BIOLOGICAL ASSESSMENT OF HABITAT COMPLEXING IN THE NECHAKO RIVER, 1997

NECHAKO FISHERIES CONSERVATION PROGRAM
Technical Report No. RM97-3

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Contents

List of Figures

List of Tables

List of Appendices

ABSTRACT

Artificial habitat complexes were installed from 1989 through 1991 in the upper Nechako River to alleviate chinook salmon (*Oncorhynchus tshawytscha*) conservation concerns and as part of the remedial measures outlined by the Nechako Working Group (Anon. 1987). The goal of this program was to increase habitat complexity in the Nechako River and to replace and offset any habitat loss after the change to the long term flow regime. Although the change to long-term flows will not take place, the monitoring of the complexes is being continued for scientific probity. The complexes consist of instream cover structures (debris bundles and debris catchers), instream channel modifications and side channel developments. They were compared with natural sites with similar physical criteria and which had a variety of available cover. From 1989 to 1997, habitat complexes were sampled annually to assess juvenile chinook use. In 1996 and 1997 emergent fry structures were installed along the margins to assess their use by newly emergent fry during low flow conditions in the early spring.

Chinook relative abundance was determined through two techniques: underwater snorkel counts and electrofishing. Indices of chinook relative abundance (fry density and catch per unit effort (CPUE)) were calculated to determine the degree of chinook association with habitat complexes and natural sites. The length, weight and condition factor of the chinook sampled and the composition of the fish community at natural and habitat complex sites were also described.

The 1997 study was the ninth consecutive year of the assessment program. Results of the 1997 study were complicated by unusually high water levels in the river during field programs. High water levels made assessment of some structures by electrofishing difficult or impossible at certain times of the year and significantly reduced visibility during snorkel surveys. In addition, the emergent fry structure sites were washed out and made inoperable because of increased flows.

However, electrofishing indicated that the habitat complexes were well used by chinook fry (0+) and chinook pre-smolts (0+ and 1+). When both types of sites were sampled at similar times, artificial habitat complexes were either used as much or more than natural sites. Within habitat complex types, there were no consistent differences in utilization of debris bundles or debris catchers in either Reach 2 or Reach 4. Similar trends of complex utilization have been reported in previous Nechako River studies.

There were no significant differences in length, weight and condition factor among chinook 0+ sampled in habitat complexes and natural sites within day and night samples. In addition, fish communities within complex and natural sites were dominated by cyprinids, catostomidae and chinook 0+, as in previous years.

INTRODUCTION

The Nechako River Working Group (Anon. 1987) recognized that the change from the short term to the long term flow regime, resulting from the proposed Kemano Completion Project (KCP), may influence the amount of debris cover habitat available to chinook salmon (*Oncorhynchus tshawytscha*) in the Nechako River. Debris cover provides rearing and overwintering habitat for juvenile chinook salmon. In response to chinook conservation concerns, and as part of the remedial measures outlined by the Nechako River Working Group, artificial habitat complexes were installed from 1989 through 1991 to demonstrate the feasibility of increasing habitat complexity in the Nechako River. In 1991, 45 habitat complexes were installed in Reach 2 and 17 in Reach 4. Over the last five years twelve structures have been lost or damaged, with 37 complexes remaining in Reach 2 and 13 complexes in Reach 4 in 1997 (Table 1). In 1996 and 1997, emergent fry structures were added to the sampling program to determine the potential for enhancing habitat for newly emergent fry in low velocity, shallow water along the river margins. Since the cancellation of the KCP in 1995, data collection continues to allow its use in a technical review of the program.

Instream habitat complexing techniques have been reviewed by various authors and have been shown to be successful in stream and river systems in Oregon and British Columbia. In particular, debris cover structures appear to provide rearing and overwintering habitat for juvenile chinook (Parkinson and Slaney 1975, Ward and Slaney 1981, Slaney et al. 1994). Buell (1989) suggests that the artificial habitat created should mimic the type of structural material that produces habitat naturally in an area. In the Nechako River, the naturally occurring large woody debris (LWD) are well utilized by chinook (Lister & Associates 1993), and the artificial structures installed are primarily composed of large woody debris.

