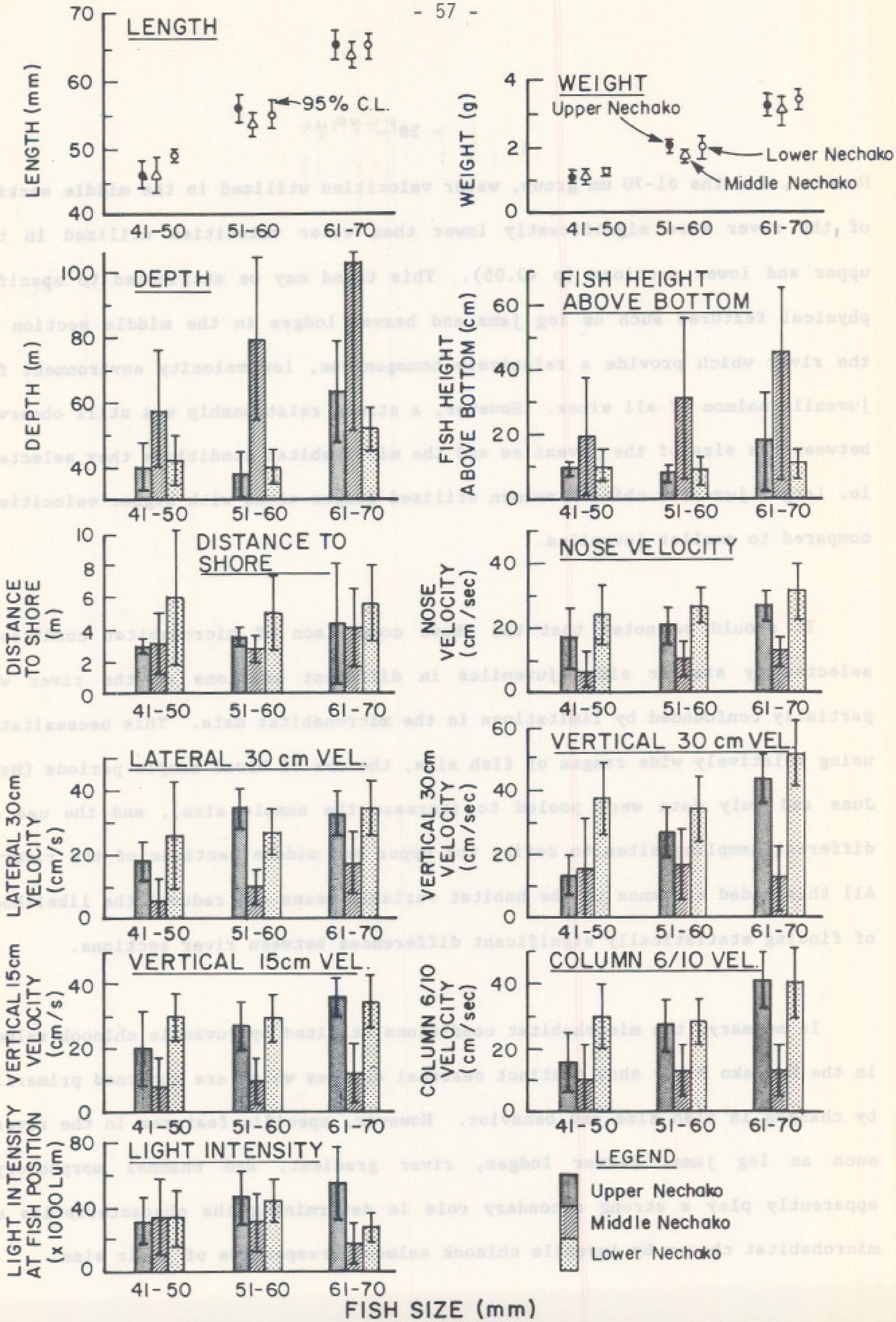

Figure 9 Microhabitat Conditions Selected by Juvenile Chinook Salmon of Similar Size in the Upper, Middle, and Lower Sections of the Nechako River Mainstem, 1986.

However, for the 61-70 mm group, water velocities utilized in the middle section of the river were significantly lower than water velocities utilized in the upper and lower sections ($p < 0.05$). This trend may be attributed to specific physical features such as log jams and beaver lodges in the middle section of the river which provide a relatively homogeneous, low velocity environment for juvenile salmon of all sizes. However, a strong relationship was still observed between the size of the juveniles and the microhabitat conditions they selected, ie. larger juvenile chinook salmon utilized deeper areas with higher velocities, compared to smaller juveniles.

It should be noted that the above comparison of microhabitat conditions selected by similar sized juveniles in different sections of the river was partially confounded by limitations in the microhabitat data. This necessitated using relatively wide ranges of fish size, the use of broad sample periods (May, June and July data were pooled to increase the sample size), and the use of different sampling sites to define the upper and middle sections of the river. All this added variance to the habitat variable means and reduced the likelihood of finding statistically significant differences between river sections.

In summary, the microhabitat conditions utilized by juvenile chinook salmon in the Nechako River show distinct seasonal changes which are governed primarily by changes in fish size and behavior. However, specific features in the river, such as log jams, beaver lodges, river gradient, and channel morphology, apparently play a strong secondary role in determining the characteristics of microhabitat chosen by juvenile chinook salmon irrespective of their size.

LATERAL DISTRIBUTION OF JUVENILE CHINOOK SALMON ACROSS THE RIVER CHANNEL

Department of Fisheries and Oceans Data 1986

The sites surveyed, the duration of each diving period, and the number and species of fish observed at each site are shown in Appendix 14 and the results are summarized in Table 11. During the 131 hours of diving along the river margins, 18,611 juvenile chinook salmon, 769 rainbow trout and over 2,800 non-salmonids were observed, compared to 15 juvenile chinook salmon and over 1,740 non-salmonids counted during the 7.3 hours of mid-channel diving. (Note that the non-salmonid counts indicate only a relative abundance since on several occasions, they were underestimated by an unknown amount e.g. the diary entry for a particular species read "many". Also, the counts of juvenile chinook salmon along the river margins underestimate their true abundance because much of the time was spent measuring microhabitat conditions, and not searching for fish. The counts of juvenile chinook salmon along the river margins should therefore be considered as conservative.)

Assuming that the distance covered per unit time was similar for the marginal and mid-channel dives but time spent in the two habitats was disproportionate (7,864 min versus 437 min), the mid-channel counts were expanded by a factor of 18.0 (7,864 min ÷ 437 min) in order to equalize the search effort expended in the two types of dives. This procedure yielded 18,611 chinook and 2,800 other species for the marginal dives, and 270 chinook and 31,320 other species for the mid-channel dives. Chinook juveniles were,

Table 11. Relative abundance of juvenile chinook salmon and other species along the margins and in mid-channel of the Nechako River, 1985 and 1986.

Number of days sampling	RIVER MARGIN: Duration of search (minutes)	RIVER MARGIN: No. fish observed: Chinook Salmon	RIVER MARGIN: No. fish observed: Others[1]	MID-CHANNEL: Duration of search (minutes)	MID-CHANNEL: No. fish observed: Chinook salmon	MID-CHANNEL: No. fish observed: Others
46	7,864 (131.1 hrs.)	18,611 (2.367 per min.)	769 RBT (0.098 per min.)	437 (7.3 hrs.)	15 (0.034 per min.)	21 RBT (0.048 per min.)
			508 MW (0.065 per min.)			1,042 MW (2.384 per min.)
			1,089 SU (0.139 per min.)			608 SU (1.391 per min.)
			436 SQ (0.055 per min.)			68 SQ (0.156 per min.)
			8 DV (0.001 per min.)			0 DV
						1 ST (0.002 per min.)

[1]RBT = rainbow trout
MW = mountain whitefish
SU = common sucker
SQ = northern squawfish
DV = Dolly Varden
ST = white sturgeon

therefore, approximately 69 times more abundant near the margins compared to mid-channel areas on a per unit area basis. In contrast, non-salmonids were approximately 11 times more abundant in the mid-channel compared to the river margins. Because the assumption that the distance covered per minute searching along the margins was the same as in the mid-channel is false, the relative abundance of fish along the river margins is much greater than these data indicate.

These diving observations show that during May to July, chinook juveniles utilize primarily the river margins within approximately 4 m of the shore and are rarely encountered in the mid-stream sections, 20 m or more from the shore. A reverse situation was observed for non-salmonids which were encountered in greatest numbers in the mid-channel of the river. It is likely that by utilizing a different ecological niche from other species, chinook juveniles may be experiencing reduced interspecific competition.

Provincial Fisheries Branch Fish and Wildlife Data, 1985, 1986

Additional information on the lateral distribution of juvenile chinook salmon in the Nechako River was obtained during the 1985 and 1986 snorkeling surveys by the Provincial Fisheries Branch, and is summarized in Table 12.

During snorkeling on July 3, 1985, a total of 5,650 juvenile chinook salmon were estimated in Reach 1. Of these fish, 53% were observed in the shore lanes

Table 12. Lateral distribution of juvenile chinook salmon in the Nechako River, and comparison of relative chinook salmon densities between reaches, 1985, 1986 (Provincial Fisheries Branch data).

Reach[a]	Lane No.	Lane position (m to shore)	Count 1	Count 2	Count 3	Mean count	% Lateral distribution	Total chinook[b]	No. chinook /ha
					JULY 3, 1985				
1	1	Shore (0-4)	630	-	-	630	11.0	630	-
	2	Nearshore (4-8)	280	-	-	280	4.9	280	-
	3	Mid (8-12)	100	-	-	100	3.4	900	-
	4	Nearshore (4-8)	2,240	-	-	2,240	39.0	2,240	-
	5	Shore (0-4)	2,400	-	-	2,400	41.7	2,400	-
		Total				5,650	100[c]	6,450	248.1
					JUNE 17-24, 1986				
1	1	Shore (0-3)	571	2,455	-	1,513	37.2	1,513	-
	2	Nearshore (3-6)	0	0	200	67	1.6	67	-
	3	Mid	0	0	0	0	0	0	-
	4	Mid	0	0	0	0	0	0	-
	5	Nearshore (3-6)	200	0	0	67	1.6	67	-
	6	Shore (0-3)	1,350	-	3,500	2,425	59.6	2,425	-
		Total				4,072	100	4,072	156.6
2	1	Shore (0-2)	150	250	-	200	30.5	200	-
	2	Nearshore (2-4)	10	0	-	5	0.8	5	-
	3	Mid	0	0	-	0	0	0	-
	4	Mid	0	0	-	0	0	0	-
	5	Nearshore (2-4)	0	0	-	0	0	0	-
	6	Shore (0-2)	700	200	-	450	68.7	450	-
		Total				655	100	655	31.2
3	1	Shore (0-2)	250	210	-	230	34.7	230	-
	2	Nearshore (2-4)	0	75	-	38	5.7	38	-
	3	Mid	15	50	-	33	5.0	677	-
	4	Mid	0	150	-	75	11.3	1,537	-
	5	Nearshore (2-4)	-	135	-	135	20.4	135	-
	6	Shore (0-2)	-	152	-	152	22.9	152	-
		Total				663	100	2,769	55.9
4	ZERO CHINOOK OBSERVED IN THIS REACH								
					SEPTEMBER 9-10, 1986				
1	1	Shore (0-2)	431[d]	90[c]	-	261	66.2	261	-
	2	Nearshore (2-4)	80	20	-	50	12.7	50	-
	3	Mid	42	20	-	31	7.9	279	-
	4	Mid	12	13	-	13	3.3	117	-
	5	Nearshore (2-4)	6	36	-	21	5.3	21	-
	6	Shore (0-2)	25	10	-	18	4.6	18	-
		Total				394	100	746	33.9

[a] Reach locations sampled by the Provincial Fisheries Branch are shown in Figure 3.

[b] Mid-zone counts expanded by the following factors to correct for unsurveyed mid-zone width: Reach 1, 1985 - 9x; Reach 1, June 1986 - 6.7x; Reach 2, 1986 - 15.5x; Reach 3, 1986 - 20.5x, Reach 1, Sep. 1986 - 9x.

[c] Lateral distribution based on a total reach count of (5,650+100)=5,750 fish since mid-count of 100 fish was doubled to equalize effort/zone.

[d] Difference in lane 1 counts probably related to how closely the snorkler inspected debris accumulation.

(0-4 m from shore), 44% in the nearshore lanes (4-8 m from shore), and 3% 8-12 m from shore.

During June 1986, estimates of juvenile chinook salmon in the four surveyed reaches ranged from 0 in Reach 4 to 4,072 in Reach 1 (Table 12). During these observations, juvenile chinook salmon had the greatest affinity for the shore lanes (0-3 m from shore) and 58-99% of all chinook salmon counted occurred along the immediate margin of the river. In the nearshore lanes (2-6 m from shore) 1-26% of the total chinook salmon were observed, and only 0-16% of the chinook salmon observed were further than 6 m from shore. The September 1986 data for Reach 1 also showed that 89% of the total chinook salmon observed occurred along the margins (0-4 m from shore) and only 11% occurred further than 4 m from shore (Table 12). The lateral distribution of juvenile chinook salmon in 1986 agrees with the 1985 observations when 97% of the counted chinook were sighted 0-8 m from shore. Summing the 1985 and 1986 observations from all the reaches shows that 97% of all chinook salmon observed occurred within 8 m from shore and only 3% occurred further than 8 m from shore. Clearly, juvenile chinook salmon in the Nechako River show a definite preference for the river margins.

In 1985, the distribution of juvenile chinook salmon was also examined in relation to the frequency of pools, glide-runs and riffles in Reach 1. Pools were arbitrarily defined as relatively deep and slow flowing, riffles as relatively shallow and turbulent, and glide-runs as intermediate in depth and flow. The unit frequency (i.e., % length of surveyed area) of pools, glide-runs and riffles in Reach 1 was 44%, 31% and 25% respectively (Slaney et al. 1984).

Of the 5,610 chinook counted in Reach 1, 79% occupied pools, 19% glide-runs and 2% riffles. It appears therefore that in the canyon areas of the river immediately downstream from Cheslatta Falls, juvenile chinook salmon show the greatest affinity for slow, deeper areas, and a much lower affinity for faster, shallower areas.

During the above 1985 and 1986 observations, juvenile chinook salmon were frequently found associated with wood accumulation, especially log jams and beaver lodges. Hundreds of juvenile chinook salmon congregated within the submerged branches and often schools of squawfish surrounded such areas (P. Slaney, Provincial Fisheries Branch, personal communication). For example, the heavy concentration of juvenile chinook salmon observed on July 3, 1985 along one side of the canyon pool in Reach 1 (82% of total count made in lanes 4 and 5, Table 12) was due to the presence in that area of two large schools, each of a couple of thousand fish. Unlike the opposite side of the surveyed reach, this side had a beaver lodge and considerable log debris which provided structures under which the young chinook salmon could hide (P. Slaney, personal communication). This tendency by juvenile chinook salmon to congregate near accumulations of wood agrees with the 1985 and 1986 DFO observations. It appears that habitat which provides protection from predators likely is critical for rearing juvenile chinook salmon in the Nechako River and that any fixed debris in the river serves as a preferred daytime habitat.

DAY vs NIGHT DISTRIBUTION OF JUVENILE CHINOOK SALMON

The purpose of the day and night distribution study was to compare the utilization of the nearshore river areas by rearing juvenile chinook salmon during these two periods.

June-July 1986 sampling

The physical parameters for each quadrat surveyed and the fish counts within the grids and along the margins are shown by sampling date in Table 13. The overall mean physical parameters observed in the quadrats were as follows: water temperature 14.6°C (range 7.2-18.7°C), water depth 12.9 cm (range 7-20 cm), water velocity of 6/10 of the depth 17.2 $cm \cdot s^{-1}$ (range 4.1-27.1 $cm \cdot s^{-1}$) and distance to shore 2.1 m (range 0.7-7.0 m). Gravel was generally the dominant substrate observed in the grids (Table 13).

Daytime counts of juvenile chinook salmon in all quadrats and margin counts were consistently zero. Night time counts showed an overall mean density of 1.4 juvenile chinook salmon per m^2 for the quadrats (range 0-3.7 $fish \cdot m^{-2}$) and 0.8 juvenile chinook salmon per m^2 for the margin counts (range 0.3-1.1 $fish \cdot m^{-2}$). The difference in overall mean fish density between quadrats and margin counts was not significant at the 95% confidence level. In fact, quadrat counts closely paralleled margin counts on any given date (Table 13). This was expected since the four quadrats at each site were contained within the area of the margin counted, and were therefore considered to represent the full

Table 13. Night and day distribution of juvenile chinook salmon along the margins of the Nechako River, 1986 (mean ± 1S.E.; n = No. obs.)

Date 1986	Location (Fig. 1)	Quadrat No.	PHYSICAL PARAMETERS IN QUADRATS: Temp. (°C)	Depth (cm)	Velocity 6/10 (cm/s)	Distance to shore (m)	Substrate[a]	CHINOOK COUNTS – Quadrats: Day (n)	Day Fish/m²	Night (n)	Night Total fish	Night Fish/m²	Margin Count (n = 1 on each sampling date): Day Total fish	Day Fish/m²	Night Total fish	Night Fish/m²	L x W (m)	Area m²	Period obs. (min)[b]
June 30	Hill Larson's (Site 24)	1	18.3	9	16.1	4.0	GR, CO	(1)	0	(2)	2	1	Not done		55	0.3	100x2	200	0/30
		2	17.7	18	24.2	7.0	CO, GR	(1)	0	(2)	0	0							
		3	18.7	10	6.6	1.0	GR, SI	(1)	0	(2)	1	0.5							
		4	17.7	13	27.1	4.1	GR, SA	(1)	0	(2)	0	0							
		Mean	18.1±0.2	12.5±2.0	18.5±4.6	4.0±1.2	-	(4)	0	(8)	3	0.4±0.2							
July 4	Bridge at Vanderhoof (Site 36)	1	7.4	8	4.1	1.5	GR	(5)	0	(5)	5	1	0	0	92	0.9	36x3	108	5/7
		2	7.3	19	17.2	2.5	GR	(5)	0	(5)	2	0.4							
		3	7.4	6	10.1	1.5	SA, GR	(5)	0	(5)	0	0							
		4	7.2	16	26.7	2.5	SA, GR	(5)	0	(5)	10	2							
		Mean	7.3±0.05	12.3±3.1	14.5±4.9	2.0±0.3	-	(20)	0	(20)	17	0.9±0.2							
July 9, 10	Bert Irvine's Dock (Site 9)	1	17.0	19	9.4	1.3	SI, SA, GR	(5)	0	(6)	15	2.5	0	0	59	1.1	18x3	54	3/4
		2	17.0	14	20.7	1.2	GR, CO, SI	(5)	0	(6)	22	3.7							
		3	17.0	10	14.7	0.8	GR, SI	(5)	0	(6)	9	1.5							
		4	16.9	20	11.2	1.8	GR, SI	(5)	0	(6)	9	1.5							
		Mean	17.0±0.03	15.8±2.3	14.0±2.5	1.3±0.2	-	(20)	0	(24)	55	2.3±0.3							
July 17	Bridge at Vanderhoof (Site 36)	1	16.0	7	22.1	0.7	GR, SA	(3)	0	(3)	3	1	Not done		125	0.9	44x3	132	0/10
		2	15.9	9	26.7	1.7	GR, SA	(3)	0	(3)	2	0.7							
		3	16.0	9	11.2	0.8	GR, SA	(3)	0	(3)	3	1							
		4	15.9	20	26.4	1.8	GR, SA	(3)	0	(3)	5	1.7							
		Mean	16.0±0.03	11.3±3.0	21.6±3.6	1.3±0.3	-	(12)	0	(12)	13	1.1±0.2							
OVERALL MEAN (n = 16)			14.6±1.1	12.9±1.3	17.2±2.0	2.1±0.4		(56)	0	(64)	88	1.4±0.2	(2) 0	0	(4) 331	0.8±0.2			

[a] Substrate listed in order of decreasing abundance; CO - cobble, GR - gravel, SA - sand, SI - silt.

[b] Day/night count periods.

variation of fish densities and corresponding habitat conditions found in the larger and less homogeneous strip. Bert Irvine's (site 9) had the highest salmon densities. At night there were 2.3 chinook salmon per m^2 in the quadrats and 1.1 chinook salmon per m^2 along the margins. The quadrats at this site were relatively close to shore (1.3 m) and had on the average greatest depth (15.8 cm) and lowest water velocity (14.0 $cm \cdot s^{-1}$) compared to the other sites. The lowest chinook salmon densities of 0.4 $fish \cdot m^{-2}$ for quadrats and 0.3 $fish \cdot m^{-2}$ for along the river margins were observed for Hill Larson's (site 24). The low abundance of juvenile chinook salmon at this site could not be explained on the basis of the available physical parameters. Site 36 at Vanderhoof bridge, sampled on July 4 and 17, showed similar mean chinook salmon densities on the two occasions (0.9-1.1 $fish \cdot m^{-2}$). This was despite warmer temperatures (16.0°C vs 7.3°C) and faster flows (21.6 $cm \cdot s^{-1}$ vs 14.5 $cm \cdot s^{-1}$) observed at that site on July 17.

Counts of juvenile chinook salmon within the quadrats were pooled for all sites and dates to determine the effects of water depth and velocity on the choice of position by juvenile chinook salmon at night. Chinook salmon densities were compared between quadrats located at $\leq$ 10 cm depth and those located at > 10 cm depth. Mean chinook salmon density ($number \cdot m^{-2}$) was 0.9 ± 0.1 (S.E.) in the eight shallow quadrats (29 observations) and 1.8 ± 0.3 (S.E.) in the eight deeper quadrats (35 observations); this difference was significant ($p < 0.05$). A comparison between the three low water velocity quadrats where the 6/10 of the depth water velocity was < 10 $cm \cdot s^{-1}$ (13 observations) and seven higher quadrats where the water velocity at 6/10 of the depth was > 20 $cm \cdot s^{-1}$

(24 observations) had mean fish densities of 1.6 ± 0.4 (S.E.) and 1.8 ± 0.3 (S.E.) chinook salmon per m^2 respectively. This difference was not significant ($p<0.05$). Further comparisons between fish densities and habitat parameters were not made due to insufficient data.

These day-night observations clearly showed that during June and July, juvenile chinook salmon utilized the river margins at night. The margins surveyed were approximately 0-4 m from the shore, had a mean depth of 12.9 cm and a mean water velocity at 6/10 of the depth of 17.2 $cm \cdot s^{-1}$. A significantly greater number of juvenile chinook salmon utilized deeper areas of the margins (>10 cm) than the shallow areas (<10 cm) ($p <0.05$). These and other relationships between chinook salmon distribution at night and habitat parameters require additional study.