Emergent fry structures were installed in the upper Nechako River to assess the possibility of supplementing low velocity, shallow rearing habitat. Juvenile chinook use of the artificial structures has been assessed annually from 1989 through 1997. Results of these assessments indicate that the habitat complexes in the Nechako River were as well or better utilized than natural sites during all times of the year (Triton 1996 a - h, Ward and Slaney 1993, Slaney et al. 1994). This report details the results of the assessment in 1997, the ninth year of the project.

Table 1
Habitat Complex Sites Along the Nechako River, 1997

Habitat Type	Abbr.	Number Present - April - July		Number Present - November	
		Reach 2	Reach 4	Reach 2	Reach 4
Instream Cover Structures:					
Sweeper	SWPR	5	9	1	5
Rootwad Sweeper	RS	1	0	1	0
Rail Debris Catcher	RDC	16	4	15	4
Pipe-pile Debris Catcher	PDC	2	0	2	0
Floating Crib	FC	2	0	2	0
Pseudo Beaver Lodge	PBL	2	0	1	0
Brush Pile	BP	1	0	0	0
Instream Channel Modifications:					
Pocket Pool	PP	1	0	1	0
Point Bar	PB	3	0	3	0
Side Channel Development:					
Side Channel/Debris Boom	DB	1	0	1	0
Complexed Side Channel	SC	1	0	1	0
Totals:		35	13	28	9

METHODS

Study Sites

The project area includes sites within a 25 km section (km 15 - 40) of Reach 2 and a 17 km section (km 72 - 89) of Reach 4 of the Upper Nechako River (Figures 1 and 2). The Nechako River drops 10 to 13 m with an average gradient of 0.06 % through the study area in Reaches 2 and 4. Habitat complexes were established in areas which lacked cover, but had physical characteristics which met the chinook habitat criteria identified by Envirocon (1984): depth greater than 0.4 m, substrate composition predominantly gravel to cobble and velocities from 0.15 to 0.50 $m.s^{-1}$. The natural sites were similarly identified as prime chinook habitat with varying amounts of available cover and physical characteristics within these criteria. All sites are described in Appendix 1.

Habitat complex assessment sites consist of instream cover structures (debris bundles and debris catchers), instream channel modifications, side channel developments and natural sites with and without LWD (Table 1). Debris bundles are complex matrices of whole trees or rafts of logs with branches and smaller debris wedged into them (sweepers, rootwad sweepers, floating cribs, pseudo beaver lodges and brush piles). Debris catchers are triangular arrangements of pipes or rails driven into the substrate which protrude above the high water level and have logs attached to them. Instream channel modifications, such as the pocket pool, point bars and side channel developments with debris booms, are only present in Reach 2.

Two emergent fry structure sites were built on April 13, 1997 in Reach 2, one in an area of high spawning activity, downstream of km 19, and the other in an area of low spawning activity, in the most downstream section of that reach. Each site consisted of a test plot and a control plot. Emergent fry structures consisted of small coniferous trees placed at a 45° angle downstream and held in place with re-bars through the base of the trunk and half way along the trunk. Each site contained 10 evenly spaced structures in 50 m long plots. The control sites were also 50 m long, and were separated from the structure plots by approximately 50 m. The sites were located in places with gravel substrates, 0.2 m deep water and velocity of approximately 0.2 $m.s^{-1}$.

Nechako River - Physical Parameters

Daily water temperatures and flows of the Nechako River were measured by Water Survey of Canada (WSC) 10 km downstream of Cheslatta Falls (WSC 08JA017). Daily flows were also recorded at Skins Lake Spillway (WSC 08JA013). Both temperature and flows are reported as preliminary data in Appendices 2, 3 and 4.

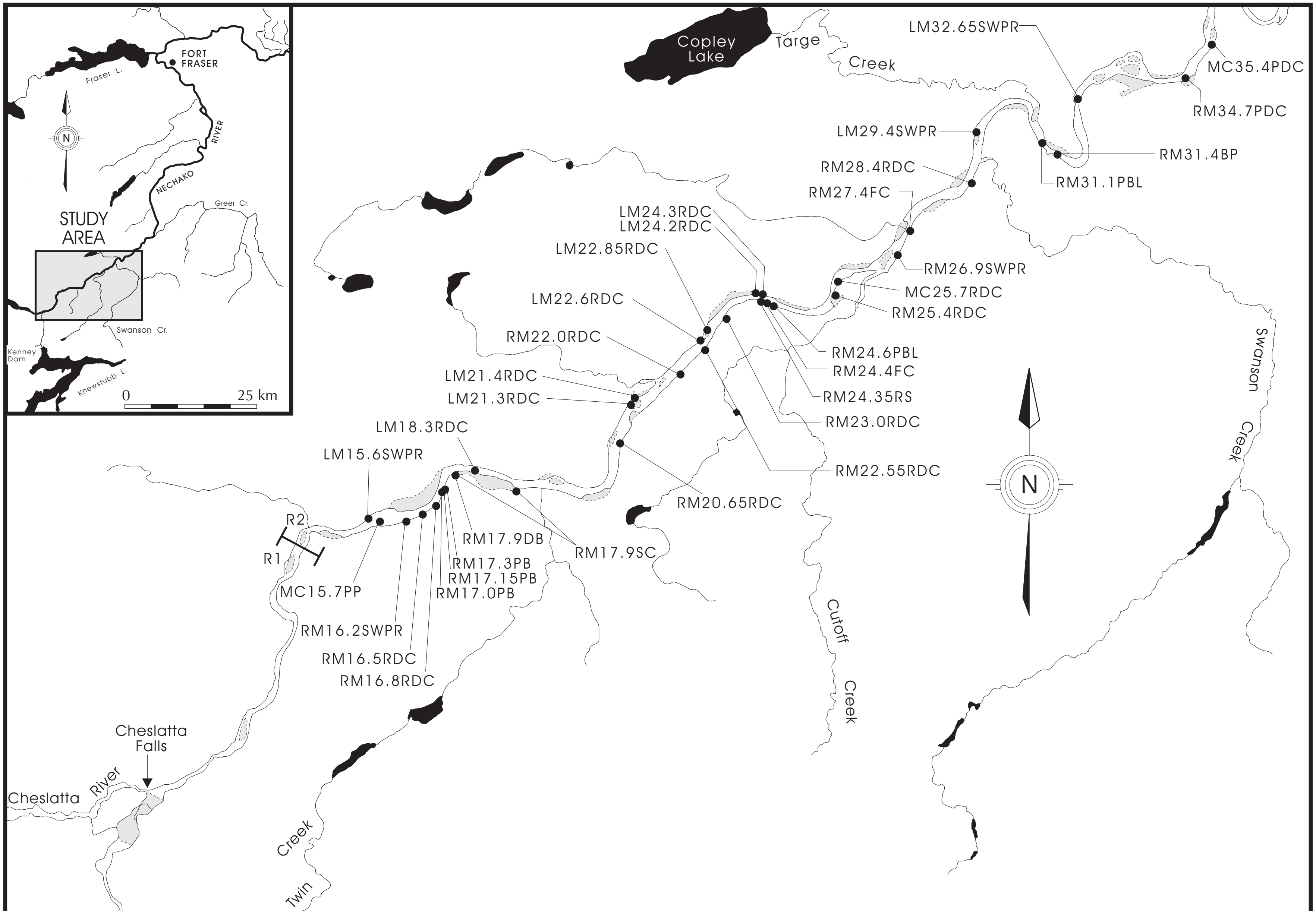
Sampling

The objective of this study was to document juvenile chinook use of the habitat complexes and natural sites. Chinook relative abundance was determined with two techniques: underwater snorkel surveys and electrofishing. The number of chinook associated with the complexes and natural sites were assessed at three life history stages: overwintered pre-smolt chinook 1+; post-emergent juvenile chinook 0+; and pre-smolt chinook 0+ remaining in the fall to potentially overwinter.

Indices of chinook relative abundance (fry density and catch per unit effort (CPUE)) were calculated to determine the degree to which chinook were associated with the complexes and natural sites. Up to 10 fish of each salmonid species were measured to the nearest mm (fork length) and weighed to the nearest 0.01 g (whole wet weight) at each site. Fulton's condition factor ($K = weight. 100{,}000 . length^{-3}$; Ricker 1975) was also calculated. The fish community composition at complexes and natural sites was also described.

Snorkel Surveys

Snorkel surveys were conducted at habitat complexes and natural sites within Reach 2 once per month in June and July. Due to extremely poor visibility, Reach 2 was not surveyed in May of 1997 and Reach 4 could not be surveyed by snorkel at all. Divers equipped with dry suits and snorkel gear swam the habitat complexes and natural sites, recording the location and number of all fish observed. The range of visibility for detection and identification of fish during snorkel surveys varied from 0.5 to 1.5 m. The number of fish observed within each habitat complex and natural site was recorded. The surveys were performed on June 20 and 21, and July 8 in Reach 2. The side channel was not surveyed by snorkel in 1997.