August-September 1986 Sampling

Quadrat sampling

Observations similar to those made in June and July were made at the Vanderhoof bridge site during August 1986. The three replicate counts for five quadrats on August 12, 1986 yielded a total of 10, 13 and 11 juvenile chinook salmon (Table 14). This indicates a density of approximately 2.0-2.6 chinook salmon per m^2 compared to densities during July of 0.9-1.1 chinook salmon per m^2 at the same site (Tables 13 and 14). Juvenile chinook salmon were not observed at this site during a count along the river margin during the daytime; however,

Table 14. Day and night distribution of juvenile chinook salmon determined by quadrat sampling, beach seining and snorkeling in the Nechako River during August-September 1986.

QUADRAT SAMPLING AT VANDERHOOF BRIDGE, AUG. 12

Quadrat No.	Count 1 2345 hr	Count 2 2355 hr	Count 3 0005 hr
1	2	0	0
2	3	1	2
3	4	7	8
4	0	2	0
5	1	3	1
Total ($\bar{X}$)	10 (2.0)	13 (2.6)	11 (2.2)

BEACH SEINING

Date	Time[a]	Site No. (Fig. 4)	No. chinook (3 sets)
Aug. 13	1615	2 mainstem	29 (2 sets)
13	2045*	2 mainstem	45
Aug. 14	1400	11	0
14	2140*	11	7
Aug. 14	1530	13	18
14	2020*	13	8
Sep. 26	1845*	8	39
28	1140	8	16
30	1950*	8	2
		Total day count	63
		Total night count	101

SNORKELING

Date	Time[a]	Site No. (Fig. 4)	No. chinook
Aug. 13	1550	2 sidechannel	35
13	2010*	2 sidechannel	67
Aug. 13	1745	8	9
13	2115*	8	20
Aug. 14	1315	10	4
14	2120*	10	15
Aug. 14	1520	13	3
14	2000*	13	8
		Total day count	51
		Total night count	110

[a]Sunset occurred at about 2100 during August and 1900 during September; an asterisk indicates evening sampling.

some chinook salmon were captured by beach seining during the day indicating that chinook salmon were in the area but not as abundant or using the same habitat as at night.

Beach seining and snorkeling

Results of the replicate day and night beach seining and snorkeling surveys are shown in Table 14. Juvenile chinook salmon catches and counts were generally larger in the evening than during the daytime with the exception of one beach seine site. Although the day and night catch per unit effort was similar at site 2, only 3 of the 45 juvenile chinook salmon caught at night were recaptures of the day sample (scales were taken from chinook in the day catches and thus could be recognized in the night sample). This suggests that juvenile chinook salmon are likely moving into the shallows at night. All the snorkeling surveys also yielded greater counts of juvenile chinook salmon at night compared with during the day (110 vs 51).

Although the number of samples was insufficient to evaluate the results statistically, the results of night beach seining and snorkeling surveys suggest that juvenile chinook salmon occupy the margins of the river at night during August and September consistent with observations made earlier in the summer. Night snorkeling observations in August indicated that juvenile chinook salmon were close to shore in relatively shallow water, slow water velocities and associated with submerged vegetation and bank debris.

Because of the difficulty of navigating the river by boat at night during the lower flows in September (29 $m^3 \cdot s^{-1}$ vs approximately 171 $m^3 \cdot s^{-1}$ in August), only one site at river kilometer 10 (Bert Irvine's) was sampled by beach seining during the day and evening in September 1986. Juvenile chinook salmon were more abundant in the evening (39 vs 16, Table 14). The interpretation of these results is complicated, however, since 15 chinook salmon from the September 26 night sample were killed for stomach analysis and on the evening of September 30, only 2 chinook salmon were captured by beach seine.

While this particular site had the highest juvenile chinook salmon densities during the July 1986 quadrat studies (Table 13), night observations using lights on September 26 did not reveal any juvenile chinook salmon along the shoreline. It appears that although juvenile chinook salmon reared at this site in September as evidenced by the relatively high beach seine catches in this area, juvenile chinook salmon were not as abundant or as concentrated along the shallow margins at night in September as they were earlier in the summer.

<u>Vanderhoof bridge site, July-October 1986</u>

The strongest evidence that juvenile chinook salmon move into the shallow river margins in the evening comes from observations at the Vanderhoof bridge site, using day and night quadrat counts, counts along the river margins, and beach seining. On July 4 and 17, densities of juvenile chinook salmon within the quadrats were 0.9 to 1.1 chinook salmon per m^2 (Table 13). This density is lower than the average density of 2.0 to 2.6 chinook salmon per m^2 observed during the midnight quadrat counts conducted at that site on August 12 (Table 14). On that date, juvenile chinook salmon were concentrated in a 2 m wide band along 25 m of shoreline downstream of the Vanderhoof bridge. Therefore, using the above density, it was calculated that 100-130 juvenile chinook salmon were present in the shallows at that site during nighttime.

This phenomenon of juvenile chinook salmon concentrations along the river margin was not observed in the daytime. Quadrat counts and counts along the river margin conducted at the Vanderhoof bridge during daytime on July 4 yielded zero fish (Table 13). Also in August, no juvenile chinook salmon were sighted during daytime at the water's edge, but eight juveniles were captured in three beach seine sets made at 1420 h on August 15 (Appendix 5). On September 25, three beach seine sets made at 1800-1830 h yielded 16 juvenile chinook salmon indicating that they were still present in the area (Appendix 6). However, on October 9, night observations at 2300 h using a spotlight found no chinook along the water's edge. On that occasion, approximately 30 m of shoreline were walked upstream and downstream of the Vanderhoof bridge. There were at the most 2-3 juvenile chinook salmon within the sampled area but they were not positively identified. Fish observed in the shallows included juvenile whitefish and non-salmonid juvenile fish.

In addition to the day and night distribution sampling, the above seasonal observations at the Vanderhoof bridge site suggest that by autumn, juvenile chinook salmon either leave this area or alter their diet behavior and distribution.

In summary, the August day versus night distribution studies, using beach seining and snorkeling, showed that in all locations, except one, juvenile chinook salmon were more abundant along the river margins in the evening compared to the daytime (Table 14). This suggests that chinook juveniles move into the nearshore shallow river areas in the evening. The number of samples, however, were not adequate to evaluate the results statistically.

During the day juvenile chinook salmon were not seen in the same areas where they were abundant at night. Daytime snorkeling, both by B.C. Fish and Wildlife divers and by DFO divers found that juvenile chinook salmon were still near the river margins but in much different locations and displaying much different behavior. During the daytime, juvenile chinook salmon were almost always associated with wood accumulations in the Nechako River (mainly beaver lodges) and were usually in schools of 10 or more. This trend was particularly evident from study sites 4 to 33 (river kilometer 6 to 77) during the June to July 1986 studies when school sizes averaged 50 fish and some schools were larger than 2,000 during the day. This is in sharp contrast to the nighttime observations where the fish were observed in shallow, exposed areas, always individually, and in random spacing.

Studies elsewhere have also shown that chinook and coho salmon juveniles use distinctly different habitats at night compared to daytime (H. Mundie, PBS, personal communication to C. Shirvell). The night habitat generally consists of shallow, (approximately 15 cm deep), and slow or near stagnant water along the river margins often with emergent vegetation. The juveniles may utilize these areas for night-time feeding as indicated by the prey of terrestrial origin commonly found in the stomachs of juvenile salmon captured at night (H. Mundie, personal communication).

USE OF DEEP CANYON WATERS BY JUVENILE CHINOOK SALMON

Gee minnow trapping, September 17, 1985

The two traps recovered after a 24-h sampling period contained zero fish. The third trap was lost. Water flow at Cheslatta Falls during the sampling period averaged 64 $m^3 \cdot s^{-1}$.

Scuba diving, June 26, 1986

The numbers of fish observed and the corresponding physical parameters measured at the diving sites are shown in Table 15. Approximately 278 juvenile chinook salmon were sighted during the four replicate dives which together represented an observation period of 102 min. The juvenile salmon were approximately 50 - 60 mm long and formed schools of up to 100 individuals. On one occasion (Dive No. 2), a school of 75-100 juvenile chinook salmon was seen holding against the current in an exposed well-lit area. On another occasion (Dive No. 3), over 100 juvenile chinook salmon were observed in a 6 m deep area holding at 10-30 cm above the bottom. All juvenile chinook salmon were observed at less than 10 m depth although the maximum surveyed depth was 15 m. Because the juvenile salmon were in schools and the canyon is narrow, it is likely that

Table 15. Scuba diving survey of Nechako Canyon, June 26, 1986.

Dive no.	Location	Diving interval (min)	Diver	Water temp. (°C)	Column depth (m)	Velocity (cm/s)	Substrate	Number fish observed Chinook	Other[a]
1	Along centre of canyon, mid-water to deep dive	20	#1	13	5 mean, 10 max	10-15	-	0	10 SU, 3 MW, 3 RBT
			#2	-	approx. 8	10-15	-	30[b]	0
2	Along centre of canyon, deep dive	16	#1	-	8-9	10-15	Bedrock, gravel	75-100[c]	few RBT and MW
					approx. 15	-		0	0
			#2	-	8-9	10-15	-	0	1 SU, 3 RBT
3	Down the right bank (looking upstream)	8	#1	-	approx. 5	10-15	Gravel	20-30	0
				-	approx. 6	10-15	Gravel	>100[d]	0
				-	approx. 9	10-15	Gravel	6	few SU
			#2	-	approx. 5	10-15	Gravel	15	1 RBT
4	Down the left bank (looking upstream)	7	#1	14	approx. 8	15-20	Gravel	2[e]	0
			#2	-	-	15-20	-	25-30[f]	0

[a] SU - sucker, RBT - rainbow trout, MS - mountain whitefish.
[b] In a school.
[c] Approx. 50 mm long, in a school, holding against current in a lit area.
[d] Approx. 50-60 mm long at 10-30 cm above gravel.
[e] 5 cm above bottom.
[f] At water surface, probably sockeye fry.

many of the fish were observed more than once on successive dives. The actual population of juvenile chinook salmon in the canyon may have been near 150 fish. Several other fish species were also seen, including suckers, mountain whitefish and rainbow trout.

Water temperature at the surveyed sites was 13-14°C; water depth ranged from 5-15 m; estimated water velocity was generally 10-15 $cm \cdot s^{-1}$; and gravel constituted the predominant substrate. Streamflow at Cheslatta Falls during the diving survey averaged 59 $m^3 \cdot s^{-1}$.

Scuba diving, July 3, 1985

During a survey of the same canyon of the Nechako River by the B.C. Provincial Fisheries Branch on July 3, 1985, only a few juvenile chinook salmon were observed at about 8 m depth. Similar sampling was done in 1984 and many juvenile chinook salmon were observed in the canyon (R. Morley, B.C. Provincial Fisheries Branch, personal communication), however the observation of large numbers of juvenile chinook salmon in the canyon has never been duplicated. The difference between the two years cannot be readily explained since the 1984 and 1985 observations were made at similar times of the year and at similar river flows.

In summary, the low numbers of juvenile chinook salmon observed in the canyon in July 1985 and June 1986 suggest that the rearing fish may make only limited use of deep water habitat in the Nechako River.

USE OF NECHAKO RIVER TRIBUTARIES BY JUVENILE CHINOOK SALMON, MAY 1986, AUGUST, 1986, SEPTEMBER 1985

By late May juvenile chinook salmon were found to be present in every tributary of the Nechako River which was checked for their presence (Table 16). At this time of the year these tributaries had high streamflows relative to their annual regime resulting from melting snow in their headquarters. Juvenile chinook salmon were equally or more abundant per unit area than in the mainstem Nechako River in May (Appendix 15) and the largest individuals captured anywhere in the Nechako River system at this season were in the tributaries (Appendix 9).

Water levels in all tributaries sampled in August were low and in the case of Swanson Creek, the area sampled was cut off from the Nechako River. Nevertheless, juvenile chinook salmon were abundant near the mouth of this tributary in an isolated pool that contained log debris (Table 16). Seventeen juvenile chinook salmon were captured and more were observed escaping upstream. Water temperatures in Swanson Creek was considerably cooler than the Nechako River mainstem (13.1°C compared to 17.8°C). The mean length and weight of juvenile chinook salmon in Swanson Creek was also less than the mean observed for the Nechako River juveniles at this time (See section on growth). Two juvenile chinook salmon were captured in Greer Creek in August and they were also found in pool habitat using log debris for cover. No juvenile chinook salmon were found in Smith or Cutoff Creeks (Table 16).

Table 16. Use of Nechako River Tributaries by Juvenile Chinook Salmon, May 1986, August 1986, and September 1985.

Date	Tributary	Number of Fish captured Chinook Salmon	Others'	Comments
May 19	Targe Ck.	1	0	
May 20	Twin Ck.	8	0	
May 20/24	Cutoff Ck.	5	0	
May 23	Smith Ck.	5	0	
May 23	Leech Ck.	9	0	
May 23	Trankle Ck.	30	0	
May 23	Redmond Ck.	5	0	
May 24	Swanson Ck.	5	0	
TOTAL		68 (5.5 per 100 sec electrofishing)		
Aug 12	Smith Ck.	0	1 RBT + DA	sampled near beaver dam with overhanging vegetation, gravel/ silt substrate; log debris
Aug 14	Swanson Ck.	17	0	Swanson Ck.=13.1°C; Nechako R.=17.8°C
Aug 15	Cutoff Ck.	0	0	Cutoff Ck.=13.1°C. Nechako R.=17.8°C;
Aug 15	Greer Ck.	2 19	2 RBT	Greer Ck.=13.8°C
Sep 13	Tahultzu Ck.	0	0	Stagnant water, beaver dams
Sep 17	Targe Ck.	0	74 DA 118 SU 5 SH 2 CY 1 SQ	Dry creek bed stagnant pools
Sep 17	Swanson Ck.	0	80 DA 36 SH 168 SU 2 SQ	Dry creek bed stagnant pools T = 10.5-12.5°C
Sept 17	Cutoff Ck.	0	18 DA 15 SU 4 SH 2 CY	Dry creek bed with broad, shallow pools T=13.5°C

Table 16 Continued

Date	Tributary	Number of Fish captured Chinook Salmon	Others'	Comments
Sep 17	Twin Ck.	0	34 CO 3 RBT	Creek running, T=8°C water velocity 2-5
Sep 18	Twin Ck.	6	2 CO 22 MW 10 SQ 3 RBT 2 SU 2 DA 1 SH	$cm.s^{-1}$ sample taken at creek mouth in Nechako River. $\bar{x}$ = chinook salmon 90.7 mm, 8.9 g.
Sep 18	Greer Ck.	0	2 CO	T = 7°C
Sep 18	"Old" Nechako R. Channel	0	1 SU	water flowing, T=10°C
TOTAL		6 1 of 7 tributaries containing juvenile chinook salmon.		

CO = coho salmon, RBT = rainbow trout, MW = mountain whitefish
SU = sucker, SQ = squawfish, SH = shiner, DA = dace
CY = unidentified cyprinid

By September most of the tributaries were near dry, and consisted of stagnant, tepid pools. Of the seven tributaries surveyed, only three - the original Nechako River channel upstream of Cheslatta Falls, Twin Creek and Greer Creek, had running water. No juvenile chinook salmon were found in the pools of those tributaries that had stopped flowing (Table 16) although they were utilized by a number of non-salmonids including dace, sculpins, shiners, suckers, squawfish and mountain whitefish. Sampling in the three running tributaries produced one sucker in the original Nechako River channel above Cheslatta Falls, two coho (81 and 84 cm) and in Twin Creek a mix of non-salmonids, six rainbow trout, 34 juvenile coho salmon and six juvenile chinook salmon (mean juvenile chinook salmon size 90.7 cm, 8.9 g, Table 16).

It should be noted that the 8 km of original Nechako River channel located between Kenney Dam and Cheslatta Falls has been essentially dry since completion of Kenney Dam in 1952. Presently, the channel consists of a series of pools controlled by beaver dams, with seepage from Kenney Dam and minor local flows providing a small residual flow (Envirocon 1984).

From this study it was concluded that in some years during late summer and early autumn, some Nechako River tributaries are not running and are not utilized by juvenile chinook salmon for rearing. In these studies all tributaries examined were being occupied by juvenile chinook salmon in May, 2 of 4 tributaries were occupied in August, and 2 of 7 tributaries were occupied in September. Because sampling locations and amount of sampling effort expended was inconsistent direct comparisons over seasons are difficult, nevertheless, as summer progressed there was a clear decline in the number of juvenile chinook salmon rearing in Swanson and Cutoff Creeks coinciding with their reduced streamflows.

	May	August	September
Swanson Creek	5	17	0
Cutoff Creek	5	0	0

The degree of tributary use by juvenile chinook salmon may be a function of late summer precipitation since ALCAN reports indicate that in some years Nechako River tributaries are flowing in late summer and autumn and may serve as potential juvenile chinook salmon rearing habitat. Therefore, as a result of variable flows, seasonal differences may be expected in the use of Nechako River tributaries by juvenile chinook salmon. During particularly dry years, juvenile chinook salmon may move out of the tributaries into the mainstem by mid-August (Russell et al. 1983).

LONGITUDINAL DISTRIBUTION WITHIN THE NECHAKO RIVER AND GENERAL HABITAT USE BY JUVENILE CHINOOK SALMON

The main objectives of the May, August, September and October chinook salmon rearing studies, which utilized electroshocking in May, and beach seining and snorkeling during August-October, were as follows:

1. to monitor the distribution of juvenile chinook salmon in the Nechako River system during the emergence and early freshwater rearing stages in May, during the high summer flows in August (170 $m^3 \cdot s^{-1}$), and during the low fall flows in September (28 $m^3 s^{-1}$),
2. to describe (non-quantitatively) the general habitat utilization by juvenile chinook salmon in the Nechako River,
3. to investigate the day and nighttime distribution of juvenile chinook salmon in the river,
4. to determine the growth of juvenile chinook salmon from progressive measurements of their length and weight through the summer rearing period,

and 5. to determine the diet of juvenile chinook salmon in the Nechako River from analyses of their stomach contents.

Items 1 and 2 are dealt with in this section; items 3 has already been dealt with in earlier sections of this report (page 35), item 4 is dealt with on page 54, while analyses for item 5 are not yet complete.

Longitudinal distribution of juvenile chinook salmon during summer

The relative abundance and distribution of juvenile chinook salmon in the Nechako River system during spring (May data), summer (August data) and autumn (September/October data) are summarized in Figure 10 and Table 17. Detailed information on the May electroshocking is given in Appendix 15 and on the August and September/October beach seining in Appendices 5 and 6. Based on the available sampling sites, the catch data were evaluated for three Nechako River reaches: upper Nechako River (km 0-24), middle Nechako River (km 39-48 and km 68-82), and the lower Nechako River (km 114-123 and km 137-144).

Chinook salmon abundance in May is expressed as catch per unit effort (CPUE), in numbers of juvenile chinook salmon captured per 100 seconds of electrofishing. A total of 3,473 seconds of electrofishing were expended during May 16-24, yielding 160 chinook (Table 17). CPUE for the entire Nechako River system averaged 4.6 chinook salmon per 100 seconds and ranged from around 3 chinook salmon per 100 seconds for the upper and middle reaches to around 16 chinook salmon per 100 seconds for the lower reaches (Table 17). CPUE for individual sites ranged from 0-57.7 chinook salmon per 100 seconds (Appendix 15). The highest chinook salmon concentrations were in the lower Nechako River at site 26A (Figure 1, km 113.5-114, 42.6 fish·100 s^{-1}) and at Trankle Creek (site 58, km 120, 57.7 fish·100 s^{-1}) (Appendix 15).

Chinook salmon abundance in August, based on beach seine catches, averaged

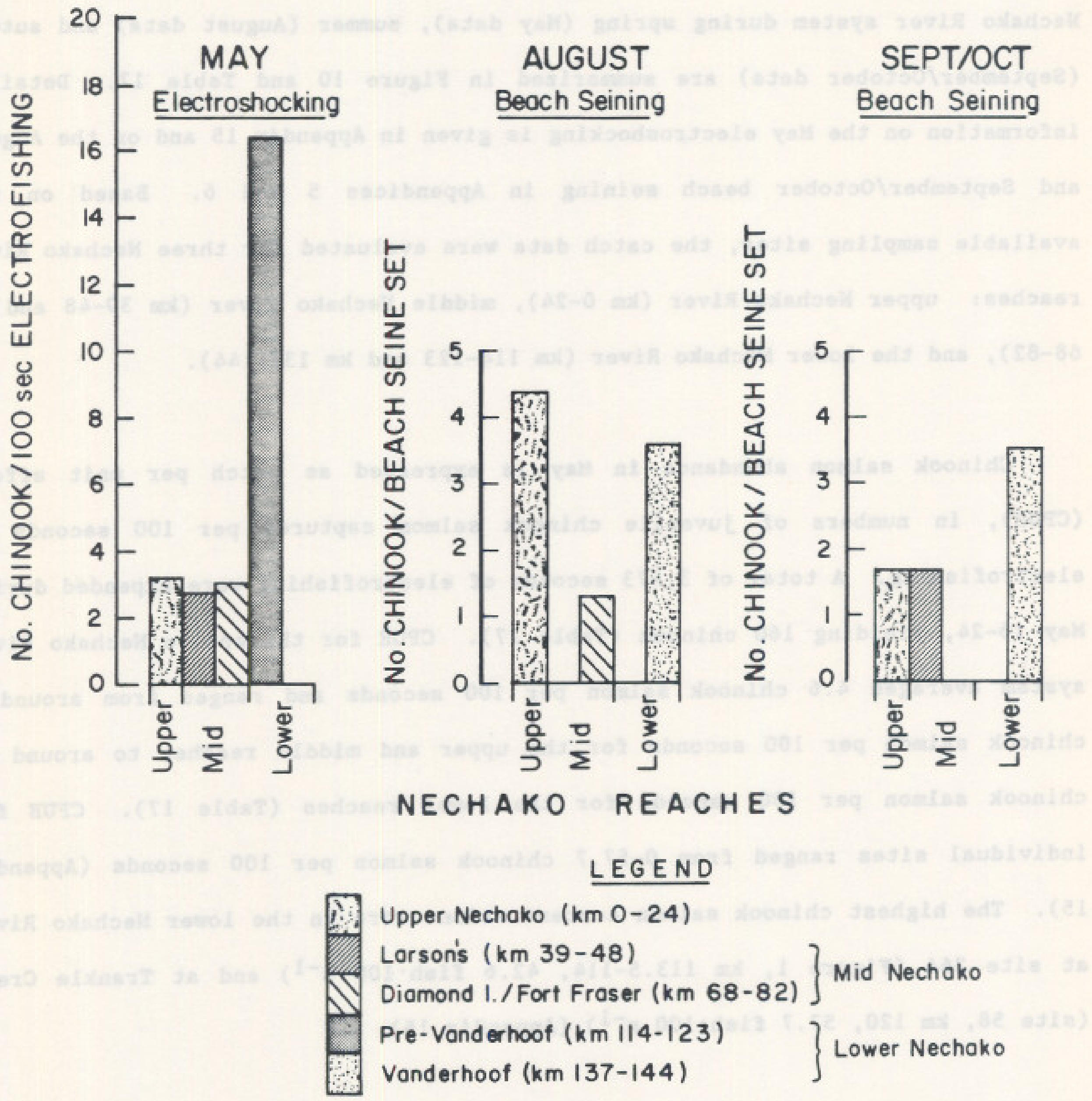

Figure 10 Seasonal Abundance and Distribution of Juvenile Chinook Salmon in the Upper, Middle, and Lower Nechako River Reaches During May, August and September/October 1986

Table 17. Seasonal abundance and distribution of juvenile chinook salmon in the Nechako River system, May-Sep./Oct. 1986.

Location[a] (km below Cheslatta Falls)	May 16:24[b] Electrofishing			August 11-14[c] Beach seining			Sep. 25 - Oct. 1[c] Beach seining		
	Total sec.	Total chinook	Chinook /100 sec	Total sets	Total chinook	Chinook /set	Total sets	Total chinook	Chinook /set
Upper Nechako (km 0-24)	2,156	70	3.2	25	110	4.4	52	87	1.7
Larson's area (km 39-48)	561	15	2.7	-	-	-	11	19	1.7
Diamond I/Fort Fraser (km 68-82)	365	11	3.0	6	8	1.3	-	-	-
Braeside area (km 114-123)	391	64	16.4	-	-	-	-	-	-
Vanderhoof area (km 137-144)	-	-	-	12	40	3.3	22	78	3.5
TOTAL SYSTEM	3,473	160	4.6	43	158	3.7	85	184	2.2

[a] Tributaries electroshocked in May are included in the appropriate Nechako section: Upper Nechako includes Twin, Cutoff, Swanson and Targe Creeks; Diamond Island/Fort Fraser area includes Smith Creek; pre-Vanderhoof area includes Leech, Trankle and Redmond Creeks.

[b] Data extracted from Appendix 15.

[c] Data extracted from Table 18.

3.7 chinook salmon per set for the entire system, and ranged from 1.3 chinook salmon per set in the middle Nechako River to around 4.4 chinook salmon per set and 3.3 chinook salmon per set in the upper and lower reaches respectively (Table 17). The number of juvenile chinook salmon caught per set for individual sites ranged from 0-24 chinook salmon (Table 18), with the highest catches reported at site 2 (Figure 4, km 7, 14.8 chinook salmon per set) and site 27 (Figure 4, km 137, 24.0 chinook salmon per set).

Chinook salmon abundance in September and October, based on beach seine catches, averaged 2.2 chinook salmon per set for the Nechako River upstream of Vanderhoof, and ranged from 1.7 chinook salmon per set for the upper and middle reaches, to 3.5 chinook salmon per set for the lower reaches (Table 17). Mean catch per set for individual sites ranged from 0-11.7 chinook salmon (Table 18), with the highest catches reported at site 32 (Figure 4, km 141.5, 11.7 chinook salmon per set) and site 34 (Figure 4, km 144, 11.0 chinook salmon per set).

Based upon beach seine data, the upper Nechako River chinook salmon juveniles were approximately twice as abundant during summer than in autumn (4.4 chinook salmon per set in August vs 1.7 chinook salmon per set in September/October, Figure 10). In contrast, the abundance of juvenile chinook salmon in the middle and lower Nechako River reaches remained relatively stable during the summer and autumn (Figure 10). This may be the result of a redistribution of juvenile chinook salmon downstream in late summer or disproportional mortality rates in different parts of the river. The seasonal difference in catch rates may also have been influenced by changes in the

Table 18. Beach seine catches of juvenile chinook salmon in the Nechako River, August-October 1986.

Date	Site No. (Fig 4)	Approx. km below Cheslatta Falls	No. sets[a]	Total chinook[a]	Mean No. Chinook/ set[a]
		AUGUST - UPPER NECHAKO RIVER			
Aug. 13	1	2 km	2	0	0
13	2	7 km	5	74	14.8
13	8a	10 km	3	3	1.0
14	11[b]	12.5 km	6	7	1.2
14	13[a]	14 km	6	26	4.3
14	15[b]	17 km	3	0	0
		TOTAL	25	110	x̄=4.4
		AUGUST - DIAMOND ISLAND/FORT FRASER AREA			
Aug. 12	23	78 km	1	0	0
12	24	79 km	3	7	2.3
12	25	82 km	2	1	0.5
		TOTAL	6	8	x̄=1.3
		AUGUST - VANDERHOOF AREA			
Aug. 11	27	137 km	1	24	24.0
11	28	139 km	2	2	1.0
11	29	139.5 km	1	0	0
11	30	140 km	1	1	1.0
11	31	141 km	1	1	1.0
11	32	141.5 km	3	4	1.3
15	33	142 km	3	8	2.7
		TOTAL	12	40	x̄=3.3
	AUGUST TOTAL SYSTEM		43	158	x=3.7
		SEPTEMBER - UPPER NECHAKO RIVER			
Sep. 26	2	7 km	3	0	0
26	3	7.5 km	3	1	0.3
26	4	8 km	3	2	0.7
26	5	9 km	3	1	0.3
26	6	9.2 km	3	0	0
26	7	9.5 km	3	1	0.3
26,28,30	8a	10 km	9	57	6.3
28	8b	10 km	3	5	1.7
28	10	12 km	1	0	0
28	11a	12.5 km	3	0	0

Table 18. (cont'd.)

Date	Site No. (Fig 4)	Approx. km below Cheslatta Falls	No. sets[a]	Total chinook[a]	Mean No. Chinook/ set[a]
28	11b	12.5 km	3	1	0.3
28	12	13 km	3	1	0.3
28	15a	17 km	3	15	5.0
28	15b	17 km	3	1	0.3
28	13a	14 km	3	1	0.3
28	13b	14 km	3	1	0.3
		TOTAL	52	87	$\bar{x}$=1.7
		OCTOBER - LARSON'S AREA			
Oct. 1	17b	45.5 km	3	1	0.3
1	18a	46 km	3	15	5.0
1	18b	46 km	3	0	0
1	17a	45.5 km	2	3	1.5
		TOTAL	11	19	$\bar{x}$=1.7
		SEPTEMBER - VANDERHOOF AREA			
Sep. 25	31	141 km	3	0	0
25	32	141.5 km	3	35	11.7
25	33	142 km	3	16	5.3
29	27a	137 km	3	6	2.0
29	27b	137 km	3	3	1.0
29	28	139 km	3	1	0.3
29	30	140 km	3	6	2.0
29	34	144 km	1	11	11.0
		TOTAL	22	78	$\bar{x}$=3.5
	SEP-OCT TOTAL SYSTEM		85	184	x=2.2

[a] Includes day and evening samples.

efficiency of beach seining as a sampling technique. Larger juvenile salmon may be less susceptible to capture by beach seines due to their increased size and speed or changes in their distribution within the river.

Although the beach seine catch data has been presented as an average catch per set, most chinook salmon were captured at only a few of the sites sampled (Table 18). This confirms the clumped distribution of juvenile chinook salmon during the day that was observed by the divers sampling the microhabitat data. The most productive sites in the upper Nechako River included the upper spawning area at km 7 (site 2), Bert Irvine's (site 8), site 13, and River Ranch (site 15) [all Figure 4]. In the Vanderhoof area, site 27 in August and sites 32 and 34 in September had the highest catch of chinook salmon. It appeared that the middle Nechako River is less used by juvenile chinook salmon for rearing although the beach seining sampling effort was limited in this area. The relative distribution of juvenile chinook salmon within the river was consistent with the snorkeling surveys which indicated that juvenile chinook salmon were most abundant in the upper reaches. No snorkeling, however, was conducted in the Vanderhoof area. In general, the relative distribution of juvenile chinook salmon throughout the river in August and September 1986 appeared similar to that which was observed during the same period in 1985.

During their emergence and early rearing stages in May, chinook salmon abundance as determined by electroshocking, was relatively uniform in the upper and middle Nechako River reaches, but rose dramatically in the lower reaches

(Fig. 10, Table 17). Because the capture methods used in different seasons in 1986 were different (electrofishing and beach seining), a direct comparison of juvenile chinook salmon abundance between spring and summer/fall periods could not be made.

Snorkeling survey, August-October 1986

The August to October snorkeling survey investigated the general habitat conditions used by juvenile chinook salmon during the late summer and autumn.

In August, streamflow in the Nechako River ranged between approximately 170-200 $m^3 \cdot s^{-1}$ (6000-7000 cubic feet per second). At this flow, the river flooded the vegetated margins of the main river channel, and many of the side channels, which were dry at low flows, had enough water in them in early August to provide rearing habitat for juvenile chinook salmon.

The number of juvenile chinook salmon observed in each of the nine sites sampled during the August snorkeling survey (Figure 4, Appendix 4) is shown in Appendix 7. A total of 187 juvenile chinook salmon were counted, and most were sighted in the upper Nechako River above Bert Irvine's (km 10). The area with the highest juvenile chinook salmon abundance was a small side channel at site 2, just above a major spawning area at km 7, where 35 and 67 juvenile chinook salmon were observed during the day and in the evening respectively. At this site, the substrate consisted of cobble and large gravel, and the juvenile salmon were found close to the flooded fringe of vegetation along the margin. The water depth was about 30 cm and the water temperature was 17.7°C.

During the September and October snorkeling survey, streamflow in the Nechako River was about 28 $m^3 \cdot s^{-1}$ (1,000 cfs), which was a significant reduction from the August streamflow. The water had receded from the vegetated margins and little of the shoreline vegetation remained in contact with the water. The water temperatures ranged between 11°C and 12°C and were much cooler than the August temperatures (range 17°C-18°C).

During the September and October snorkeling survey, only 56 juvenile chinook salmon were observed at the four sites sampled (Nos. 9, 14, 16 and 19, Figure 4, Appendices 4 and 8). This is considerably less than the August count of 187 juvenile chinook salmon (Appendix 7) although a quantitative comparison was not possible. As in August, the majority of the juvenile chinook salmon were observed in the upper Nechako River between kilometer 7 (site 2) and kilometer 10 (Bert Irvine's, site 9). The side channel that contained a large number of juvenile chinook salmon in August was dry in September. Only two juvenile chinook salmon were observed in the other locations surveyed (sites 14, 16 and 19, Figure 4).

The snorkeling surveys in August 1986 along the margins of the mainstem and side channels showed that chinook salmon juveniles were most often associated with cover; that is, they were found in the vicinity of log debris, beaver lodges, and often within 30-60 cm of the submerged vegetation border, over clean gravel/cobble substrate. Juvenile chinook salmon were usually observed occupying positions as individuals or in groups of less than six.

At the reduced streamflows in September, vegetation in the water along the river edges was extremely limited, and juvenile chinook salmon were observed in open water over gravel/cobble substrate. It appears that in September, the juvenile salmon preferred areas of moderate velocities since the large marginal areas with slack and slow flowing water did not contain juvenile chinook salmon or any other species of fish.

It should be emphasized that no attempt was made to interpret these snorkeling observations quantitatively and only a general commentary on the relative abundance and distribution of juvenile chinook salmon should be inferred. A quantitative analysis was not attempted since this survey was not intended to provide estimates of juvenile salmon abundance. That would have required a more systematic survey and an assessment of each diver's searching success i.e. the proportion of the actual fish population observed by a given diver.

GROWTH OF JUVENILE CHINOOK SALMON, 1986

The mean lengths and weights of 395 juvenile chinook salmon captured in the Nechako River mainstem during May to October 1986 and 57 juvenile chinook salmon captured in the tributaries during May and August 1986 are summarized in Figure 11 and Table 19. Individual fish sizes are listed by sampling date and site in Appendix 9. Samples were pooled for each month to provide a monthly mean and this was plotted against the mean monthly sampling date calculated as the date on which half the monthly sample was accumulated (Appendix 17). In this study, the captured fish were assumed to be representative of the entire population sampled at a given site.

Juvenile chinook salmon increased steadily in length and weight from 39 mm and 0.5 g in May to 91 mm and 8.7 g by the end of September. They grew consistently over the summer and their increase in length (25.3 mm) in the first half of summer (May to July) was similar to their increase in length (26.8 mm) in the last half of summer (July to September, Figure 11). Their increase in weight, however, was much greater in the last half of summer (2.71 g in the first half of summer versus 5.55 g in the last half of summer, Table 19).

The size of juvenile chinook salmon from the upper and lower reaches was compared over the summer growing season. Upper reaches were defined as the section between Cheslatta Falls and Greer Creek (sampling sites 1-20 and 50-54), and lower reaches as the section between Greer Creek and Vanderhoof (sites 21-36 and 55-59, Fig. 1). The size of the juvenile chinook salmon was similar in the upper and lower mainstem reaches (Fig. 11).

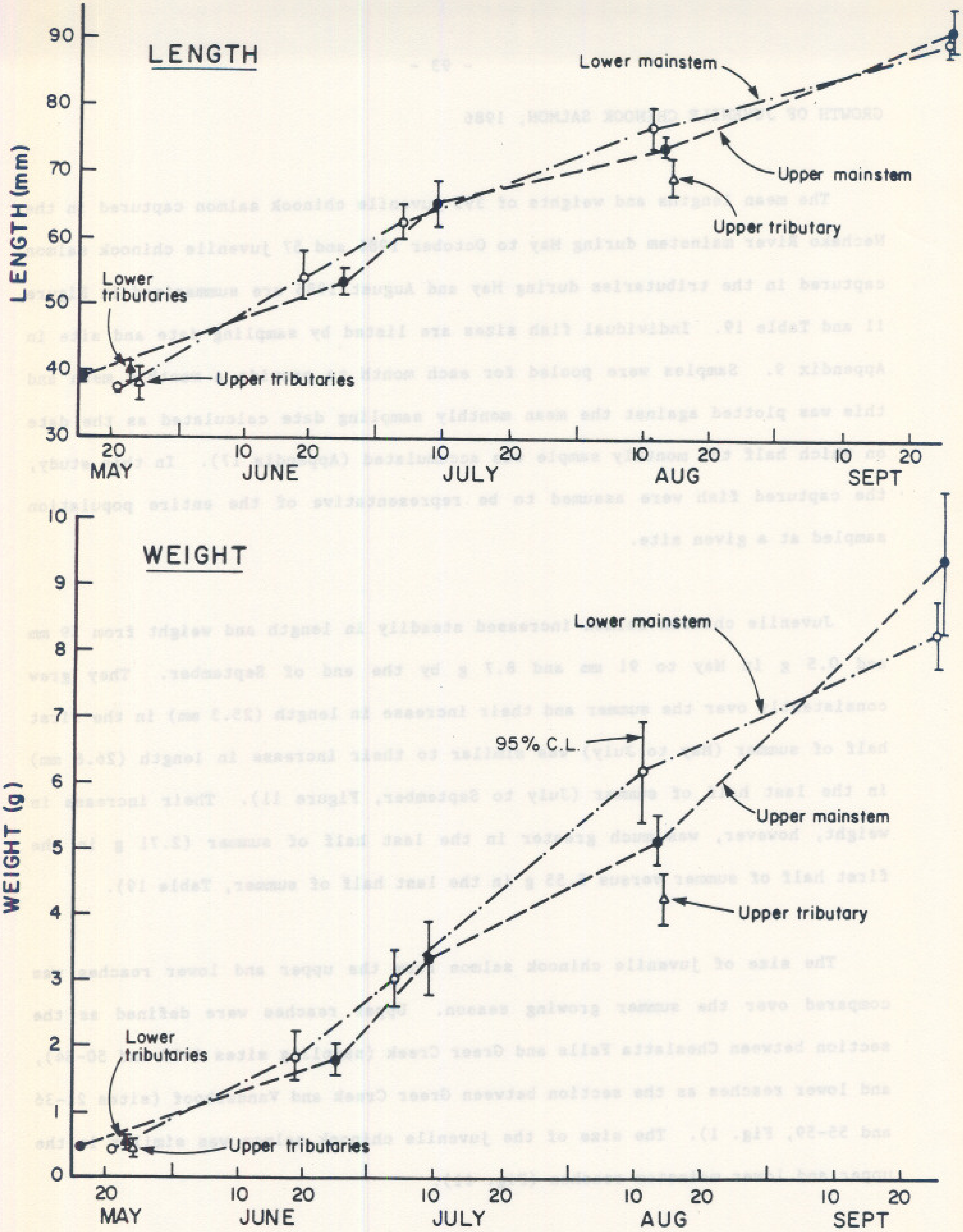

Figure 11 Mean Lengths and Weights of Juvenile Chinook Salmon in the Upper and Lower Nechako River Mainstem During May to Sept., and in Tributaries During May and August, 1986.

Table 19. Mean monthly lengths and weights (± I S.E.) of juvenile chinook salmon in the Nechako River system, 1986 (n = sample size, 95% C.L. given in parenthesis).

NECHAKO RIVER SECTION[a]	MAY (14-24) Length (mm) Mean±IS.E.	(n)	MAY (14-24) Weight (g) Mean±IS.E.	JUNE (12-30) Length (mm) Mean±IS.E.	(n)	JUNE (12-30) Weight (g) Mean±IS.E.	JULY (1-17) Length (mm) Mean±IS.E.	(n)	JULY (1-17) Weight (g) Mean±IS.E.	AUGUST (11-14) Length (mm) Mean±IS.E.	(n)	AUGUST (11-14) Weight (g) Mean±IS.E.	SEPTEMBER (25-Oct) Length (mm) Mean±IS.E.	(n)	SEPTEMBER (25-Oct) Weight (g) Mean±IS.E.
Upper mainstem	39.2±0.37 (38.4-39.9)	(50)	0.48±0.02 (0.43-0.53)	53.7±1.04 (51.6-55.8)	(43)	1.79±0.12 (1.55-2.04)	65.5±1.61 (62.2-68.8)	(31)	3.34±0.28[b] (2.77-3.91)	74.6±0.96 (72.7-76.5)	(55)	5.17±0.19 (4.79-5.56)	92.2±1.81 (88.6-95.9)	(35)	9.39± 0.52 (8.33-10.45)
Upper tributaries	38.2±1.19 (35.7-40.7)	(16)	0.44±0.06 (0.31-0.58)	—			—			69.6± 1.23 (67.0-72.3)	(17)[e]	4.26±0.19 (3.86-4.66)	—		
Upper system	38.9±0.40 (38.1-39.7)	(66)	0.47±0.02 (0.43-0.52)	—			—			73.4± 0.82 (71.8-75.1)	(72)	4.96±0.16 (4.64-5.27)	—		
Lower mainstem	37.5±0.35 (36.8-38.2)	(26)	0.41±0.02 (0.38-0.44)	54.3±1.59 (50.9-57.6)	(19)	1.84±0.18 (1.46-2.22)	62.7±1.30 (60.0-65.3)	(40)	3.04±0.21[c] (2.62-3.46)	77.1±1.56 (73.9-80.2)	(42)	6.19±0.38 (5.42-6.96)	89.8±0.90 (88.0-91.6)	(54)	8.28±0.26 (7.77-8.79)
Lower tributaries	40.1±0.86 (38.3-41.9)	(24)	0.55±0.05 (0.44-0.66)	—			—			—			—		
Lower system	38.7±0.49 (37.8-39.7)	(50)	0.48±0.03 (0.42-0.53)	—			—			—			—		
Total mainstem	38.6±0.29 (38.0-39.2)	(76)	0.46±0.02 (0.42-0.49)	53.9±0.87 (52.1-55.6)	(62)	1.81±0.10 (1.61-2.01)	63.9±1.02 (61.9-65.9)	(71)	3.17±0.17[d] (2.83-3.51)	75.7±0.87 (73.9-77.4)	(97)	5.61±0.20 (5.21-6.01)	90.7±0.90 (89.0-92.5)	(89)	8.72±0.26 (8.20-9.24)
Total tributaries	39.4±0.71 (37.9-40.8)	(40)	0.51±0.04 (0.43-0.59)	—			—			69.6± 1.23 (67.0-72.3)	(17)[e]	4.26±0.19 (3.86-4.66)	—		
Total system	38.8±0.31 (38.2-39.5)	(116)	0.48±0.02 (0.44-0.51)	—			—			74.8±0.79 (73.2-76.3)	(114)	5.41±0.18 (5.04-5.77)	—		

[a] Upper and lower sections are defined as Cheslatta Falls to Greer Creek, and Greer Creek to Vanderhoof respectively.
[b] n = 33
[c] n = 41
[d] n = 74
[e] Swanson Creek only.

The general similarity in juvenile chinook salmon sizes observed in the upper and lower sections of the Nechako River over summer suggests that they may be experiencing similar rearing conditions in both parts of the river. Likewise, chinook salmon fry sampled in the mainstem and tributaries during May had nearly identical sizes (Fig. 11). A few much larger fry were found in the tributaries that were not found in the mainstem in spring. In contrast, juvenile chinook salmon sampled during August in Swanson Creek were significantly smaller compared to the overall size of juveniles in the mainstem (69.6 mm, 4.26 g in Swanson Creek vs 75.7 mm, 5.61 g in mainstem, $p < 0.05$, Table 19). The lower condition of the juvenile chinook salmon in Swanson Creek suggest a possibly poorer rearing environment there by mid-summer (note the temperature differences in the tributaries, p. 78, Table 16).

Comparison of the mean lengths and weights of juvenile chinook salmon captured in the Nechako River mainstem during May and September of 1980, 1981 and 1986, indicated differences in condition of the juvenile salmon at the end of the summers of the three years. This may indicate the juvenile chinook salmon experienced different rearing conditions in the three years.

YEAR	MAY	SEPTEMBER	CONDITION[1]	SOURCE
1980	36 mm	81 mm, 7.2 g (Aug)	1.35×10^{-5}	Russell et al. (1983)
1981	39 mm, 0.4 g	93 mm, 11.6 g	1.44×10^{-5}	Russell et al. (1983)
1986	39 mm, 0.5 g	91 mm, 8.7 g	1.15×10^{-5}	Present report

[1] Condition = $\frac{w\ (g)}{l^3\ (mm)}$

It should be noted that the above size comparison between years is affected by annual differences in sampling site location, sample size, and method of fish capture (eg., use of inclined plane traps, fyke nets and beach seines in 1981 vs use of electroshocker, spearfishing and beach seines in 1986). The observation in 1980 that seasonal growth rates of juvenile chinook salmon were considerably lower in the tributaries compared to the mainstem (Russell et al. 1983) could not be confirmed in 1986 due to insufficient data from the tributaries. However, the Swanson Creek data from 1986 (Table 19) suggest the same pattern may still be present. It appears that juvenile chinook salmon in the tributaries are initially larger than those in the mainstem in spring, but that by August this size advantage is reversed. This appears to be especially so for those tributaries in the lower reaches (Table 19), however, because these tributaries frequently go dry by late summer it was not possible to collect sufficient data to form a definite conclusion.

SUMMARY

1. The primary aim of the 1985 and 1986 studies on juvenile chinook salmon in the Nechako River system was to evaluate the rearing environment necessary for the juveniles of the population. The seasonal distribution of juvenile chinook salmon between Cheslatta Falls and Vanderhoof, and seasonal growth rates were also examined.