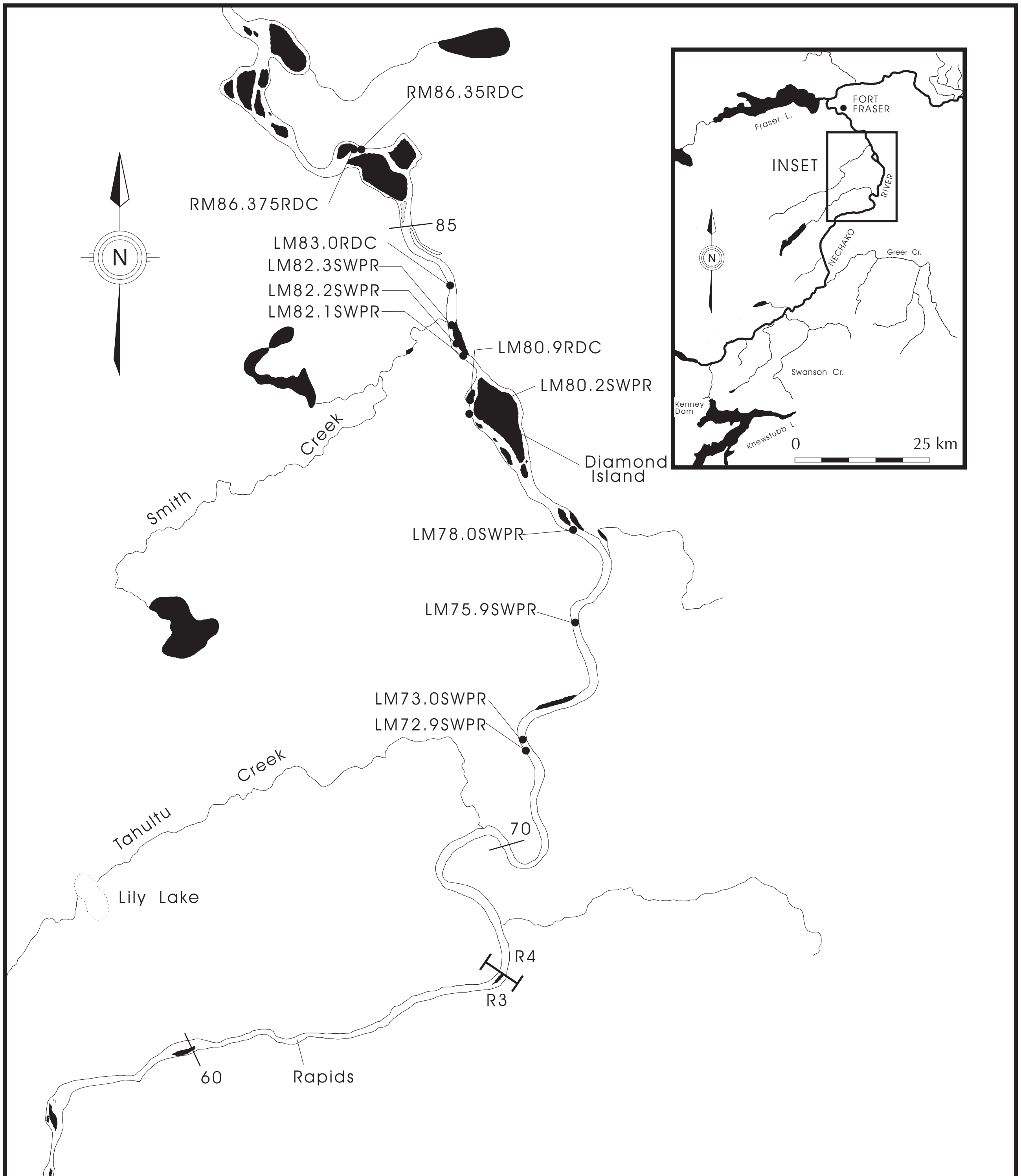


Nechako Fisheries Conservation Program

Map # RM97-3-1

0 5 km

FIGURE 1. MAINSTEM STUDY AREA, NECHAKO RIVER, REACH 2



Nechako Fisheries Conservation Program

Map # RM97-3-2

FIGURE 2. MAINSTEM STUDY AREA, NECHAKO RIVER, REACH 4

The reduced visibility that occurred during spring was due to very high flows from the Nechako Reservoir. The reduced visibility made comparisons with previous years' data difficult. However comparisons were made between complexes and natural sites.