2. The behavior and habitat use of recently emerged chinook salmon fry in May changed dramatically 10 to 14 days after emergence, usually in June. The newly emerged fry formed schools very close to shore in shallow, sheltered, margin areas with little or no current, and dispersed into the gravel if disturbed. Older juveniles were aggressive, competitive, and maintained irregular territories in deeper, faster water.

3. The microhabitat study investigated several major microhabitat criteria for juvenile chinook salmon in the Nechako River system: fish's distance from shore, water depth and water velocity, substrate size, light intensity, and the presence or absence of wood accumulations. Changes in microhabitat conditions used by the juvenile chinook salmon were examined in relation to the season, their size, and their location in the river.

4. Microhabitat characteristics used by fish changed significantly over the summer. During May, juvenile chinook salmon utilized river margins, shallow, low velocity areas which were on the average 2 m from shore, 29 cm

deep and had a flow of 9 $cm \cdot s^{-1}$ at the fish's position. During June to September, the juvenile salmon utilized deeper and faster flowing areas offshore which were on the average 4-7 m from shore, 59-62 cm deep and had a flow of 21-29 $cm \cdot s^{-1}$ at the fish's position. Therefore in spring, juvenile chinook salmon selected microhabitats which were roughly 2-3 times closer to shore, with half the depth and a third the velocity compared to microhabitats used by older juveniles later in the season. Gravel was the most frequently utilized substrate during all summer months.

5. In the presence of lateral and vertical velocity gradients, juvenile chinook salmon selected a lower velocity position which suggests a behavioral adaptation to water currents.

6. Microhabitat conditions selected by the juvenile chinook salmon changed with their increasing size and these changes paralleled the seasonal trend described in points 2 and 4 above.

7. Microhabitat characteristics selected by juvenile salmon of the same size varied between reaches of the Nechako River. Specific features in the river, such as log jams and beaver lodges, provided preferred areas for the juvenile salmon during the day and these were heavily utilized especially in late June and early July before the higher cooling streamflows of late July occurred. The presence of these structures plays a strong role in determining the distribution of juvenile chinook salmon during the day irrespective of fish size and may have an influence on the number of chinook salmon smolts which the Nechako River can ultimately produce.

8. Frequent close association of juvenile chinook salmon with log jams, beaver lodges and areas with submerged vegetation during the day suggests that protection from predators may be critical for the survival of young salmon in the Nechako River and that any fixed accumulation of wood in the river may serve as a preferred daytime habitat.

9. The day and night distribution of juvenile chinook salmon in the Nechako River determined from beach seining, snorkeling and quadrat sampling suggested that they redistribute along the shallow river margins at night (approximately 2 m from shore, 12 cm deep) to feed and reform into loose schools next to wood accumulations for safety during the day.

The Provincial Fisheries Branch data on the lateral distribution of juvenile chinook salmon in the Nechako River showed that 72% of all juveniles were observed next to shore (0 up to 4 m from shore), 25% were in nearshore areas (2 m up to 8 m from shore) and 3% were in the mid-channel areas. Therefore, juvenile chinook salmon in the Nechako River show a definite preference for the river margins.

10. Study of the lateral distribution of juvenile chinook salmon relative to the shore showed that during May to July 1986, juvenile chinook salmon were approximately 18 times more abundant along the river margins (0-4 m from shore) compared to the mid-channel (20+ m from shore), while other species were approximately 24 times more abundant in the mid-channel compared to the margins. This inverse relationship in habitat use by juvenile chinook

salmon and other species may serve to reduce interspecific competition. More importantly, it may indicate critical areas of juvenile chinook salmon habitat which must be protected if chinook salmon production is to be maintained in the Nechako River.

11. Juvenile chinook salmon made limited use of deep water in the Nechako River canyons during the 1985 and 1986 observations. No chinook salmon were captured in minnow traps in September 1985, and less than 300 juvenile chinook salmon were observed at less than 10 m depth in June 1986.

12. Of the seven Nechako River tributaries examined in September 1985, only the original Nechako River channel upstream of Cheslatta Falls and Twin Creek had running water with some chinook salmon juveniles observed in Twin Creek. However in other years, Nechako River tributaries have continued flowing after mid-summer and may provide potential juvenile chinook salmon rearing habitat.

13. Beach seining during August to October 1986 showed that juvenile chinook salmon in the upper Nechako River were approximately twice as abundant during summer than in autumn. In comparison, the number of juvenile chinook salmon in the middle and lower Nechako River reaches remained relatively stable during the summer and autumn, suggesting a seasonal redistribution of juvenile chinook salmon along the Nechako River.

14. The available beach seining, snorkeling and electroshocking data suggest

that during 1986, some sections of the Nechako River, because they had very few or no juvenile chinook salmon were unused, while other sections which had an abundance of juvenile chinook salmon were heavily used for rearing.

15. A single sampling technique such as beach seining or snorkeling during day or night, proved ineffective for estimating juvenile chinook salmon abundance or for documenting temporal changes in fish abundance or distribution in the Nechako River.

16. Juvenile chinook salmon grew steadily in length and weight from 39 mm and 0.5 g in May to 91 mm and 8.7 g by the end of September 1986. The size of juvenile chinook salmon was similar in both the upper and lower Nechako River, but there was some indication that fish in the tributaries were larger than those in the main river early in the year and smaller than those in the main river later in the year (Swanson Creek, August 1986 data). Tributaries therefore appear to be initially a beneficial habitat but because they frequently dry up, by mid-summer they can become a detrimental environment.

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Appendix 1. Juvenile chinook salmon survey in the Nechako River, August - September, 1985.

Date 1985	Site (Fig. 1)	Distance from Cheslatta Falls (km)	Survey reach and comments	Survey method	Survey effort	No. Fish Observed Ck[a]	Other[b]
Aug 23	1	0	SW side of Cheslatta Falls plunge pool	Electrofishing	275 sec	0	3 RBT, 1 SC
	2	1.2 - 1.5	Canyon just downstream from log jam/ riffle	Electrofishing	96 sec (site 1)	0	1 SU
					358 sec (site 2)	0	1 SC
	3	4.9 - 5.1	SE shore of island	Electrofishing	679 sec	1	3 DA, 14 SC, 1 MW
	4	7.2 - 7.8	NE side of island	Snorkeling	2 h 26 min	14	20 MW
	5	7.8 - 8.2	West river bank	Snorkeling	10 min	1	1 RBT, many MW, many SU, several redds
	6	8.2 - 8.9	West river bank	Snorkeling	7 min	0	1 RBT, many MW, many SU
	7	8.9 - 10.1	Includes mid-channel	Snorkeling	15 min	16	71 SU, 3 RBT, 90 MW
	8	10.1 - 11.2	Mid-channel	Snorkeling	8 min	0	15 MW
	9	9.2 - 10.1	Just upstream of Bert Irvine's E side; most fish upstream of small trib.	Snorkeling	28 min	11	4 RBT, 7 MW, 10 SU
Aug 24	4*[c]	4.9 - 5.1	Mid-channel to north side of channel; finish at Bert Irvine's	Snorkeling & Electrofishing	37 min (dive)	0	75 SU, 207 MW, 5 redds
Aug 25	9*	9.2 - 10.1	Upper 1/3	Snorkeling	12 min	5	3 RBT, 4 MW, 3 SU
			Opposite Burt Creek's mouth middle 1/3	Snorkeling	N/A[d]	19	0
			North side	Snorkeling	N/A	0	0

Appendix 1. (cont'd).

Date 1985	Site (Fig. 1)	Distance from Cheslatta Falls (km)	Survey reach and comments	Survey method	Survey effort	No. Fish Observed Ck[a]	Other[b]
Aug 27	10	12.7 - 13.1	-	Snorkeling	20 min	0	
	11	13.2 - 13.6	West side of river	Snorkeling	20 min	0	
	12*	13.5 - 13.7	East side	Snorkeling	10 min	1	
	13*	13.7 - 14.3	East side	Snorkeling	1 h 50 min	18	2 RBT
	14*	14.3 - 14.7	East side	Snorkeling	50 min	8	
	15*	16.8 - 18.6	No times recorded	-	-	-	
Aug 28	15*	16.8 - 18.6	West side	Snorkeling	2 h 38 min	29	
	16*	19.3 - 19.8	No times recorded	-	-	-	
	17*	20.7 - 21.2	No times recorded	-	-	-	
	18	21.2 - 21.7	No fish seen	-	-	0	
Aug 29	19*	21.7 - 24.0	-	Snorkeling	3 h 05 min	15	
	20*	26.6	No times recorded	-	-	-	
Sep 10	21*	39.3 - 40.0	-	Snorkeling	1 h 20 min.	9	
	22*	40.0 - 42.0	-	Snorkeling	1 h 30 min.	1	
	23	42.4 - 44.0	No fish seen, no times recorded	-		0	
Sep 11	24*	44.7 - 47.5	-	Snorkeling	2 h 41 min	12	7 RBT
	25*	47.5 - 47.7	-	Snorkeling	2 h 20 min	0	7 RBT
	26	48.0 - 49.5	No chinook observed, no times recorded	Snorkeling	-	0	

Appendix 1. (cont'd).

Date 1985	Site (Fig. 1)	Distance from Cheslatta Falls (km)	Survey reach and comments	Survey method	Survey effort	No. Fish Observed Ck[a]	Other[b]
Sep 13	27*	52.7 - 54.8	-	Snorkeling	2 h 20 min	11	127 RBT
	28	65.5 - 66.7	-	Snorkeling	30 min	0	11 RBT
	29	62.0 - 62.8	-	Snorkeling	30 min	0	2 RBT
	30*	59.5 - 60.7	-	Snorkeling	1 h 05 min	3	19 RBT
Sep 14	31*	68.7 - 71.0	-	Snorkeling	1 h 30 min	17	11 RBT, 1 DV
	32*	74.0 - 76.0	-	Snorkeling	1 h 10 min	3	8 RBT, 1 DV
	33*	76.5 - 78.0	-	Snorkeling	1 h 30 min	1	13 RBT
	34*	89.3 - 89.7	-	Snorkeling	15 min	1	
Sep 15	35*	111.3 - 114.0	-	Snorkeling	1 hr 05 min	15	3 RBT
	36*	138.6 - 139.3	-	Snorkeling	1 hr 15 min	19	9 RBT, 2 SQ.

[a] Ck - chinook juveniles sighted but not captured during the survey.

[b] CO - coho, DA - dace, DV - Dolly Varden, MW - mountain whitefish, RBT - rainbow trout, RSH - redsided shiner, SC - sculpin, SQ - squafish, SU - sucker.

[c] * Indicates where microhabitat parameters were measured.

[d] Not available.

Appendix 2. Juvenile chinook salmon sampling sites, Nechako River, 1986.[a]

Site No.	Distance from Cheslatta Falls (km)	Site Length (km)	Description
Seined and electrofished	0	-	At Cheslatta Falls
Beach seine #1	7.2 - 7.4	0.2	North bank, 1985 study
Beach seine #2	7.5 - 7.6	0.1	North bank, 1985 study
Beach seine #3	9.9 - 10.0	0.1	Just west of Twin Cr. mouth, 1985 study
Beach seine #4	10.1 - 10.2	0.1	Just east of Twin Cr. mouth, 1985 study
1	0	-	At Cheslatta Falls, (SW side of Cheslatta Falls plunge pool
1A	5.8 - 6.2	0.4	North bank
2	1.2 - 1.5	0.3	North Bank, canyon just downstream from log/jam/riffle
3	4.9 - 5.1	0.2	Off island (along SE shore of island)
4	7.2 - 7.8	0.6	Center river
5	7.8 - 8.2	0.4	North bank
6	8.2 - 8.9	0.7	North bank
7	8.9 - 10.1	0.2	North bank, opposite Twin Cr.
8	10.1 - 11.2	1.1	North bank
9	9.2 - 10.1	0.9	South bank, upstream of Twin Cr.
10	12.7 - 13.1	0.4	North bank
11	13.2 - 13.6	0.4	North bank
12	13.5 - 13.7	0.2	South bank
13	13.7 - 14.3	0.6	South bank
14	14.3 - 14.7	0.4	South bank

Appendix 2. (cont'd)

Site No.	Distance from Cheslatta Falls (km)	Site Length (km)	Description
15	16.8 - 18.6	1.8	North bank, mouth of Cutoff Cr
15a	19.3	At fallen tree	South bank, just u/s of Swanson Cr.
15b	19.8	At beaver lodge	North bank behind island, between Swanson and Targe Creeks
15c	19.0	At fallen tree	South bank, u/s of Swansen Cr.
15d	20.3	At beaver lodge	North bank, just u/s of Targe Creek
16	19.3 - 19.8	0.5	South bank
17	20.7 - 21.2	0.5	East bank, at Targe Creek
18	21.2 - 21.7	0.5	South bank
19	21.7 - 24.0	2.3	N/S banks
19A	25.2 - 25.6	0.4	South bank
20	26.6	-	River transect, shore to island
20A	26.2	Beaver lodge	North bank
20B	28.0	Log jam	North bank
21	39.3 - 40.0	0.7	West bank
21D	32.2 - 34.2	2.0	West bank, opposite Greer Cr.
22	40.0 - 42.0	2.0	E/W banks
23	42.4 - 44.0	1.6	E/W banks
24	44.7 - 47.5	2.8	West & North banks, at Hill Larson's Island
25	47.5 - 47.7	0.2	North bank, below Hill Larson's
26	48.0 - 49.5	1.5	North bank
27	52.7 - 54.8	2.1	N/S banks

Appendix 2. (cont'd)

Site No.	Distance from Cheslatta Falls (km)	Site Length (km)	Description
28	65.5 - 66.7	1.2	West bank
28A	67.4 - 68.4	1.0	West bank
29	62.0 - 62.8	0.8	South bank
30	59.5 - 60.7	1.2	West bank
31	68.7 - 71.0	2.3	West bank of Diamond Island
32	74.0 - 76.0	2.0	W/E banks
33	76.5 - 78.0	1.5	Braided section
34	89.3 - 89.7	0.4	East bank
35	113.5 - 114.0	0.5	West bank, mid-island
36	138.6 - 139.3	0.7	South bank, u/s of Vanderhoof (Bird Sanctuary)
50	9.7	0.5	Twin Creek
51	17.1	0.5	Cutoff Creek
52	19.5	0.5	Swanson Creek
53	21.0	-	Targe Creek
54	32.4	0.5	Greer Cr. u/s from mouth
55	57.8	0.5	Tahultzu Creek, u/s from mouth
56	71.0	0.5	Smith Creek, u/s from mouth
57	114.0	1.5	Leech Creek, u/s from mouth
58	120.0	0.4	Trankle Creek, u/s from mouth
59	122.3	0.4	Redmond Creek, u/s from mouth
TOTAL		43.1	

[a] Note, the accuracy of site location and length is approx. ± 100 m, as read from field maps.

Appendix 3. Juvenile chinook salmon sampling program, Nechako River, 1985.

Date 1985	Location (Fig. 1)	Method of capture	Period of capture	Area sampled	No. fish captured CK[a]	Other[b]
Sep 17	Approx. 1 km below Cheslatta Falls, deep canyon	3 Gee minnow traps	approx. 24 hr/trap	-	0	0
Sep 18	Nechako R. immediately above Cheslatta Falls	Pole seining	45 sec 90 sec	50m x 1.5m 50m x 1.5m	0 0	0 1 SU
		Electro-fishing	205 sec	120m	0	0
Sep 18	Greer Cr., 32.4 km below Cheslatta Falls	Pole Seining	40 sec	40m x 1.5m	0	2 CO, 1 MW, 2 SU
		Electro-fishing	322 sec	100m	0	1 MW
Sep 18	Nechako R. approx. 7 km below Cheslatta Falls	Beach Seine #1	-	150m x 15m	0	3 MW, 1 SC
Sep 18	Nechako R. approx. 7.5 km below Cheslatta Falls	Beach Seine #2	-	100m x 15m	0	41 MW, 1 RBT
Sep 18	Nechako R. approx. 10 km below Cheslatta Falls near Twin Creek outlet	Beach Seine #3	-	110m x 15m	2	1 DA, 3 SC, 52 RSH, 5 SQ, 9 SU
Sep 18	Nechako R. approx. 10.2 km below Cheslatta Falls near Twin Creek outlet	Beach seine #4	-	60m x 15m	6	23 MW, 3 RBT, 2 CO, 6 SC, 2 SU, 2 DA, 1 RSH

[a] CK - chinook juvenile.

[b] CO - coho, DA - dace, MW - mountain whitefish, RBT - rainbow trout, RSH - redsided shiner, SC - sculpin, Sq - squafish, SU - sucker.

Appendix 4. Beach seining and snorkeling survey sites in the Nechako River, August-October 1986.[a]

Site No. (Fig. 4)	Approx. km below Cheslatta Falls	Beach seining		Snorkeling	
		Aug.	Sep./Oct.	Aug.	Sep./Oct.
UPPER NECHAKO RIVER					
1	2 km	X		X	
2	7 km	X	X	X	
3	7.5 km		X		
4	8 km		X		
5	9 km		X		
6	9.2 km		X		
7	9.5 km		X		
8a,b[b]	10 km	X	X	X	
9	7-11 km				X
10	12 km		X		
11a,b[b]	12.5 km	X	X	X	
12	13 km		X		
13a,b[b]	14 km	X	X	X	
14	12-15 km				X
15a,b[b]	17 km	X	X	X	
16	17-18 km				X
LARSON'S					
17a,b[b]	45.5 km		X		
18a,b[b]	46 km		X		
19	45-47 km				X
DIAMOND ISLAND/FORT FRASER					
20	68 km			X	
21	69 km			X	
22	76 km			X	
23	78 km	X			
24	79 km	X			
25	82 km	X			
VANDERHOOF AREA					
26	136.5 km	X			
27a,b[b]	137 km	X	X		
28	139 km	X	X		
29	139.5 km	X			
30	140 km	X	X		
31	141 km	X	X		
32	141.5 km	X	X		
33	142 km		X		
34	144 km		X		

[a] "X" indicates that sampling occurred at that site.
[b] Opposite river banks were sampled; a = right bank, b = left bank.

Appendix 5. Beach seine catches of juvenile chinook salmon in the Nechako River, August 1986.

Date	Time[a,b] (h)	Site No. (Fig. 4)	Approx. km below Cheslatta Falls	Set No.	No. chinook	Water T(°C)	Comments
			AUGUST - UPPER NECHAKO RIVER				
Aug. 13	1515	1	2 km	1	0	17.5	
				2	0		
Aug. 13	1615	2	7 km	1	23	17.7	Day/night samples
				2	6		
Aug. 13	2045*	2	7 km	1	18		
				2	14		
				3	13		
Aug. 13	2145*	8b	10 km	1	3	17.1	
				2	0		
				3	0		
Aug. 14	1400	11b	12.5 km	1	0	-	Day/night samples
				2	0		
				3	0		
Aug. 14	2140*	11b	12.5 km	1	2	16.4	
				2	4		
				3	1		
Aug. 14	1530	13a	14 km	1	0	18.2	Day/night samples
				2	0		
				3	18		
Aug. 14	2020*	13a	14 km	1	0	16.8	
				2	2		
				3	6		
Aug. 14	1700	15b	17 km	1	0		
				2	0		
				3	0		
			TOTAL	25	110		

Appendix 5. (cont'd.)

Date	Time[a,b] (h)	Site No. (Fig. 4)	Approx. km below Cheslatta Falls	Set No.	No. chinook	Water T(°C)	Comments
			AUGUST - DIAMOND ISLAND/FORT FRASER AREA				
Aug. 12	2050*	23	78 km	1	0	19.5	Boat seine
Aug. 12	2100*	24	79 km	1	0	-	Boat seine
				2	1		Boat seine
				3	6		Boat seine
Aug. 12	2200*	25	82 km	1	1		
				2	0		
			TOTAL	6	8		
			AUGUST - VANDERHOOF AREA				
Aug. 11	2000*	27	137 km	1	24	19.1	
Aug. 11	2100*	28	139 km	1	2	19.2	
				2	0		
Aug. 11	2130*	29	139.5 km	1	0	18.9	Boat seine
Aug. 11	2200*	30	140 km	1	1	-	
Aug. 11	2230*	31	141 km	1	1	-	
Aug. 11	2300*	32	141.5 km	1	0	18.9	
				2	2		
				3	2		
Aug. 15	1420	33	142 km	1	7	17.6	
				2	1		
				3	0		
			TOTAL	12	40		

[a] Time refers to start of seining.

[b] In August, sunset occurred at about 21:00; asterisk indicates an evening sample (around sunset or later).

Appendix 6. Beach seine catches of juvenile chinook salmon in the Nechako River, September-October 1986.

Date	Time[a,b] (h)	Site No. (Fig. 4)	Approx. km below Cheslatta Falls	Set No.	No. chinook	Water T(°C)	Comments
			SEPTEMBER - UPPER NECHAKO RIVER				
Sep. 26	1420	2	7 km	1	0	12.4	
				2	0		
				3	0		
Sep. 26	1500	3	7.5 km	1	0	12.4	
				2	1		
				3	0		
Sep. 26	1530	4	8 km	1	0	-	
				2	1		
				3	1		
Sep. 26	1620	5	9 km	1	0	-	
				2	1		
				3	0		
Sep. 26	1700	6	9.2 km	1	0	12.3	Boat seine
				2	0		
				3	0		
Sep. 26	1815*	7	9.5 km	1	0	-	
				2	1		
				3	0		
Sep. 26	1845*	8a	10 km	1	6	-	
				2	12		
				3	21		
Sep. 28	1140	8a	10 km	1	4	11.8	Day/night samples
				2	0		
				3	12		
Sep. 30	1950*	8a	10 km	1	0		Day/night samples
				2	1		
				3	1		
Sep. 28	1210	8b	10 km	1	5	-	
				2	0		
				3	0		
Sep. 28	1345	10	12 km	1	0	-	Boat seine
Sep. 28	1406	11a	12.5 km	1	0	-	
				2	0		
				3	0		

Appendix 6. (cont'd.)

Date	Time[a,b] (h)	Site No. (Fig. 4)	Approx. km below Cheslatta Falls	Set No.	No. chinook	Water T(°C)	Comments
			SEPTEMBER - UPPER NECHAKO RIVER (cont'd.)				
Sep. 28	1435	11b	12.5 km	1	0	-	
				2	1		
				3	0		
Sep. 28	1520	12	13 km	1	1	-	
				2	0		
				3	0		
Sep. 28	1620	15a	17 km	1	0	-	
				2	2		
				3	13		
Sep. 28	1700	15b	17 km	1	0	-	
				2	0		
				3	1		
Sep. 28	1745	13a	14 km	1	0	-	
				2	0		
				3	1		
Sep. 28	1810*	13b	14 km	1	1	-	
				2	0		
				3	0		
			TOTAL	52	87		
			OCTOBER - LARSON'S AREA				
Oct. 1	1655	17b	45.5 km	1	0	-	
				2	0		
				3	1		
Oct. 1	1720	18a	46 km	1	11	-	
				2	4		
				3	0		
Oct. 1	1753	18b	46 km	1	0	10.6	
				2	0		
				3	0		
Oct. 1	1830*	17a	45.5 km	1	3	-	Boat seine
				2	0		
			TOTAL	11	19		

Appendix 6. (cont'd.)

Date	Time[a,b] (h)	Site No. (Fig. 4)	Approx. km below Cheslatta Falls	Set No.	No. chinook	Water T(°C)	Comments
			SEPTEMBER - VANDERHOOF AREA				
Sep. 25	1615	31	141 km	1	0	11.5	
				2	0		
				3	0		
Sep. 25	1645	32	141.5 km	1	4	11.6	
				2	24		
				3	7		
Sep. 25	1800*	33	142 km	1	4	11.4	
				2	4		
				3	8		
Sep. 29	1515	27a	137 km	1	2	11.1	
				2	3		
				3	1		
Sep. 29	1540	27b	137 km	1	2	-	
				2	1		
				3	0		
Sep. 29	1645	28	139 km	1	0	-	
				2	0		
				3	1		
Sep. 29	1715	30	140 km	1	6	-	
				2	0		
				3	0		
Sep. 29	1815*	34	144 km	1	11		Boat seine
			TOTAL	22	78		

[a] Time refers to start of seining.
[b] In September sunset occurred at about 1900 h; asterisk indicates an evening sample (around sunset or later).

Appendix 7. Snorkeling observations of juvenile chinook salmon in the Nechako River, August 1986.

Site No.	Date	Time (h)	Approx. km below Cheslatta Falls	Site description[a]	No. chinook observed[a]	Comments[a]
1	Aug. 13	14:45-15:00	2 km	Upper Nechako River, side channel with substrate of bedrock, cobble and boulders.	8	Chinook in brush pile.
2	Aug. 13	15:50-16:12	7 km	Upper spawning site; snorkeled in side channel and margin of main channel along island; large gravel/cobble substrate; this channel was dewatered in Sep; water depth 30 cm, water T = 17.7°C.	27 (L.H. margin) 8 (R.H. margin)	Chinook associated with weeds along margins.
2	Aug. 13	20:10-20:30	7 km	Upper spawning site, snorkeled in side channel.	67	Chinook over large gravel and associated with sedge margin.
8	Aug. 13	17:45-17:55	10 km	Twin Cr. to Bert's boat launch, water T = 17.9°C; snorkeled both R.B. and L.B. along island.	5 (R.B.) 4 (L.B.)	Some chinook in brush debris along vegetated margin, others at gravel interface with willow, sedge border in 10-20 cm of water.
8	Aug. 13	21:15-21:30	10 km	Twin Cr. to Bert's boat launch; repeat of daytime snorkeling; water T = 17.1°C.	18 (R.B.) 2 (L.B.)	
11	Aug. 14	13:15-13:45	12 km	Approx. 2 km d/s of Bert Irvine's; snorkeled along L.B. of side channel and along both banks of main channel.	2 (side channel)	Chinook in side channel, - low velocity, silty, cobbles, pond weed and willows; also 4 RBT.
					2 (L.B. main channel)	Chinook in main channel - abundant debris, beaver lodge, gravel/grassy margin; also 7 trout and 1 adult chinook.
					0 (R.B. main channel)	

Appendix 7. (cont'd.)

Site No.	Date	Time (h)	Approx. km below Cheslatta Falls	Site description[a]	No. chinook observed[a]	Comments[a]
11	Aug. 14	21:20-21:40	12 km	Repeat of daytime dive at this site (see above); snorkeled with lights.	5 (L.B. of side channel)	Chinook at gravel/weed margin.
					1 (L.B. of main channel)	Also 3 RBT.
					9 (R.B. of main channel)	Chinook in slow water with weeds at gravel/weed margin, in dead water.
13	Aug. 14	15:20-15:40	14 km	Cutoff launch site to Cutoff Channel.	2 (R.B.)	Chinook (R.B.) in debris and at gravel/weed margin; also 6 RBT.
					1 (L.B.)	Chinook (L.B.) in log jam near bank with grassy substrate; also 4 RBT.
13	Aug. 14	20:00-20:20	14 km	Cutoff launch site to Cutoff Channel.	7 (R.B.)	Chinook (R.B.) in log jam and in pocket of gravel in weeds; also 11 RBT.
					1 (L.B.)	Chinook (L.B.) in log jam near bank; also 5 RBT.
15	Aug. 14	16:20-16:50	17 km	Mouth of Cutoff Cr. d/s to end of island (River Ranch); snorkeled along both sides of side channel and L.B. of main channel.	0	Also 2 RBT.
20	Aug. 12	13:00	68 km	Diamond Island, south end; L.H. margin behind island.	4	Chinook behind debris in fast water and over gravel with no cover.
		13:30		Beaver dam d/s of site 7.	1	
21	Aug. 12	13:50-14:25	69 km	Diamond Island, north end; undercut grassy bank and gravel substrate.	13	Chinook observed along shoreline in moderate velocities and among submerged branches.
22	Aug. 12	16:30	76 km	Approx. 5 km d/s of Diamond Island; low water velocity, silty with abundant cover, swam both margins.	0	
					187	

[a] Abbreviations: d/s - downstream, L.H. - left hand, R.H. - right hand, L.B. - left bank, R.B. - right bank, RBT - rainbow trout.

Appendix 8. Snorkeling observations of juvenile chinook salmon in the Nechako River, September/October 1986.

Date	Time (h)	Site No. (Fig. 4)	Approx. km below Cheslatta Falls	Site description[a]	No. chinook observed[a] Margin[b]	Offshore	Comments[a] Section	Bank	Other Species
Sep. 30	12:45-15:40	9	km 7-11	Upper spawning area (km 7.3) to km 10.6 d/s of Bert Irvines.	8	3	km 7.3-8.0	R.B.	Many MW.
					1	14	km 8.0-9.0	R.B.	
					8	14	km 9.0-10.0	L.B./R.B.	
					0	4	km 9.5-10.6	L.B.	
					2	1	km 10.6-11.1	L.B.	
Sep. 30	15:50-17:30	14	km 12-15	u/s and d/s of Cutoff launch site.	1	0	km 12-12.7	L.B.	4 RBT, MW
					0	0	km 12.7-13.1	L.B./R.B.	
					0	0	km 13.1-13.7	R.B./L.B.	2 RBT
					0	0	km 13.7-14.6	R.B./L.B.	4 RBT, 1 DV
Sep. 30	17:40-17:50	16	km 17-18	River Ranch	0	0	km 17.2-17.5	R.B.	MW
Oct. 1	14:10-15:30	19	km 45-47	Larson's	1	0	km 44.7-45.0	L.B.	MW,
					0	0	km 45.0-46.0	L.B./R.B.	SU,
					0	0	km 46.0-47.6	R.B./L.B.	SQ.
					21	36			

[a] Abbreviations: d/s - downstream, u/s - upstream, R.B. - right bank, L.B. - left bank, MW - mountain whitefish, RBT - rainbow trout, DV - Dolly Varden, SU - sucker, SQ - squawfish.

[b] Marginal areas generally <3 m from shore. Note that 3 m is more correctly the width of the margin at night. During daytime the margin is <10m. Consequently most of the fish identified as "offshore" in this table are occupying the river margins.

Appendix 9. Length and weight of juvenile chinook salmon in the Nechako River system, 1985-1986.

Date	Site (Fig. 1)	Length (mm)	Weight (g)	Capture method[a]
SEP. 1985				
18	9	92	8.5	BS
18	9	85	6.9	BS
18	50	76	5.0	BS
18	50	83	6.4	BS
18	50	96	9.8	BS
18	50	108	15.0	BS
18	50	95	10.0	BS
18	50	86	7.3	BS
MAY 1986				
14	9	40	0.5	EL
14	13	45	0.8	EL
14	13	43	0.6	EL
14	13	39	0.5	EL
16	9	38	0.5	EL
16	9	37	0.4	EL
16	9	39	0.6	EL
16	9	37	0.3	EL
16	9	37	0.5	EL
16	9	42	0.6	EL
16	9	38	0.4	EL
16	9	38	0.3	EL
16	9	39	0.4	EL
16	9	35	0.3	EL
16	9	38	0.4	EL
16	9	39	0.4	EL
16	9	38	0.4	EL
16	9	43	0.7	EL
16	9	40	0.5	EL
16	9	37	0.3	EL
16	9	39	0.5	EL
16	9	40	0.6	EL
16	9	42	0.8	EL
16	9	38	0.3	EL
16	9	35	0.3	EL
16	9	38	0.4	EL
16	9	41	0.6	EL
16	9	44	0.9	EL
16	9	44	1.0	EL
16	9	38	0.5	EL
16	9	37	0.3	EL
18	13	37	0.4	EL
18	13	42	0.5	EL
18	13	38	0.3	EL
18	15	41	0.5	EL
18	15	41	0.5	EL
18	15	39	0.5	EL
18	15	43	0.8	EL
MAY 1986 (cont'd)				
18	15	35	0.3	EL
19	53	40	0.5	EL
19	19	36	0.3	EL
19	19	42	0.6	EL
19	19	41	0.4	EL
19	19	39	0.4	EL
19	19	39	0.4	EL
19	19	40	0.5	EL
19	21	38	0.4	EL
19	21	39	0.5	EL
19	21	38	0.5	EL
19	21	36	0.4	EL
19	21	38	0.4	EL
20	50	39	0.5	EL
20	50	39	0.4	EL
20	50	38	0.4	EL
20	50	37	0.4	EL
20	50	37	0.4	EL
21	24	37	0.3	EL
21	24	39	0.5	EL
21	24	39	0.5	EL
21	24	38	0.5	EL
21	24	38	0.5	EL
21	25	39	0.3	EL
21	25	38	0.5	EL
21	25	41	0.5	EL
21	25	39	0.4	EL
21	25	39	0.4	EL
23	31	35	0.3	EL
23	31	37	0.4	EL
23	31	38	0.4	EL
23	31	36	0.3	EL
23	31	36	0.3	EL
23	31	32	0.3	EL
23	56	39	0.4	EL
23	56	38	0.4	EL
23	56	37	0.4	EL
23	56	40	0.4	EL
23	56	48	0.8	EL
23	35	37	0.4	EL
23	35	38	0.5	EL
23	35	37	0.4	EL
23	35	37	0.4	EL
23	35	35	0.3	EL
23	57	41	0.4	EL
23	57	50	1.2	EL
23	57	39	0.4	EL
23	57	48	1.1	EL

Appendix 9. (cont'd)

Date	Site (Fig. 1)	Length (mm)	Weight (g)	Capture method[a]
MAY 1986 (cont'd)				
23	57	34	0.2	EL
23	57	43	0.6	EL
23	57	37	0.4	EL
23	57	44	0.8	EL
23	57	39	0.4	EL
23	58	38	0.5	EL
23	58	38	0.4	EL
23	58	36	0.4	EL
23	58	36	0.3	EL
23	58	34	0.3	EL
23	59	43	0.9	EL
23	59	43	0.8	EL
23	59	39	0.6	EL
23	59	39	0.5	EL
23	59	40	0.7	EL
24	4	38	0.4	EL
24	4	35	0.3	EL
24	4	37	0.4	EL
24	4	34	0.3	EL
24	4	43	0.7	EL
24	52	32	0.1	EL
24	52	37	0.4	EL
24	52	38	0.4	EL
24	52	38	0.4	EL
24	52	39	0.4	EL
24	51	39	0.4	EL
24	51	33	0.3	EL
24	51	51	1.2	EL
24	51	44	0.8	EL
24	51	30	0.1	EL
JUNE 1986				
12	13	48	1.1	SN
12	13	65	2.1	SN
13	13	42	0.7	SN
13	13	46	0.8	SN
14	9	50	1.7	SN
14	9	57	2.3	SN
14	9	49	1.2	SN
14	13	47	1.4	SN
14	13	47	1.3	SN
15	19	56	1.9	SN
15	19	48	1.1	SN
15	19	51	1.6	SN
16	19	43	0.8	SN
16	19A	43	0.8	SN
16	19	43	0.6	SN
16	19	49	1.3	SN
16	20A	52	1.6	SN
JUNE 1986 (cont'd)				
16	20B	53	1.6	SN
17	24	62	2.7	SN
17	24	50	1.5	SN
17	24	42	0.8	SN
18	31	53	1.5	SN
18	31	55	1.9	SN
18	31	46	1.0	SN
18	31	56	1.9	SN
19	35	54	1.7	SN
19	35	49	1.3	SN
19	35	55	1.7	SN
19	35	48	1.2	SN
19	35	52	1.4	SN
19	35	65	3.2	SN
19	35	50	1.4	SN
25	4	65	3.9	SN
25	4	65	3.1	SN
25	4	66	3.3	SN
25	4	67	3.9	SN
25	9	49	1.4	SN
25	9	58	2.2	SN
25	9	47	1.0	SN
25	9	59	2.2	SN
26	4	62	2.8	SN
26	9	55	1.6	SN
26	9	53	1.6	SN
26	9	60	2.5	SN
26	9	49	1.4	SN
27	3	59	2.2	SN
27	9	61	2.4	SN
27	9	54	2.0	SN
27	13	49	1.4	SN
27	13	54	1.5	SN
27	15A	54	1.7	SN
27	15A	56	1.9	SN
28	20B	51	1.3	SN
28	15A	58	2.1	SN
29	15C	51	1.4	SN
29	15D	63	2.7	SN
29	15D	55	1.7	SN
29	21D	47	1.2	SN
29	21D	69	3.9	SN
30	25	57	1.9	SN
30	25	62	2.6	SN
30	25	59	2.2	SN
JULY 1986				
1	21	61	2.8	SN
1	21	55	1.9	SN

Appendix 9. (cont'd)

Date	Site (Fig. 1)	Length (mm)	Weight (g)	Capture method[a]
JULY 1986 (cont'd)				
1	23	48	1.1	SN
2	28	60	2.6	SN
2	28	62	2.4	SN
2	30	58	2.1	SN
3	35	73	4.4	SN
3	35	71	4.3	SN
3	35	69	3.9	SN
3	35	66	3.9	SN
3	35	60	2.4	SN
3	35	51	1.5	SN
3	35	54	1.9	SN
3	35	61	2.8	SN
3	35	69	3.8	SN
4	36	49	1.1	SN
4	36	63	2.6	SN
4	36	54	1.6	SN
4	36	52	1.4	SN
4	36	50	1.2	SN
4	36	59	2.6	SN
4	36	60	2.5	SN
4	36	57	2.1	SN
4	36	57	2.6	SN
4	36	62	3.1	SN
4	36	63	3.0	SN
7	3	73	4.3	SN
7	3	75	4.8	SN
7	3	62	3.1	SN
7	3	-	2.5	SN
7	3	83	7.7	SN
7	3	70	3.7	SN
7	3	60	2.3	SN
8	9	57	2.1	SN
8	9	60	2.3	SN
8	9	58	1.9	SN
8	9	-	2.9	SN
8	9	68	3.6	SN
8	9	68	4.4	SN
8	13	58	2.1	SN
9	9	51	1.3	SN
9	9	58	2.2	SN
9	9	65	3.3	SN
9	9	72	4.3	SN
9	9	70	3.8	SN
9	13	65	3.4	SN
10	21	84	7.3	SN
10	21	64	3.0	SN
11	15D	61	2.6	SN
11	19	63	2.7	SN

Date	Site (Fig. 1)	Length (mm)	Weight (g)	Capture method[a]
JULY 1986 (cont'd)				
13	25	65	3.1	SN
13	25	72	4.6	SN
13	25	65	2.8	SN
13	25	66	4.2	SN
13	25	54	1.7	SN
13	25	68	3.5	SN
14	36	68	3.8	SN
14	36	76	3.5	SN
14	36	-	4.1	SN
14	36	69	3.8	SN
14	36	80	6.6	SN
14	36	64	3.3	SN
15	36	67	3.9	SN
15	3	75	4.9	SN
15	3	69	2.7	SN
15	3	71	3.6	SN
15	3	49	1.2	SN
16	9	51	1.7	SN
16	9	62	2.5	SN
16	9	74	4.7	SN
17	13	65	3.0	SN
17	13	65	3.0	SN
17	13	62	2.6	SN
17	13	90	8.9	SN
AUG. 1986 (Fig. 4)				
11	27	94	10.1	BS
11	27	72	6.1	BS
11	27	73	4.8	BS
11	27	69	5.2	BS
11	27	71	4.2	BS
11	27	87	8.5	BS
11	27	76	5.4	BS
11	27	73	5.0	BS
11	27	85	7.6	BS
11	27	73	4.3	BS
11	27	71	4.7	BS
11	27	90	9.1	BS
11	27	72	4.5	BS
11	27	85	7.7	BS
11	27	79	6.8	BS
11	27	73	5.7	BS
11	27	72	4.4	BS
11	27	70	4.7	BS
11	27	79	6.5	BS
11	27	71	4.2	BS
11	27	77	5.8	BS
11	27	73	5.7	BS

Appendix 9. (cont'd)

Date	Site (Fig. 4)	Length (mm)	Weight (g)	Capture method[a]	Date	Site (Fig. 4)	Length (mm)	Weight (g)	Capture method[a]
AUG. 1986 (cont'd)					AUG. 1986 (cont'd)				
11	27	79	6.5	BS	13	2	64	3.5	BS
11	27	77	5.4	BS	14	13	84	6.7	BS
11	27	72	4.7	EL	14	13	81	6.6	BS
11	27	56	2.2	EL	14	13	73	4.6	BS
11	28	69	4.1	BS	14	13	77	5.4	BS
11	28	76	5.6	BS	14	13	76	5.4	BS
11	30	86	7.9	BS	14	13	74	4.2	BS
11	31	78	6.6	BS	14	13	79	5.8	BS
11	32	75	5.6	BS	14	13	79	5.3	BS
11	32	72	5.0	BS	14	13	71	4.4	BS
11	32	94	9.8	BS	14	13	74	4.8	BS
11	32	84	6.8	BS	14	13	84	6.9	BS
12	24	60	2.4	BS	14	13	81	6.3	BS
12	24	81	5.8	BS	14	13	78	5.4	BS
12	24	96	10.1	BS	14	13	73	4.4	BS
12	24	84	6.5	BS	14	13	71	4.0	BS
12	24	109	16.5	BS	14	13	81	7.3	BS
12	24	76	5.6	BS	14	13	75	4.1	BS
12	24	68	3.6	BS	14	13	69	3.7	BS
12	25	59	8.2	BS	14	13	78	5.6	BS
13	2	67	4.1	BS	14	13	76	5.4	BS
13	2	66	3.9	BS	14	13	82	6.4	BS
13	2	66	3.8	BS	14	13	89	8.6	BS
13	2	71	4.7	BS	14	13	80	5.9	BS
13	2	82	6.6	BS	14	13	80	5.5	BS
13	2	68	4.2	BS	14	13	78	5.4	BS
13	2	77	6.0	BS	14	13	67	3.8	BS
13	2	64	4.2	BS	14	Swanson Ck.	71	3.9	EL
13	2	68	4.5	BS	14	Swanson Ck.	71	4.6	EL
13	2	72	5.0	BS	14	Swanson Ck.	66	3.9	EL
13	2	70	4.7	BS	14	Swanson Ck.	71	4.2	EL
13	2	75	5.2	BS	14	Swanson Ck.	75	4.9	EL
13	2	64	3.6	BS	14	Swanson Ck.	72	5.1	EL
13	2	85	7.2	BS	14	Swanson Ck.	72	4.2	EL
13	2	100	11.4	BS	14	Swanson Ck.	61	3.3	EL
13	2	75	5.4	BS	14	Swanson Ck.	74	5.4	EL
13	2	70	4.1	BS	14	Swanson Ck.	68	3.9	EL
13	2	68	3.9	BS	14	Swanson Ck.	65	2.7	EL
13	2	72	4.3	BS	14	Swanson Ck.	65	3.1	EL
13	2	71	4.4	BS	14	Swanson Ck.	80	5.5	EL
13	2	69	4.3	BS	14	Swanson Ck.	74	4.7	EL
13	2	67	3.7	BS	14	Swanson Ck.	62	4.0	EL
13	2	83	6.1	BS	14	Swanson Ck.	65	4.4	EL
13	2	71	4.3	BS	14	Swanson Ck.	72	4.6	EL
13	2	73	4.9	BS	15	33	83	5.9	BS
13	2	72	5.1	BS	15	33	69	4.2	BS
13	2	64	3.4	BS	15	33	75	4.9	BS
13	2	80	6.1	BS	15	33	75	5.3	BS

Appendix 9. (cont'd)

Date	Site (Fig. 4)	Length (mm)	Weight (g)	Capture method[a]
AUG 1986 (cont'd)				
15	33	65	3.8	BS
15	33	67	4.1	BS
15	33	48	1.8	BS
SEP 1986				
25	32	81	5.6	BS
25	32	88	7.9	BS
25	32	92	11.2	BS
25	32	90	9.0	BS
25	32	94	10.5	BS
25	32	101	13.0	BS
25	32	95	10.3	BS
25	32	87	8.0	BS
25	32	87	8.3	BS
25	32	77	5.6	BS
25	32	100	9.7	BS
25	32	96	10.4	BS
25	32	95	9.4	BS
25	32	82	6.2	BS
25	32	83	6.8	BS
25	32	92	8.6	BS
25	32	87	7.4	BS
25	32	95	11.4	BS
25	32	92	9.0	BS
25	32	87	7.5	BS
25	32	103	12.0	BS
25	32	88	7.7	BS
25	32	76	5.1	BS
25	32	88	6.8	BS
25	32	91	8.3	BS
25	32	86	6.8	BS
25	32	87	7.4	BS
25	32	81	6.0	BS
25	32	78	5.5	BS
25	32	81	5.8	BS
25	32	78	5.3	BS
25	32	89	7.2	BS
25	32	93	9.4	BS
25	32	86	6.6	BS
25	32	90	8.0	BS
26	3	75	4.8	BS
26	3	97	10.0	BS
26	3	86	7.6	BS
26	5	90	8.0	BS
26	7	103	12.3	BS
26	8a	99	11.0	BS
26	8a	97	10.4	BS
26	8a	99	10.8	BS

Date	Site (Fig. 4)	Length (mm)	Weight (g)	Capture method[a]
SEP 1986 (cont'd)				
26	8[a]	99	11.3	BS
26	8[a]	105	12.4	BS
26	8[a]	96	9.6	BS
26	8[a]	99	11.9	BS
26	8[a]	99	11.9	BS
26	8[a]	78	5.5	BS
26	8[a]	89	9.0	BS
26	8[a]	96	10.6	BS
26	8[a]	91	8.8	BS
26	8[a]	88	8.4	BS
26	8[a]	69	3.8	BS
26	8[a]	83	5.9	BS
26	8[a]	103	13.3	BS
26	8[a]	114	18.0	BS
26	8[a]	88	7.4	BS
26	8[a]	96	10.7	BS
26	8[a]	96	9.9	BS
26	8[a]	104	13.5	BS
26	8[a]	94	9.5	BS
26	8[a]	96	9.9	BS
26	8[a]	99	11.0	BS
26	8[a]	98	10.7	BS
26	8[a]	86	7.4	BS
26	8[a]	93	9.6	BS
26	8[a]	86	6.6	BS
26	8[a]	72	4.1	BS
26	8[a]	65	3.0	BS
OCT 1986				
1	17,18	96	9.0	BS
1	17,18	95	9.2	BS
1	17,18	91	8.7	BS
1	17,18	98	10.2	BS
1	17,18	91	7.7	BS
1	17,18	85	7.6	BS
1	17,18	96	9.8	BS
1	17,18	105	11.5	BS
1	17,18	90	7.8	BS
1	17,18	91	7.8	BS
1	17,18	91	8.1	BS
1	17,18	92	8.4	BS
1	17,18	81	5.6	BS
1	17,18	100	11.5	BS
1	17,18	85	6.7	BS
1	17,18	94	9.2	BS
1	17,18	90	7.8	BS
1	17,18	86	7.3	BS
1	17,18	95	9.6	BS

[a] Capture method: BS - beach seining, EL - electroshocking, SN - snorkeling.

Appendix 10: Sampling dates and sample sizes for each site monitored each month for the length and weight of juvenile chinook salmon in the Nechako River system, May - October 1986[a].

Date	Site No.	No Fish		Date	Site No.	No. Fish
	UPPER MAINSTEM		MAY		LOWER MAINSTEM	
May 24	4	5		May 19	21	5
May 14,16	9	28		May 21	24	5
May 14,18	13	6		May 21	25	5
May 18	15	5		May 23	31	6
May 19	19	6		May 23	35	5
Total	-	50		Total	-	26
	UPPER TRIBUTARIES				LOWER TRIBUTARIES	
May 20	50 Twin Cr.	5		May 23	56 Smith Cr.	5
May 24	51 Cutoff Cr.	5		May 23	57 Leech Cr.	9
May 24	52 Swanson Cr.	5		May 23	58 Trankle Cr.	5
May 19	53 Targe Cr.	1		May 23	59 Redmond Cr.	5
Total	-	16		Total	-	24
	UPPER MAINSTEM		JUNE		LOWER MAINSTEM	
June 27	3	1		June 29	21D	2
June 25,26	4	5		June 17	24	3
June 14,25, 26,27	9	13		June 30	25	3
June 12,13 14,27	13	8		June 18	31	4
June 27,28	15A	3		June 19	35	7
June 29	15C	1		Total	-	19
June 29	15D	2				
June 15,16	19	6				
June 16	19A	1				
June 16	20A	1				
June 16,28	20B	2				
Total	-	43				
	UPPER MAINSTEM		JULY		LOWER MAINSTEM	
July 7,15	3	11		July 1,10	21	4
July 8,9,16	9	14		July 1	23	1
July 8,9,17	13	6		July 13	25	6
July 11	15D	1		July 2	28	2
July 11	19	1		July 2	30	1
Total	-	33		July 3	35	9
				July 4,14	36	18
				Total	-	41

Appendix 10: (cont'd.)

AUGUST

UPPER MAINSTEM

Date	Site No.	No Fish
Aug. 13	2	29
Aug. 14	13	26
Total		55

LOWER MAINSTEM

Date	Site No.	No. Fish
Aug. 11	27	26
11	28	2
11	30	1
11	31	1
11	32	4
11	24	7
11	25	1
Total		42

AUGUST - UPPER TRIBUTARY

Date	Site No.	No Fish
Aug. 14	52 Swanson Cr.	17

SEPT-OCT

UPPER MAINSTEM

Date	Site No.	No Fish
Sep. 26	3	3
26	5	1
26	7	1
26	8[a]	30
Total		35

LOWER MAINSTEM

Date	Site No.	No. Fish
Sep. 25	32	35
Oct. 1	17,18	19
Total		54

[a] Upper mainstem is between Cheslatta Falls and Greer Creek; lower mainstem is between Greer Creek and Vanderhoof.

Appendix 11. Microhabitat data for juvenile chinook salmon in the Nechako River, August-September, 1985.

						Water Velocity ($cm \cdot s^{-1}$)			Light (x1000 lux)		
Date	Site	Fish No.	Water Temp. (°C)	Water depth (cm)	Fish ht. above bottom (cm)	Fish's position	30 cm lateral to fish's position	30 cm vertical to fish's position	At fish position	Shore distance (m)	Dominant substrate[a]
Aug. 24	4	1	–	48	4	25	31	77	60.9	10	GR
Aug. 24	4	2	–	50	5	44	43	68	60.9	8	GR
Aug. 24	4	3	–	35	3	31	36	61	76.0	2	SA
Aug. 24	4	4	–	39	4	31	38	67	81.9	5	GR
Aug. 24	4	5	–	44	4	26	48	64	72.5	6	GR
Aug. 24	4	6	–	45	1	33	22	82	51.2	5	BO
Aug. 24	4	7	–	46	2	37	44	82	85.3	5	GR
Aug. 24	4	8	–	53	2	23	15	65	59.3	8	GR
Aug. 24	4	9	–	48	2	27	34	71	76.1	10	GR
Aug. 24	4	10	–	47	3	32	46	68	77.8	12	GR
Aug. 24	4	11	–	56	3	18	33	68	63.5	12	GR
Aug. 24	4	12	–	36	10	7	26	35	55.2	7	GR
Aug. 24	4	13	–	60	3	24	42	69	51.2	13	GR
Aug. 24	4	14	–	38	4	21	36	42	48.9	7	GR
Aug. 24	4	15	–	38	5	20	24	42	48.6	6	GR
Aug. 24	4	16	–	44	6	32	41	54	50.0	7	GR
Aug. 24	4	17	–	46	8	22	36	63	42.0	8	CO
Aug. 24	4	18	–	48	7	25	35	50	44.0	4	GR
Aug. 24	4	19	–	56	4	30	36	65	38.5	5	GR
Aug. 24	4	20	–	55	4	27	52	62	36.9	6	GR
Aug. 25	9	1	–	86	20	19	19	24	10.3	6	CO
Aug. 25	9	2	–	74	22	15	18	20	15.3	8	GR
Aug. 25	9	3	–	66	20	25	28	33	21.9	8	CO
Aug. 25	9	4	–	59	10	26	30	33	23.8	6	CO
Aug. 25	9	5	–	56	8	30	27	43	64.0	7	GR
Aug. 25	9	6	–	62	3	34	18	51	22.3	8	BO

Appendix 11. cont'd

Date	Site	Fish No.	Water Temp. (°C)	Water depth (cm)	Fish ht. above bottom (cm)	Water Velocity (cm·s[-1]): Fish's position	Water Velocity (cm·s[-1]): 30 cm lateral to fish's position	Water Velocity (cm·s[-1]): 30 cm vertical to fish's position	Light (x1000 lux): At fish position	Shore distance (m)	Dominant substrate[a]
Aug. 25	9	7	-	49	8	27	33	45	26.9	7	GR
Aug. 25	9	8	-	62	6	24	30	52	60.5	10	GR
Aug. 25	9	9	-	53	4	20	30	72	76.7	9	GR
Aug. 25	9	10	-	63	5	23	29	78	71.6	12	GR
Aug. 25	9	11	-	33	6	17	9	29	16.3	5	GR
Aug. 25	9	12	-	57	4	20	42	75	12.8	5	GR
Aug. 25	9	13	-	45	7	31	47	45	67.1	4	GR
Aug. 25	9	14	-	55	5	16	40	82	15.9	3	SA
Aug. 25	9	15	-	55	4	38	58	73	12.6	4	SA
Aug. 25	9	16	-	49	8	36	49	65	16.1	4	GR
Aug. 25	9	17	-	54	6	40	40	61	73.8	6	GR
Aug. 25	9	18	-	60	25	34	34	39	58.6	3	GR
Aug. 25	9	19	-	69	2	27	48	75	12.2	4	GR
Aug. 25	9	20	-	56	4	31	40	75	7.3	4	GR
Aug. 27	12	1	-	83	16	33	32	38	46.4	8	GR
Aug. 27	13	2	-	81	15	29	34	52	41.9	4	CO
Aug. 27	13	3	-	88	17	30	40	15	4.5	4	GR
Aug. 27	13	4	-	79	18	10	17	22	48.1	3	GR
Aug. 27	13	5	-	95	15	18	31	45	53.3	4	GR
Aug. 27	13	6	-	88	8	19	25	37	55.4	3	GR
Aug. 27	13	7	-	96	3	20	26	58	40.5	3	GR
Aug. 27	13	8	-	80	25	30	36	41	31.6	4	GR
Aug. 27	14	9	-	87	12	24	25	32	28.4	4	GR
Aug. 27	14	10	-	67	3	26	25	48	40.9	15	GR
Aug. 27	15	11	-	57	2	28	42	86	-	-	GR

Appendix 11. cont'd

Date	Site	Fish No.	Water Temp. (°C)	Water depth (cm)	Fish ht. above bottom (cm)	Water Velocity ($cm \cdot s^{-1}$) Fish's position	30 cm lateral to fish's position	30 cm vertical to fish's position	Light (x1000 lux) At fish position	Shore distance (m)	Dominant substrate[a]
Aug. 28	15	1	-	39	9	22	28	28	104.9	2	SA
Aug. 28	15	2	-	41	3	26	33	46	54.3	3	GR
Aug. 28	15	3	-	69	15	29	33	17	22.0	3	GR
Aug. 28	15	4	-	79	20	30	38	26	49.7	6	GR
Aug. 28	15	5	-	97	60	36	50	-	48.2	4	GR
Aug. 28	15	6	-	87	25	22	29	16	44.0	3	GR
Aug. 28	16	7	-	48	6	15	49	63	22.4	-	SA
Aug. 28	17	8	-	39	5	26	32	44	16.1	-	SA
Aug. 28	17	9	-	50	20	39	37	37	18.5	-	CO
Aug. 29	19	1	-	67	21	37	40	49	-	15	BO
Aug. 29	19	2	-	68	13	26	33	44	-	14	CO
Aug. 29	19	3	-	89	65	31	27	41	-	16	CO
Aug. 29	19	4	-	93	50	42	38	-	21.3	3	GR
Aug. 29	19	5	-	82	8	36	38	52	31.7	3	GR
Aug. 29	19	6	-	51	5	27	47	25	4.3	1	GR
Aug. 29	20	7	-	79	3	31	41	79	-	3	GR
Aug. 29	20	8	-	46	6	31	46	52	-	3	GR
Sep. 10	21	1	-	59	5	21	35	50	54.3	4	GR
Sep. 10	21	2	-	54	4	24	29	48	60.2	4	GR
Sep. 10	21	3	-	63	18	28	43	48	51.6	4	GR
Sep. 10	21	4	-	50	8	25	27	37	50.9	3	GR
Sep. 10	22	5	-	84	4	29	33	59	57.1	4	GR
Sep. 11	24	1	-	50	4	30	32	52	49.0	40	GR
Sep. 11	24	2	-	77	8	27	48	55	48.9	4	CO

Appendix 11. cont'd

Date	Site	Fish No.	Water Temp. (°C)	Water depth (cm)	Fish ht. above bottom (cm)	Water Velocity (cm·s^{-1}): Fish's position	Water Velocity (cm·s^{-1}): 30 cm lateral to fish's position	Water Velocity (cm·s^{-1}): 30 cm vertical to fish's position	Light (x1000 lux): At fish position	Shore distance (m)	Dominant substrate[a]
Sep. 11	24	3	-	79	8	35	36	62	37.5	4	CO
Sep. 11	24	4	-	55	20	38	42	-	17.1	3	CO
Sep. 11	24	5	-	62	6	21	28	50	32.3	3	CO
Sep. 11	24	6	-	72	35	43	40	50	32.5	4	CO
Sep. 11	24	7	-	52	23	26	32	39	41.0	4	CO
Sep. 11	25	8	-	68	18	44	44	54	36.0	5	GR
Sep. 11	25	9	-	69	10	30	43	53	32.4	6	GR
Sep. 11	25	10	-	65	8	27	33	52	23.4	5	GR
Sep. 11	25	11	-	63	12	40	44	57	22.1	6	CO
Sep. 11	25	12	-	60	16	32	46	61	20.4	6	GR
Sep. 13	27	1	-	72	35	48	47	50	20.0	6	BO
Sep. 13	27	2	-	61	18	35	42	51	29.8	9	CO
Sep. 13	27	3	-	64	22	26	38	25	30.6	7	CO
Sep. 13	27	4	-	64	6	34	27	49	24.4	11	CO
Sep. 13	30	5	-	95	5	20	29	72	4.0	6	CO
Sep. 13	30	6	-	49	15	32	15	43	-	11	CO
Sep. 13	30	7	-	56	9	33	33	40	-	6	GR
Sep. 14	31	1	-	69	15	34	36	60	17.7	4	GR
Sep. 14	31	2	-	83	10	36	36	50	20.3	30	CO
Sep. 14	31	3	-	48	8	48	45	59	16.3	35	GR
Sep. 14	31	4	-	75	20	34	36	44	15.8	4	GR
Sep. 14	31	5	-	79	15	38	38	53	19.4	4	CO
Sep. 14	32	6	-	46	4	35	23	67	9.9	9	GR
Sep. 14	33	7	-	63	13	20	32	49	18.2	15	GR
Sep. 14	33	8	-	68	10	25	31	45	24.6	15	GR

Appendix 11. cont'd

						Water Velocity (cm·s^{-1})			Light (x1000 lux)		
Date	Site	Fish No.	Water Temp. (°C)	Water depth (cm)	Fish ht. above bottom (cm)	Fish's position	30 cm lateral to fish's position	30 cm vertical to fish's position	At fish position	Shore distance (m)	Dominant substrate[a]
Sep. 14	33	9	-	75	3	32	32	71	16.3	13	GR
Sep. 14	34	10	-	60	29	22	16	38	7.0	4	SI
Sep. 15	35	1	-	81	25	38	40	34	-	5	CO
Sep. 15	35	2	-	90	50	33	39	16	-	6	CO
Sep. 15	35	3	-	51	9	37	31	52	-	10	GR
Sep. 15	35	4	-	62	6	26	30	50	-	9	CO
Sep. 15	35	5	-	62	14	39	51	73	-	15	CO
Sep. 15	35	6	-	66	12	36	30	56	-	15	CO
Sep. 15	36	7	-	46	6	32	38	58	-	8	CO
Sep. 15	36	8	-	51	6	26	34	56	-	8	GR
Sep. 15	36	9	-	52	8	33	46	65	-	14	GR

[a] BO - boulder, CO - cobble, GR - gravel, SA - sand, SI - silt.

Appendix 12. Microhabitat data for juvenile chinook salmon in the Nechako River, May-July 1986.

Date	Site	Fish No.	L (mm)	Wt. (g)	Water temp. (°C)	Water depth (cm)	Fish ht. above bottom (cm)	Velocity ($cm \cdot s^{-1}$): Fish's Position	Velocity ($cm \cdot s^{-1}$): 30 cm lateral to fish's position	Velocity ($cm \cdot s^{-1}$): 30 cm vertical to fish's position	Velocity ($cm \cdot s^{-1}$): 15 cm above bottom at fish's position	Velocity ($cm \cdot s^{-1}$): 6/10 of the depth	Light (x 1000 lux): At fish's position	Shore distance (m)	Dominant substrate[a]
May 14	9	1	40	0.5	6.8	(fish #1 not holding a position)									
May 14	13	2	45	0.8	6.8	-	-		-	-	-	-	-	-	-
May 14	13	3	43	0.6											
May 14	13	4	39	0.5	(fish #3-4 in a school of 30)										
May 16	9	5	38	0.5	6.2	28	5	9.4	12.6	19.0	-	13.3	12.8	3.0	GR
May 16	9	6	37	0.4											
May 16	9	7	39	0.6	(fish #5-8 from 55 sec electrofishing)										
May 16	9	8	37	0.3											
May 16	9	9	37	0.5	6.2	28	8	9.4	20.7	15.1	-	11.5	31.3	2.0	GR
May 16	9	10	42	0.6											
May 16	9	11	38	0.4	(fish #9-12 from 30 sec electrofishing)										
May 16	9	12	38	0.3											
May 16	9	13	39	0.4	6.0	25	9	8.0	9.1	13.3	-	8.4	24.3	2.0	GR
May 16	9	14	35	0.3											
May 16	9	15	38	0.4											
May 16	9	16	39	0.4	(fish #13-17 from 30 sec electrofishing)										
May 16	9	17	38	0.4											
May 16	9	18	43	0.7	6.5	30	10	8.0	8.7	15.1	-	10.8	18.4	2.0	GR
May 16	9	19	40	0.5											
May 16	9	20	37	0.3	(fish #18-22 from 54 sec electrofishing)										
May 16	9	21	39	0.5											
May 16	9	22	40	0.6											
May 16	9	23	42	0.8	6.8	25	16	3.4	5.5	0	-	0	13.7	3.0	GR
May 16	9	24	38	0.3											
May 16	9	25	35	0.3	(fish #23-26 from 49 sec electrofishing)										
May 16	9	26	38	0.4											
May 16	9	27	41	0.6	6.8	45	13	5.2	9.8	7.3	-	5.9	11.7	4.0	GR
May 16	9	28	44	0.9											
May 16	9	29	44	1.0											
May 16	9	30	38	0.5	(fish #27-31 from 42 sec electrofishing)										
May 16	9	31	37	0.3											

Appendix 12. Microhabitat data for juvenile chinook salmon in the Nechako River, May-July 1986.

Date	Site	Fish No.	L (mm)	Wt. (g)	Water temp. (°C)	Water depth (cm)	Fish ht. above bottom (cm)	Velocity ($cm \cdot s^{-1}$): Fish's Position	30 cm lateral to fish's position	30 cm vertical to fish's position	15 cm above bottom at fish's position	6/10 of the depth	Light (x 1000 lux): At fish's position	Shore distance (m)	Dominant substrate[a]
May 18	13	32	37	0.4	7.8	28	4	10.8	17.9	25.3	-	18.2	35.4	3.5	GR
May 18	13	33	42	0.5											
May 18	13	34	38	0.3	(fish #32-34 from 52 sec electrofishing)										
May 18	15	35	41	0.5	10.0	17	0	-	-	-	-	-	-	3.0	GR
May 18	15	36	41	0.5											
May 18	15	37	39	0.5											
May 18	15	38	43	0.8	(fish #35-39 from 335 sec electrofishing, hiding in gravel/cobble substrate)										
May 18	15	39	35	0.3											
May 19	53	40	40	0.5	8.9			-	-	-	-	-		3.0	-
May 19	19	41	36	0.3	7.9	23	7	10.8	13.0	14.7	-	10.5	34.0	3.0	GR
May 19	19	42	42	0.6	7.9	23	0	-	-	-	-	-	-	-	GR
May 19	19	43	41	0.4											
May 19	19	44	39	0.4											
May 19	19	45	39	0.4	(fish #42-46 from 164 sec electrofishing, hiding in substrate)										
May 19	19	46	40	0.5											
May 19	21	47	38	0.4	8.3	25	0	-	-	-	-	-	-	-	-
May 19	21	48	39	0.5											
May 19	21	49	38	0.5											
May 19	21	50	36	0.4	(fish #47-51 from 194 sec electrofishing, hiding in substrate)										
May 19	21	51	38	0.4											
May 20	50	52	39	0.5	7.5	34	6	13.0	18.2	22.5	-	15.4	7.8	1.0	SI
May 20	50	53	39	0.4											
May 20	50	54	38	0.4											
May 20	50	55	37	0.4	(fish #53-56 from 47 sec electrofishing; represent several schools not holding in position)										
May 20	50	56	37	0.4											
May 21	24	57	37	0.3	7.5	-	-	-	-	-	-	-	-	-	-
May 21	24	58	39	0.5											
May 21	24	59	39	0.5	(fish #57-61 from 115 sec electrofishing, hiding under log)										
May 21	24	60	38	0.5											
May 21	24	61	38	0.5											

Appendix 12. Microhabitat data for juvenile chinook salmon in the Nechako River, May-July 1986.

Date	Site	Fish No.	L (mm)	Wt. (g)	Water temp. (°C)	Water depth (cm)	Fish ht. above bottom (cm)	Velocity (cm·s^{-1}): Fish's Position	Velocity: 30 cm lateral to fish's position	Velocity: 30 cm vertical to fish's position	Velocity: 15 cm above bottom at fish's position	Velocity: 6/10 of the depth	Light (x 1000 lux): At fish's position	Shore distance (m)	Dominant substrate[a]
May 21	25	62	39	0.3	8.0	-	-	-	-	-	-	-	-	-	-
May 21	25	63	38	0.5											
May 21	25	64	41	0.5											
May 21	25	65	39	0.4	(fish #62-66 from 252 sec electrofishing)										
May 21	25	66	39	0.4											
May 23	31	67	35	0.3	8.3	25	0	-	-	-	-	-	-	2.0	GR
May 23	31	68	37	0.4											
May 23	31	69	38	0.4	(fish #67-72 from 202 sec electrofishing, hiding in substrate)										
May 23	31	70	36	0.3											
May 23	31	71	36	0.3											
May 23	31	72	32	0.3											
May 23	56	73	39	0.4	9.2	20	-	-	-	-	-	-	-	-	CO
May 23	56	74	38	0.4											
May 23	56	75	37	0.4											
May 23	56	76	40	0.4	(fish #73-77 from 48 sec electrofishing, hiding in substrate and under overhanging vegetation)										
May 23	56	77	48	0.8											
May 23	35	78	37	0.4	8.6	-	0	-	-	-	-	-	-	-	CO
May 23	35	79	38	0.5											
May 23	35	80	37	0.4											
May 23	35	81	37	0.4	(fish #78-82 from 47 sec electrofishing, hiding in substrate)										
May 23	35	82	35	0.3											
May 23	57	83	41	0.4	9.2	30	0	-	-	-	-	-	-	-	GR
May 23	57	83A	50	1.2	9.2	20	-	-	-	-	-	-	-	-	CO
May 23	57	84	39	0.4											
May 23	57	84A	48	1.1	(fish #57-87 from 196 sec electrofishing; smaller fish hiding in substrate, at 30 cm depth, larger fish "A" in a riffle with moderate current, at approx. 20 cm depth)										
May 23	57	85	34	0.2											
May 23	57	85A	43	0.6											
May 23	57	86	37	0.4											
May 23	57	86A	44	0.8											
May 23	57	87	39	0.4											

Appendix 12. Microhabitat data for juvenile chinook salmon in the Nechako River, May-July 1986.

Date	Site	Fish No.	L (mm)	Wt. (g)	Water temp. (°C)	Water depth (cm)	Fish ht. above bottom (cm)	Velocity (cm·s^{-1}) Fish's Position	30 cm lateral to fish's position	30 cm vertical to fish's position	15 cm above bottom at fish's position	6/10 of the depth	Light (x 1000 lux) At fish's position	Shore distance (m)	Dominant substrate[a]
May 23	58	88	38	0.5	-	40	-	-	-	-	-	-	-	-	CO
May 23	58	89	38	0.4											
May 23	58	90	36	0.4	(fish #88-92 from 52 sec electrofishing, in a school of approx. 30)										
May 23	58	91	36	0.3											
May 23	58	92	34	0.3											
May 23	59	93	43	0.9	9.1	25	0	-	-	-	-	-	-	0.5	-
May 23	59	94	43	0.8											
May 23	59	95	39	0.6	(fish #93-97 from 96 sec electrofishing, hiding in substrate)										
May 23	59	96	39	0.5											
May 23	59	97	40	0.7											
May 24	4	98	38	0.4	6.7	25	0	-	-	-	-	-	-	2.5	GR
May 24	4	99	35	0.3											
May 24	4	100	37	0.4	(fish #98-102 from 378 sec electrofishing, hiding in substrate)										
May 24	4	101	34	0.3											
May 24	4	102	43	0.7											
May 24	52	103	32	0.1	6.7	-	-	-	-	-	-	-	-	0.3	SI
May 24	52	104	37	0.4											
May 24	52	105	38	0.4	(fish #103-107 from 145 sec electrofishing)										
May 24	52	106	38	0.4											
May 24	52	107	39	0.4											
May 24	51	108	39	0.4	10.8	-	-	-	-	-	-	-	-	-	GR
May 24	51	109	33	0.3											
May 24	51	110	51	1.2	(fishing #108-112 from 262 sec electrofishing)										
May 24	51	111	44	0.8											
May 24	51	112	30	0.1											
June 12	13	113	48	1.1	16.1	64	4	20.4	28.5	12.6	17.2	9.1	64.7	3.0	GR
June 12	13	114	65	2.1	16.1	52	12	7.3	5.9	18.6	7.3	15.4	64.7	2.0	GR
June 13	13	115	42	0.7	15.5	48	10	12.6	16.8	12.2	12.6	13.7	50.5	3.0	CO
June 13	13	116	46	0.8	15.5	40	12	7.3	9.1	11.9	10.1	11.2	52.0	3.0	GR
June 14	9	117	50	1.7	15.4	50	13	9.1	11.5	13.7	9.1	13.7	25.0	4.0	CO

Appendix 12. Microhabitat data for juvenile chinook salmon in the Nechako River, May-July 1986.

Date	Site	Fish No.	L (mm)	Wt. (g)	Water temp. (°C)	Water depth (cm)	Fish ht. above bottom (cm)	Velocity ($cm \cdot s^{-1}$) Fish's Position	30 cm lateral to fish's position	30 cm vertical to fish's position	15 cm above bottom at fish's position	6/10 of the depth	Light (x 1000 lux) At fish's position	Shore distance (m)	Dominant substrate[a]
June 14	9	118	57	2.3	14.4	40	7	31.7	27.4	29.9	40.6	41.3	25.1	3.5	GR
June 14	9	119	49	1.2	14.4	31	7	16.5	22.8	14.0	20.0	17.2	35.4	3.0	GR
June 14	13	120	47	1.4	14.4	39	12	19.7	18.2	2.0	17.5	14.4	6.2	2.0	GR
June 14	13	121	47	1.3	14.4	40	8	20.0	21.2	–	14.7	11.5	2.8	2.5	CO
June 15	19	122	56	1.9	12.1	72	37	6.2	3.8	0	0	0	6.9	5.0	SI
June 15	19	123	48	1.1	12.3	70	5	5.5	5.2	49.2	5.5	9.8	37.9	4.5	SI
June 15	19	124	51	1.6	12.8	45	10	29.9	26.7	49.2	33.4	35.9	75.9	3.0	GR
June 16	19	125	43	0.8	12.9	61	23	4.8	3.8	7.3	4.5	5.2	23.2	6.0	SI
June 16	19A	126	43	0.8	13.1	33	13	1.6	0	0	4.5	1.7	15.7	1.0	SI
June 16	19A	126A	43	0.6	(fish #126 and 126A captured at same time and position)										
June 16	19A	127	49	1.3	13.1	31	10	5.9	4.5	9.1	6.2	7.0	19.2	1.0	SI
June 16	20A	128	52	1.6	14.1	68	12	9.4	11.5	20.7	12.6	19.7	4.3	1.5	SI
June 16	20B	129	53	1.6	13.9	89	19	14.0	9.4	22.1	8.0	21.1	22.3	1.5	CO
June 17	24	130	62	2.7	12.8	250	150	10.5	–	–	–	–	48.1	3.0	SI
June 17	24	131	50	1.5	12.8	65	20	0	5.5	8.0	0	6.6	3.8	1.0	SI
June 17	24	N/A	–	–	12.4	71	3	38.9	44.1	63.7	63.3	63.3	5.3	15.0	BO
June 17	24	N/A	–	–	12.4	63	40	23.2	17.5	47.2	38.2	45.5	1.4	15.0	CO
June 17	24	132	42	0.8	13.8	90	70	2.0	0	0	0	0	78.2	3.0	SI
June 17	24	N/A	–	–	13.9	45	13	14.7	23.9	22.1	16.8	11.5	4.3	2.5	GR
June 17	24	N/A	–	–	13.9	52	20	7.0	30.6	26.0	5.2	14.7	9.2	3.0	CO
June 18	31	N/A	–	–	14.8	56	25	13.0	37.6	12.6	20.7	14.7	13.6	1.0	SI
June 18	31	N/A	–	–	14.9	100	10	17.9	38.2	32.4	22.1	36.9	12.3	2.0	GR
June 18	31	N/A	–	–	14.9	51	17	16.8	25.0	20.0	19.3	19.7	11.7	–	SI
June 18	31	N/A	–	–	16.2	49	5	32.4	34.5	54.4	47.9	49.2	28.6	3.0	GR
June 18	31	133	53	1.5	16.0	63	6	25.7	33.4	45.5	39.6	41.7	10.7	3.0	CO
June 18	31	N/A	–	–	15.4	43	8	20.4	29.2	29.2	21.4	22.5	30.4	2.0	GR
June 18	31	N/A	–	–	15.4	56	8	27.4	28.8	38.2	28.1	35.5	14.9	2.5	GR
June 18	31	134	55	1.9	15.4	60	9	34.8	40.6	48.6	42.4	42.7	15.7	4.0	CO
June 18	31	135	46	1.0	15.2	45	8	28.5	31.3	47.5	35.2	37.6	4.2	2.0	GR
June 18	31	136	56	1.9	15.2	65	9	33.8	43.4	50.3	41.3	45.5	8.1	2.5	GR

Appendix 12. Microhabitat data for juvenile chinook salmon in the Nechako River, May-July 1986.

Date	Site	Fish No.	L (mm)	Wt. (g)	Water temp. (°C)	Water depth (cm)	Fish ht. above bottom (cm)	Velocity ($cm \cdot s^{-1}$): Fish's Position	Velocity: 30 cm lateral to fish's position	Velocity: 30 cm vertical to fish's position	Velocity: 15 cm above bottom at fish's position	Velocity: 6/10 of the depth	Light (x 1000 lux): At fish's position	Shore distance (m)	Dominant substrate[a]
June 19	35	N/A	-	-	13.8	58	10	30.2	19.3	46.8	32.7	41.0	47.3	3.0	BO
June 19	35	N/A	-	-	13.8	38	5	27.8	44.1	62.6	40.3	40.3	47.4	12.0	CO
June 19	35	137	54	1.7	13.8	36	10	27.8	25.7	42.4	34.5	33.1	51.8	10.0	BO
June 19	35	138	49	1.3	13.9	47	9	34.5	8.0	40.3	38.6	41.7	53.2	10.0	BE
June 19	35	N/A	-	-	14.1	25	11	25.3	85.3	30.6	32.7	33.4	70.6	3.0	BE
June 19	35	139	55	1.7	14.7	28	5	15.4	19.7	12.2	23.5	16.1	81.7	2.5	BE
June 19	35	N/A	-	-	14.3	20	6	16.1	16.1	14.0	14.4	15.1	23.9	1.0	CO
June 19	35	140	48	1.2	14.3	50	14	18.2	30.6	24.6	24.6	23.5	30.1	8.0	GR
June 19	35	141	52	1.4	14.3	42	14	39.3	46.5	49.6	40.0	43.4	44.3	10.0	SA
June 19	35	142	65	3.2	14.3	73	19	51.6	57.5	60.6	39.3	64.7	23.4	8.0	CO
June 19	35	143	50	1.4	14.3	36	13	29.9	29.2	36.5	33.1	31.3	41.2	7.0	GR
June 25	4	144	65	3.9	14.0	91	65	37.9	34.8	44.1	48.9	41.0	3.9	-	GR
June 25	4	N/A	-	-	14.0	84	48	27.8	63.7	50.6	65.0	41.0	6.5	-	GR
June 25	4	145	65	3.1	14.0	96	72	18.7	52.3	44.1	37.2	46.5	99.6	-	CO
June 25	4	N/A	-	-	14.1	104	4	23.9	19.6	32.4	30.6	44.1	72.4	2.0	CO
June 25	4	146	66	3.3	14.1	86	4	31.0	32.0	54.4	46.2	54.7	93.8	3.0	GR
June 25	4	147	67	3.9	14.2	74	5	44.4	46.2	61.2	54.0	61.2	78.8	1.0	CO
June 25	4	N/A	-	-	14.2	73	6	54.4	47.9	58.5	52.0	58.5	82.1	1.0	CO
June 25	9	148	49	1.4	16.1	20	6	20.7	15.1	28.5	19.7	15.4	59.0	2.0	GR
June 25	9	149	58	2.2	16.0	40	9	25.3	45.3	30.2	36.9	38.6	68.9	3.5	GR
June 25	9	149A	47	1.0	(fish #149 and 149A shot at same time and position)										
June 25	9	150	59	2.2	16.0	44	7	18.2	46.8	28.1	27.4	33.1	66.4	4.0	GR
June 26	4	151	62	2.8	14.6	41	4	22.1	28.5	57.8	38.6	43.7	84.9	17.0	GR
June 26	9	152	55	1.6	16.4	42	8	16.5	51.3	23.9	28.1	28.5	82.1	4.0	GR
June 26	9	153	53	1.6	16.4	35	6	16.1	23.9	10.1	3.8	4.1	48.6	3.0	GR
June 26	9	154	60	2.5	16.6	32	9	19.0	29.2	34.8	33.8	26.4	5.8	3.5	GR
June 26	9	155	49	1.4	16.5	37	10	65.4	41.0	34.8	64.3	64.3	7.8	4.0	GR
June 27	3	156	59	2.2	13.2	81	6	5.5	15.1	15.8	9.8	14.0	2.0	-	BO
June 27	3	N/A	-	-	13.2	72	4	27.8	21.8	42.0	34.5	42.0	64.7	-	BO
June 27	3	157	-	-	13.3	82	15	16.1	27.4	22.1	16.1	16.8	47.3	-	BO
June 27	9	158	61	2.4	15.7	41	8	29.1	28.5	51.6	41.0	45.5	-	3.5	GR

Appendix 12. Microhabitat data for juvenile chinook salmon in the Nechako River, May-July 1986.

Date	Site	Fish No.	L (mm)	Wt. (g)	Water temp. (°C)	Water depth (cm)	Fish ht. above bottom (cm)	Velocity ($cm \cdot s^{-1}$): Fish's Position	Velocity: 30 cm lateral to fish's position	Velocity: 30 cm vertical to fish's position	Velocity: 15 cm above bottom at fish's position	Velocity: 6/10 of the depth	Light (x 1000 lux): At fish's position	Shore distance (m)	Dominant substrate[a]
June 27	9	159	54	2.0	15.9	30	7	13.0	21.4	11.9	16.1	14.0	–	2.0	GR
June 27	13	N/A	–	–	16.7	60	6	22.5	27.8	30.6	31.7	36.2	79.5	3.0	GR
June 27	13	N/A	–	–	16.8	61	4	27.8	28.1	57.5	45.1	50.6	63.3	7.5	GR
June 27	13	N/A	–	–	16.9	55	5	43.1	33.8	65.0	58.2	57.1	64.4	6.5	CO
June 27	13	160	49	1.4	17.0	59	8	15.1	27.8	14.0	16.1	15.1	65.3	4.0	GR
June 27	13	161	54	1.5	17.0	52	15	14.4	21.8	22.1	14.4	18.2	62.4	3.0	GR
June 27	15	N/A	–	–	14.4	41	3	32.4	35.5	55.4	49.2	50.3	72.8	3.5	GR
June 27	15A	162	54	1.7	14.8	75	27	8.4	12.2	15.1	5.2	16.5	60.5	3.0	SI
June 27	15A	163	56	1.9	15.1	104	6	12.6	13.3	19.7	15.8	17.9	32.0	4.0	SA
June 27	15B	N/A	–	–	16.3	48	8	35.8	10.8	47.5	45.8	43.7	71.3	2.2	SA
June 27	20A	N/A	–	–	17.4	65	19	19.0	21.1	38.2	19.3	31.0	69.5	1.5	SA
June 28	20B	N/A	–	–	16.8	42	9	19.7	25.7	11.9	18.6	19.7	11.1	2.0	SA
June 28	20B	N/A	–	–	16.8	45	13	14.7	11.2	17.2	13.3	12.2	12.6	3.0	SA
June 28	20B	164	51	1.3	16.8	50	12	10.8	9.4	13.7	13.0	8.7	16.2	3.0	SA
June 28	15A	165	58	2.1	14.7	111	57	12.6	10.5	24.2	5.9	7.3	29.8	4.0	SI
June 28	15A	N/A	–	–	15.0	134	61	28.8	25.7	31.3	19.7	29.9	35.8	6.0	GR
June 29	15C	166	51	1.4	15.7	33	15	3.4	2.7	4.8	3.4	4.1	23.1	1.0	DETRITUS
June 29	15D	167	63	2.7	16.3	83	23	1.6	0	5.5	0	4.1	28.9	2.0	SI
June 29	15D	168	55	1.7	15.8	150	120	0	0	0	0	0	(too murky)	2.0	–
June 29	21D	169	47	1.2	16.1	77	3	24.6	24.2	43.7	34.8	43.1	73.7	7.0	GR
June 29	21D	N/A	–	–	16.4	60	4	36.5	37.6	47.2	40.3	46.2	11.7	6.0	GR
June 29	21D	170	69	3.9	16.5	46	14	9.8	6.6	5.9	8.4	5.5	30.9	4.0	SI
June 29	21D	N/A	–	–	16.5	59	30	10.5	20.0	6.6	10.1	9.8	44.6	3.0	WOOD
June 30	25	171	57	1.9	17.9	37	10	28.8	28.8	16.8	28.8	28.8	24.0	1.0	MUD
June 30	25	172	62	2.6	18.0	48	5	13.7	22.5	8.0	7.0	8.4	22.3	2.0	GR
June 30	25	173	59	2.2	17.9	91	45	20.4	34.8	38.9	2.0	11.5	9.5	2.0	GR
July 1	21	174	61	2.8	15.9	98	40	19.3	23.9	20.4	9.8	21.1	5.5	4.0	MUD
July 1	21	N/A	–	–	15.5	55	4	27.8	38.2	75.3	57.5	66.1	14.0	5.0	GR
July 1	21	N/A	–	–	15.5	80	25	25.7	28.3	14.7	24.6	19.0	15.7	5.0	GR
July 1	21	175	55	1.9	15.6	105	60	4.8	6.6	5.2	4.1	3.8	18.8	2.0	MUD

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Date	Site	Fish No.	L (mm)	Wt. (g)	Water temp. (°C)	Water depth (cm)	Fish ht. above bottom (cm)	Velocity ($cm \cdot s^{-1}$) Fish's Position	30 cm lateral to fish's position	30 cm vertical to fish's position	15 cm above bottom at fish's position	6/10 of the depth	Light (x 1000 lux) At fish's position	Shore distance (m)	Dominant substrate[a]
July 1	21	176	48	1.1	15.9	30	12	8.4	5.5	7.0	7.3	8.4	14.6	2.0	SI
July 1	23	N/A	-	-	15.8	110	83	2.0	1.6	2.0	0	1.6	0.5	3.0	CLAY
July 2	28	N/A	-	-	16.1	55	18	8.4	9.4	6.2	3.8	8.0	81.7	1.0	SA
July 2	28	177	60	2.6	16.2	93	56	7.0	8.7	11.5	-	8.4	79.0	3.0	MAT OF BOUGHS
July 2	28	178	62	2.4	16.3	85	42	2.4	4.5	7.3	33.8	1.6	13.1	2.0	GR
July 2	28	N/A	-	-	9.0	82	5	19.7	19.7	41.3	8.4	35.5	21.3	3.5	CO
July 2	28	N/A	-	-	10.9	41	12	8.7	9.8	11.9	8.4	8.0	45.8	0.5	CO
July 2	30	179	58	2.1	10.5	69	10	4.5	8.7	11.9	3.1	10.1	30.8	1.5	SA
July 3	35	N/A	-	-	7.8	30	4	33.8	13.7	41.7	38.9	34.1	12.0	9.0	CO
July 3	35	N/A	-	-	7.8	28	3	12.2	27.1	59.2	18.9	38.2	12.0	3.0	CO
July 3	35	180	73	4.4	7.9	50	12	30.6	24.2	48.6	35.9	34.8	25.0	4.5	CO
July 3	35	181	71	4.3	7.9	47	11	7.6	17.5	21.4	21.4	24.6	31.6	5.0	CO
July 3	35	182	69	3.9	7.9	37	5	10.8	16.1	28.1	15.8	15.8	47.9	3.5	CO
July 3	35	183	66	3.9	8.1	51	18	42.4	40.6	64.7	46.1	55.1	28.4	11.0	BO
July 3	35	184	60	2.4	8.1	55	29	40.6	40.0	56.4	28.1	30.2	25.7	8.0	GR
July 3	35	185	51	1.5	8.1	49	13	27.1	28.8	32.0	29.9	30.2	27.8	7.5	GR
July 3	35	186	54	1.9	8.1	29	8	35.8	42.6	52.0	50.6	44.1	38.3	8.5	CO
July 3	35	187	61	2.8	8.1	55	20	33.8	36.5	63.0	18.6	36.5	31.7	13.0	CO
July 3	35	188	69	3.8	8.1	42	10	35.2	45.1	66.4	38.2	41.3	46.3	7.0	BO
July 4	36	189	49	1.1	8.1	42	5	20.0	18.6	37.6	28.5	32.4	16.1	2.0	SA
July 4	36	190	63	2.6	8.0	57	8	14.0	16.8	31.0	22.5	25.3	14.3	2.5	GR
July 4	36	191	54	1.6	8.4	40	7	7.6	8.7	13.0	6.6	7.0	73.3	4.5	SI
July 4	36	192	52	1.4	8.5	33	6	21.4	16.8	14.7	14.7	14.4	36.7	3.5	GR
July 4	36	193	50	1.2	8.6	36	9	19.3	44.1	49.9	25.7	21.4	26.3	3.0	GR
July 4	36	194	59	2.6	8.4	43	6	28.1	22.5	27.1	24.2	27.8	60.6	0.8	GR
July 4	36	195	60	2.5	8.5	47	3	27.1	24.2	37.9	33.4	25.7	56.7	1.5	GR
July 4	36	196	57	2.1	8.9	48	5	25.7	29.9	46.5	37.9	32.7	14.6	2.0	GR
July 4	36	197	57	2.6	8.9	35	4	28.1	19.7	26.4	28.8	32.4	18.2	1.2	GR
July 4	36	198	62	3.1	8.9	45	20	9.4	13.6	17.2	13.0	7.6	42.9	1.8	GR

Appendix 12. Microhabitat data for juvenile chinook salmon in the Nechako River, May-July 1986.

Date	Site	Fish No.	L (mm)	Wt. (g)	Water temp. (°C)	Water depth (cm)	Fish ht. above bottom (cm)	Velocity (cm·s^{-1}): Fish's Position	Velocity (cm·s^{-1}): 30 cm lateral to fish's position	Velocity (cm·s^{-1}): 30 cm vertical to fish's position	Velocity (cm·s^{-1}): 15 cm above bottom at fish's position	Velocity (cm·s^{-1}): 6/10 of the depth	Light (x 1000 lux): At fish's position	Shore distance (m)	Dominant substrate[a]
July 4	36	199	63	3.0	-	37	7	31.7	31.3	50.6	37.9	37.9	46.7	4.5	GR
July 7	4	N/A	-	-	9.0	62	5	18.2	28.1	42.0	35.5	38.2	70.7	17.0	GR
July 7	3	200	73	4.3	8.2	85	10	26.0	39.6	41.0	40.6	42.4	67.0	3.0	BO
July 7	3	201	75	4.8	17.5	78	10	11.5	17.9	5.2	13.3	10.8	69.1	0.5	GR
July 7	3	202	62	3.1	17.5	67	8	27.1	31.0	35.8	27.4	30.6	26.3	3.0	GR
July 7	3	203	-	2.5	17.5	50	25	23.5	35.8	7.3	29.1	26.4	10.4	4.0	CO
July 7	3	204	83	7.7	17.8	42	9	27.1	55.8	77.4	50.6	53.7	29.3	5.0	CO
July 7	3	205	70	3.7	18.0	35	3	27.4	29.2	42.0	32.0	33.1	41.0	1.0	GR
July 7	3	206	60	2.3	17.5	37	11	11.2	21.1	20.4	11.5	11.5	-	-	CO
July 8	9	207	57	2.1	17.9	45	5	19.0	31.0	46.8	37.6	37.6	61.3	4.5	GR
July 8	9	N/A	-	-	17.9	29	3	26.0	38.2	53.0	43.4	43.4	12.8	2.5	GR
July 8	9	208	60	2.3	18.1	22	4	26.4	38.9	7.3	23.5	23.5	16.6	1.5	GR
July 8	9	208A	58	1.9	(fish #208 and 208A shot at same time and position)										
July 8	9	209	-	2.9	18.9	48	4	20.0	28.5	47.9	34.5	34.5	85.3	4.0	GR
July 8	9	210	68	3.6	18.9	40	30	20.4	47.9	51.0	26.0	27.1	20.0	4.0	GR
July 8	9	210A	68	4.4	(fish #210 and 210A shot at same time and position)										
July 8	13	211	58	2.1	19.7	56	25	20.0	40.6	15.4	27.8	22.5	18.6	2.0	GR
July 9	9	212	51	1.3	17.0	26	5	40.3	40.6	38.6	40.0	45.8	19.3	4.0	GR
July 9	9	213	58	2.2	17.0	37	12	20.7	25.7	35.5	23.9	23.9	44.4	4.0	GR
July 9	9	213A	65	3.3	(fish #210 and 213A captured at same time and position)										
July 9	9	214	72	4.3	17.5	68	40	31.7	23.2	11.2	8.7	41.7	64.4	5.0	CO
July 9	9	215	70	3.8	17.6	33	6	24.2	16.5	35.2	29.5	27.1	73.7	3.5	GR
July 9	13	216	65	3.4	19.9	29	17	17.9	46.2	11.5	19.3	19.3	47.3	0.3	GR
July 10	21	217	84	7.3	17.1	50	23	50.3	48.9	66.1	35.2	39.6	27.5	20.0	CO
July 10	21	218	64	3.0	17.1	84	21	19.3	33.4	33.8	10.8	28.5	5.1	-	CLAY
July 11	15C	N/A	-	-	16.2	97	25	34.8	41.0	40.6	29.2	37.2	25.7	12.0	GR
July 11	15B	N/A	-	-	16.5	35	10	13.3	19.7	21.1	14.0	14.0	17.7	2.0	SA
July 11	15A	219	61	2.6	16.9	62	24	9.8	11.2	2.7	9.1	9.8	39.2	3.0	SI
July 11	19	220	63	2.7	17.6	34	17	7.3	31.0	41.3	21.1	23.9	121.4	2.0	WOOD
July 11	19	N/A	-	-	18.1	87	27	10.8	13.0	4.5	2.4	4.1	80.6	1.0	SA

Appendix 12. Microhabitat data for juvenile chinook salmon in the Nechako River, May-July 1986.

Date	Site	Fish No.	L (mm)	Wt. (g)	Water temp. (°C)	Water depth (cm)	Fish ht. above bottom (cm)	Velocity ($cm \cdot s^{-1}$): Fish's Position	Velocity: 30 cm lateral to fish's position	Velocity: 30 cm vertical to fish's position	Velocity: 15 cm above bottom at fish's position	Velocity: 6/10 of the depth	Light (x 1000 lux): At fish's position	Shore distance (m)	Dominant substrate[a]
July 11	19A	N/A	-	-	17.6	64	24	6.6	10.8	7.6	3.8	5.9	77.1	4.0	CO
July 13	31	N/A	-	-	17.6	57	17	2.7	2.4	4.8	8.7	7.0	72.0	5.6	SI
July 13	28A	N/A	-	-	17.6	40	19	2.4	6.2	2.7	5.9	5.5	26.7	-	WOOD
July 13	28	N/A	-	-	18.1	80	21	36.9	54.4	-	36.5	54.0	33.6	10.8	GR
July 13	25	221	65	3.1	17.0	107	55	11.5	14.0	9.8	8.7	11.9	26.5		WOOD
July 13	25	222	72	4.6	16.9	91	40	33.8	16.1	14.0	17.2	35.5	7.7	7.2	GR
July 13	25	223	65	2.8	16.9	95	70	10.5	6.2	5.9	32.0	5.5	4.1	8.0	GR
July 13	25	224	66	4.2	16.9	66	12	17.9	19.0	11.5	17.2	15.8	18.9	5.8	SI
July 13	25	225	54	1.7	16.9	90	30	2.7	3.1	8.0	3.8	5.2	9.0	3.0	GR
July 13	25	226	68	1.5	16.9	80	15	2.0	3.4	2.0	2.0	3.4	7.4	2.0	GR
July 14	35	N/A	-	-	17.7	52	9	46.5	41.0	61.2	47.9	56.1	59.8	14.1	GR
July 14	36	227	68	3.8	19.3	59	7	44.4	42.7	44.1	43.1	44.1	13.5	2.4	GR
July 14	36	N/A	-	-	19.5	73	57	18.2	23.9	9.1	38.9	35.8	11.5	1.8	GR
July 14	36	228	76	3.5	19.3	56	12	12.6	17.2	17.9	15.4	12.2	14.0	2.7	CO
July 14	36	229	-	4.1	19.4	54	10	49.2	56.4	72.6	56.1	60.6	13.6	5.2	GR
July 14	36	230	69	3.8	19.4	47	11	38.6	37.2	63.7	39.6	46.5	16.9	4.7	CO
July 14	36	230A	80	6.6	(fish #230A found dead in shallows)										
July 14	36	231	64	3.3	19.3	56	6	28.1	35.2	68.8	53.4	55.8	12.7	7.0	CO
July 15	36	232	67	3.9	16.8	65	8	44.4	43.1	56.4	45.1	55.8	7.7	2.1	GR
July 15	36	N/A	-	-	16.9	64	5	46.5	49.9	80.5	67.4	71.6	13.8	2.3	GR
July 15	36	N/A	-	-	16.8	54	35	2.4	2.0	0	0	1.6	7.4	-	MA
July 15	3	233	75	4.9	16.0	98	25	20.4	20.7	9.4	29.5	24.6	2.2	-	GR
July 15	3	234	69	2.7	16.0	100	10	25.3	25.7	20.7	24.2	20.7	16.7	-	GR
July 15	3	235	71	3.6	16.0	91	19	34.8	34.5	27.4	28.1	34.5	18.5	-	GR
July 15	3	236	49	1.2	16.1	91	50	26.7	28.5	28.8	20.0	25.7	32.9	-	-
July 15	9	N/A	-	-	16.4	58	18	19.7	33.1	7.3	22.5	9.4	9.0	4.7	GR
July 15	9	N/A	-	-	16.4	53	10	42.0	9.1	13.0	34.8	19.0	13.4	4.0	GR
July 16	9	237	51	1.7	16.5	63	20	14.4	31.3	26.0	13.0	11.5	65.9	4.3	GR
July 16	9	238	62	2.5	16.7	59	5	19.7	20.7	27.4	27.4	63.7	63.5	3.2	GR
July 16	9	239	74	4.7	16.9	72	17	37.2	38.9	38.2	37.6	37.6	59.8	3.4	CO
July 16	9	N/A	-	-	18.4	53	22	25.7	33.4	27.8	28.8	25.7	31.1	1.9	CO

Appendix 12. Microhabitat data for juvenile chinook salmon in the Nechako River, May-July 1986.

								Velocity (cm·s⁻¹)					Light (x 1000 lux)		
Date	Site	Fish No.	L (mm)	Wt. (g)	Water temp. (°C)	Water depth (cm)	Fish ht. above bottom (cm)	Fish's Position	30 cm lateral to fish's position	30 cm vertical to fish's position	15 cm above bottom at fish's position	6/10 of the depth	At fish's position	Shore distance (m)	Dominant substrate[a]
July 16	9	N/A	–	–	17.2	44	3	27.1	24.6	27.4	27.4	38.6	67.1	1.9	GR
July 17	13	N/A	–	–	16.3	83	4	36.2	43.4	83.6	68.5	90.4	27.3	9.1	GR
July 17	13	240	65	3.0	17.3	55	3	11.5	–	15.4	13.0	15.4	14.3	–	GRASS
July 17	13	240A	65	3.0	–	–	–	–	–	–	–	–	–	–	–
July 17	13	241	62	2.6	17.4	82	46	4.1	3.4	13.7	3.8	4.5	46.3	–	SI
July 17	13	242	90	8.9	17.5	42	31	14.0	25.3	37.6	3.4	8.4	40.0	–	STICKS

[a] BE - bedrock, BO - boulder, CO - cobble, GR - gravel, SA - sand, SI - silt.

Appendix 13. Substrate composition of juvenile chinook salmon microhabitat in the Nechako River, 1985 - 1986.

Season	Period	Sample Size	% Frequency occurrence of dominant substrate						
			Silt[a]	Sand	Gravel	Cobble	Boulder	Bedrock	Other[b]
Spring	May 14 - 24, 1986	20	10.0	0	70.0	20.0	0	0	0
Summer	June 12 - July 17, 1986	183	14.2	6.6	48.1	19.7	4.9	1.6	4.9
Fall	Aug 24 - Sep 15 1986	111	0.9	5.4	64.9	25.2	3.6	0	0
TOTAL	-	314	9.2	5.7	55.4	21.7	4.1	1.0	2.9

[a] Includes mud and clay.

[b] Includes macrophytes, grass, detritus, wood and branches.

Appendix 14. Relative abundance of juvenile chinook salmon and other species along the margins and in mid-channel of the Nechako River, 1985, 1986.

		RIVER MARGIN			MID CHANNEL		
			No. fish observed			No. fish observed	
Number of days sampling	Site Number	Duration of search (minutes)	Chinook Salmon	Others[1]	Duration of search (minutes)	Chinook salmon	Others
1985							
Aug. 23	4	147	14	20 MW			
	5	10	1	20 MW			
				20 SU			
				1 RBT			
	6	7	0	1 RBT			
				20 MW			
				20 SU			
	7	10	15	18 SU	5	0	3 RBT
				13 MW			77 MW
							54 SU
	8				8	0	15 MW
	9	28	11	4 RBT			
				7 MW			
				10 SU			
Aug. 24	4				37	0	75 SU
							207 MW
Aug. 25	9	12	5	3 RBT			
				3 SU			
				4 MW			
	9	5	19				
Aug. 27	10	20	0				
	11	20	0				
	12	10	1				
	13	110	18	2 RBT			
	14	50	8				
Aug. 28	15	158	27				
Aug. 29	19	185	15				
Sep. 10	21	80	9				
	22	90	1				
Sep. 11	24	161	12	7 RBT			
	25	140	0	7 RBT			
Sep. 13	27	140	11	130 RBT			
	28	30	0	11 RBT			
	29	30	0	2 RBT			
	30	65	3	19 RBT			
Sep. 14	31	90	17	1 DV			
				11 RBT			
	32	70	3	8 RBT			
				1 DV			
	33	90	1	13 RBT			
	34	15	1				
Sep. 15	35	65	15	3 RBT			
	36	75	19	9 RBT			
				1 SQ			

Appendix 14. (cont'd.)

Number of days sampling	Site Number	RIVER MARGIN Duration of search (minutes)	No. fish observed Chinook Salmon	Others[1]	MID CHANNEL Duration of search (minutes)	No. fish observed Chinook salmon	Others
1986							
May 14	4	45	0				
	9	22	7				
		65	100				
	13	75	30				
May 18	15				30	0	6 MW
							5 SU
May 19	19				50	0	4 MW
							11 SU
May 24	4	30	0		12	0	
	9	35		1 MW	15	0	3 MW
							2 SU
Jun 11	4	30	7				
		75	12				
Jun 12	9	42	26				
		70	500	1 RBT			
	13	200	77	6 RBT			
				1 MW			
Jun 13	4	45	6	1 MW	15	0	400 MW
							200 SU
	13	70	354				
Jun 14	9	97	1000	4 RBT			
	13	45	2				
	15	42	43	1 MW	8	0	10 MW
Jun 15	17	25	5				
	19	95	53				
	21	35	16	4 RBT	10	0	
Jun 16	19	52	14		11	1	2 RBT
							30 SU
		10	300				
		20	2				
		10		1 RBT			
		20	1				
		3	12				
	20	5	1		13	0	6 MW
							5 SU
		33	63	1 RBT			
Jun 17	24	35	1				
		16		1 DV			
				1 RBT			
				2 SU			
		55	1		20	10	1 RBT
		5	100				
		20	100	1 RBT	15	0	6 MW
							6 SU
	25	5	0				
	24	25	100				

Appendix 14. (cont'd.)

Number of days sampling	Site Number	RIVER MARGIN: Duration of search (minutes)	RIVER MARGIN: No. fish observed: Chinook Salmon	RIVER MARGIN: No. fish observed: Others[1]	MID CHANNEL: Duration of search (minutes)	MID CHANNEL: No. fish observed: Chinook salmon	MID CHANNEL: No. fish observed: Others
1986							
Jun 18	31	5	30				
		15	2				
		35	120				
		141	189	4 RBT	24	0	16 SU
							15 MW
Jun 19	35	135	101	1 RBT			
		136	57	1 RBT			
				1 SQ			
Jun 25	4	135	100	1 RBT			
	9	60	3000		15	0	100 SU
							100 MW
							4 RBT
Jun 26	4	70	24	1 SU			
				15 MW			
		58	20				
	9	95	2250	21 RBT			
Jun 27	3	75	100	12 RBT			
	4	18	1				
	9	45	2500				
	13	95	115				
Jun 28	15	45	28		15	0	
		40	160		5	0	
		30	12	1 RBT			
	17	7	3				
	19	20	0				
		14	1	20 SU			
	20	19	30				
		27	100				
Jun 29	15	27	20	9 RBT	12	0	10 SQ
				20 SU			9 SU
		30	630	4 RBT			
				100 SU			
		100	153				
		35	80				
	21	20	4	1 RBT			
		42	250				
		43	30				
		18	26				
		34	5				
		58	4	2 RBT			
Jun 30	24	15	1	1 SQ			
				1 SU			
	24	5	0				
		6	0				
		4	1				
		81	87				

Appendix 14. (cont'd.)

Number of days sampling	Site Number	RIVER MARGIN: Duration of search (minutes)	RIVER MARGIN: No. fish observed: Chinook Salmon	RIVER MARGIN: No. fish observed: Others[1]	MID CHANNEL: Duration of search (minutes)	MID CHANNEL: No. fish observed: Chinook salmon	MID CHANNEL: No. fish observed: Others
1986							
Jul 1	21	111	46	21 RBT			
				2 SU			
		9	0	1 SU			
				1 SQ			
		15	50	1 RBT			
	23	10	1	1 RBT	20	0	25 MW
		5	2				2 SU
		10	200				
		3	0	1 MW			
		20	15				
Jul 2	28	10	5		4	0	1 SU
		10	16				
		10	1				
		5	0				
		10	3				
		6	0				
		5	3				
		4	0				
		10	1	3 SU			
	29	36	4	2 SQ			
				200 SU			
		20	0	100 SQ			
		7	2				
		23	8	2 RBT			
Jul 3	35	130	38				
		164	76	2 MW			
				2 SU			
Jul 4	36	67	34	2 MW			
		66	3	2 SQ			
				2 MW			
				4 RBT			
	36	8	0				
		134	44	2 RBT			
Jul 7	4	45	20				
	3	47	200				
		29	420				
		60	54	1 SQ			
				4 RBT			
Jul 8	9	33	30	100 SQ	12	0	30 MW
				8 RBT			13 SU
		34	16				1 SQ
		5	0				
		12	200				
		16	200	1 RBT			
				1 DV			
	13	39	302	3 RBT			
		17	100				

Appendix 14. (cont'd.)

		RIVER MARGIN			MID CHANNEL		
			No. fish observed			No. fish observed	
Number of days sampling	Site Number	Duration of search (minutes)	Chinook Salmon	Others[1]	Duration of search (minutes)	Chinook salmon	Others
1986							
Jul 9	9	25	52	4 RBT			
				100 SU			
				100 MW			
		50	3				
	15	10	4	2 RBT	17	2	50 SQ
				1 DV			100 MW
				50 MW			50 SU
				50 SU			
				50 SQ			
	13	34	75				
	21	104	62	301 RBT			
Jul 11	15	12	1				
		4	0	5 MW			
		37	51	21 RBT			
				40 MW			
				11 SU			
		28	50				
	17	9	0	3 MW			
				24 SU			
				3 DV			
	19	17	0	5 MW	13	0	21 MW
		39	30				
		19	10	2 MW			
				2 SQ			
Jul 12	19	3	2	2 MW			
	20	12	1				
		10	0	1 SU			
Jul 13	31	44	1	1 MW			
				2 SU			
				2 RBT			
	28	39	5	2 SQ	17	0	8 RBT
		8		200 SU			11 SU
			6	200 SU			2 SQ
		31	21	7 RBT			1 ST
				2 SU			
				1 MW			
	26	37	6		13	2	1 RBT
		50	36				2 MW
	25	40	80				
	24	3	0				
		5	0				
Jul 14	35	20	10				
		15	0				
		7	0	3 SU			
		29	2				
	36	182	174	12 SU			
				150 SQ			

Appendix 14. (cont'd.)

		RIVER MARGIN			MID CHANNEL		
		Duration	No. fish observed		Duration	No. fish observed	
Number of days sampling	Site Number	of search (minutes)	Chinook Salmon	Others[1]	of search (minutes)	Chinook salmon	Others
1986							
Jul 15	36	71	51				
	3	55	266				
		16	3	3 RBT			
				10 SU			
				10 MW			
	9	45	1452				
Jul 16	9	50	198				
		5	0				
		15	1				
		22	117	50 MW			
				36 SU			
				2 RBT			
		14	20				
Jul 17	13	20	0	1 SQ	12	0	2 RBT
				20 MW			20 SU
				30 RBT			15 MW
		56	12	58 MW			5 SQ
				17 SQ			
				30 RBT			
				15 SU			
		75	311				
		17	5	5 SQ			
		27	1	12 RBT			
				50 MW			
TOTALS							
	46 (days)	7864 (minutes)	18611 (chinook)	769 RBT ($0.098 \cdot min^{-1}$)	437 (minutes)	15 (chinook)	21 RBT ($0.048 \cdot min^{-1}$)
		131.1 (hours)	($2.367 \cdot min^{-1}$)	508 MW ($0.065 \cdot min^{-1}$)	7.3 (hours)	($0.034 \cdot min^{-1}$)	1042 MW ($2.384 \cdot min^{-1}$)
				1089 SU ($0.139 \cdot min^{-1}$)			608 SU ($1.391 \cdot min^{-1}$)
				436 SQ ($0.055 \cdot min^{-1}$)			68 SQ ($0.156 \cdot min^{-1}$)
				8 DV ($0.001 \cdot min^{-1}$)			0 DV
							1 ST ($0.002 \cdot min^{-1}$)

[1] RBT = rainbow trout, MW = mountain whitefish, SU = common sucker, SQ = northern squawfish, DV = Dolly Varden, ST = white sturgeon

Appendix 15. Abundance and distribution of juvenile chinook salmon in the Nechako River system, May 1986.

Date	May micro-habitat Site No.	Corresponding Aug/Sep Site No.	Approx. km below Cheslatta Falls	Electrofishing period (sec)	Chinook captured/stunned Total	No/100 sec electroshocking
May 24	4	3	7.5	378	10	2.6
May 16	9	5-8	9-10	260	27	10.4
May 18	13	13	14	52	3	5.8
May 18	15	16	17	335	5	1.5
May 19	17	16A[a]	21	114	0	0
May 19	19	16B[a]	23	164	6	3.7
May 19	21	17A[a]	40	194	5	2.6
May 21	24	17-19	45-47	115	5	4.3
May 21	25	19A[a]	48	252	5	2.0
May 22/23	31	21A[a]	70	317	6	1.9
May 23	35	26A[a]	114	47	20	42.6
		TOTAL MAINSTEM		2,228	92	4.1
	Creeks					
May 20	50 (Twin Cr.)		10	47	8	17.0
May 20/24	51 (Cutoff Cr.)		17	439	5	1.1
May 24	52 (Swanson Cr.)		19.5	145	5	3.4
May 19	53 (Targe Cr.)		21	222	1	0.5
May 23	56 (Smith Cr.)		71	48	5	10.4
May 23	57 (Leech Cr.)		114	196	9	4.6
May 23	58 (Trankle Cr.)		120	52	30	57.7
May 23	59 (Redmond Cr.)		122	96	5	5.2
		TOTAL TRIBUTARIES		1,245	68	5.5
TOTAL SYSTEM				3,473	160	4.6

[a] Sites denoted A and B had no exact site equivalent in the August-September sampling.

Appendix 16. Incidental observations of fish species other than chinook salmon during the snorkeling survey in the Nechako River system, 1985, 1986.[a]

Date	Site[b]	Species observed[c] DA	DV	SQ	RBT	MW	SC	SU
1985								
Aug. 23	1				3		1	
Aug. 23	2						2	
Aug. 23	3	3				1	14	
Aug. 23	4					20		
Aug. 23	5				1	MA[d]		MA
Aug. 23	6				1	MA		
Aug. 23	7				3	67		17
Aug. 23	8					15		
Aug. 23	9				4	7		10
Aug. 25	9				3	4		3
Aug. 27	13				2			
Sep. 11	24				7			
Sep. 11	25				7			
Sep. 13	27				130			
Sep. 13	28				11			
Sep. 13	29				2			
Sep. 13	30				19			
Sep. 14	31		1		11			
Sep. 14	32		1		8			
Sep. 14	33				13			
Sep. 15	35				3			
Sep. 15	36			1	9			
1986								
May 18	15					6		5
May 19	19					4		11
May 24	9					154		2
June 12	9				1			
June 12	13				5	2	1	
June 13	4					200		100
June 14	9				4			
June 14	15					10		25
June 15	21				4			
June 16	19				2			
June 16	19A				1			
June 16	20A					6		5
June 16	20B				1			
June 17	24		1		3	6		8
June 18	31				5	15		15
June 19	35			1	2			
June 25	4				1			
June 25	9				4	100		100

Date	Site[b]	Species observed[c] DA	DV	SQ	RBT	MW	SH	SU
June 26	4					15		1
June 26	9	2			21		2[e]	
June 27	3				12	50		30
June 28	15			1				
June 28	15B				1			
June 28	19A						MA	MA
June 29	15A			11	9			
June 29	15D				4		MA	100
June 29	21d			1	3			
June 30	24			MA		MA	MA	1
July 1	21			some	22		MA	2
July 1	23				1	26	MA	2
July 2	28			3			MA	1
July 2	29			MA				
July 2	30				2		MA	
July 3	35					2		2
July 4	36			2	6	4		
July 7	3			1	4			
July 8	9		1	100	10	30		13
July 8	51				3	MA		
July 9	9				4	MA		MA
July 9	15		1	50+	2	100+		50+
July 10	21				300			
July 11	15C				21	45	100	11
July 11	17		3			3		24
July 11	19					26		
July 11	19A					2	2	
July 12	19A					2		
July 12	20A						5	1
July 13	31				2	1		2
July 13	28A			2			400	
July 13	28			2	15	10		13
July 13	25				1	2		
July 14	35							3
July 14	36						150	12
July 15	3				3	5		5
July 16	9				2	50	MA	36
July 17	13			4	60	78	100	18
July 17	9			5	14	65		20
Total		5	8	184	792	1135	205C 7575H	647

[a] Snorkeling survey included nearshore and mid-channel dives; note that on August 23, 1985, electrofishing, not snorkeling was conducted at sites 1, 2 and 3.
[b] See Fig. 1 for site location.
[c] DA - dace, DV - Dolly Varden, SQ - squawfish, RBT - rainbow trout, MW - mountain whitefish, SH - shiner, SC - sculpin, SU - sucker.
[d] MA - "many" as indicated in field notes.
[e] 2 SC.

Appendix 17. Mean monthly sampling dates calculated as the dates by which half the monthly sample size was collected, Nechako River system, 1986.

Nechako River Section	MAY Sampling period	MAY Mean sampling date	JUNE Sampling period	JUNE Mean sampling date	JULY Sampling period	JULY Mean sampling date	AUGUST Sampling period	AUGUST Mean sampling date	SEPTEMBER Sampling period	SEPTEMBER Mean sampling date
Upper mainstem	14-24	16	12-29	25	7-17	9	13-14	13	26	26
Upper tributaries	19-24	24	-	-	-	-	14	14	-	-
Upper system	14-24	18	-	-	-	-	13-14	14	-	-
Lower mainstem	19-24	21	17-30	19	1-14	4	11-12	11	25-Oct 1	25
Lower tributaries	23	23	-	-	-	-	-	-	-	-
Lower system	19-24	23	-	-	-	-	-	-	-	-
Total mainstem	14-24	18	12-30	19	1-17	8	11-14	13	25-Oct 1	26
Total tributaries	19-24	23	-	-	-	-	14	14	-	-
Total system	14-24	21	-	-	-	-	11-14	13	-	-