Electrofishing

Electrofishing surveys were conducted in April, May, June, July and November to assess the use of complexes by chinook fry during peak rearing periods, assess overwintering usage and collect length and weight data. A Smith-Root Model 15-A electroshocker equipped with a TAS Model QEG 300 gas powered generator was used and voltages typically ranged from 600 to 800 V at 60 Hz. Electrofishing surveys were conducted in Reach 2 on April 8-13, May 11-15, June 10-14, July 3-5 and October 31 to November 3, 1997. Reach 4 was sampled on April 5-7, May 16-18, June 16-18 and November 5-6, 1997. Most sites were sampled once during the day and once during the night in each month. However, high flows during May and June made electroshocking conditions sufficiently hazardous that some crews could not safely sample all sites (Table 2). In addition ice conditions in April prevented several sites, including the side channel, from being surveyed. Flooding also meant that several complex sites were incompletely surveyed (e.g., surveyors could not get to the debris catchers, and could only shock along the shoreline; cf. Appendix 5). These sites were treated as natural sites during the analyses. Only 23% of all Reach 2 sites were accessible for electrofishing in July and only two of the complexes could be sampled. No sites in Reach 4 were accessible during July due to extremely high flows. Therefore the July sampling was not included in the analyses.

Table 2
Number of Sites Electrofished During the Day and Night in

Reach	Site	April		May		June		November	
		Day	Night	Day	Night	Day	Night	Day	Night
2	Complex	34	33	29	30	23	23	28	28
	Natural	32	32	37	36	32	28	39	39
	Total	66	65	66	66	55	51	67	67
4	Complex	13	13	10	10	4	3	9	9
	Natural	20	19	22	21	14	14	23	23
	Total	33	32	32	31	18	17	32	32
2 & 4	Complex	47	46	39	40	27	26	37	37
	Natural	52	51	59	57	46	42	62	62
	Total Sites	99	97	98	97	73	68	99	99

Note: Some complexed sites could not be sampled due to high flows. Sampling at these sites was documented as occurring at natural sites.

The data recorded at each site included fish measurements, area and time electrofished. Incidental catches of other species were also recorded to provide comparisons of fish community structure among various site types.

Emergent fry structures were sampled by electrofishing before the installation of the structures and every two weeks thereafter. Sampling consisted of electrofishing the sites during both day and night from downstream to upstream. Fish were collected in a 5 gallon bucket for each of the control sites, and the structure sites were further subdivided into fish captured at each individual tree. Fish sampled between trees were also counted. From each sample, a subsample of 10 chinook fry were weighed to the nearest 0.01 g and measured to the nearest mm (fork length), and all fish were returned to their point of origin.

Statistical Analyses

Due to the their limited number and / or lack of LWD cover features, the pocket pool (n = 1), point bars (n = 3), and side channel with debris boom (n = 1) were not included in the following statistical analyses of CPUE. These structures are treated in a qualitative manner. At the remaining sites, fry density ($\log_{10}$ fry.100 m^{-2}) and the geometric mean number of chinook 0+ observed in habitat complexes were calculated.

Catch per unit effort (CPUE) was calculated for each site sampled and expressed as the catch per square meter (fry.m^{-2}) and catch per second (fry.second^{-1}). Since the correlation between the CPUE calculated by area and the CPUE calculated by seconds was high (Pearsons correlation r of 0.99), further analyses were performed on catch per square meter. The data were $\log_{10}$-transformed to improve homogeneity of variance. The effects of habitat type and time of day on the CPUE data and on the length, weight and condition factor of chinook were assessed within each month using one-way analysis of variance. *A posteriori* tests (Least Squares Difference) were performed to determine the direction of any difference detected. Comparisons with probability values of $P < 0.05$ were considered significant. The effect of complex type (debris bundles or debris catchers) on fry density and on CPUE was also examined by t-test and one-way analysis of variance.

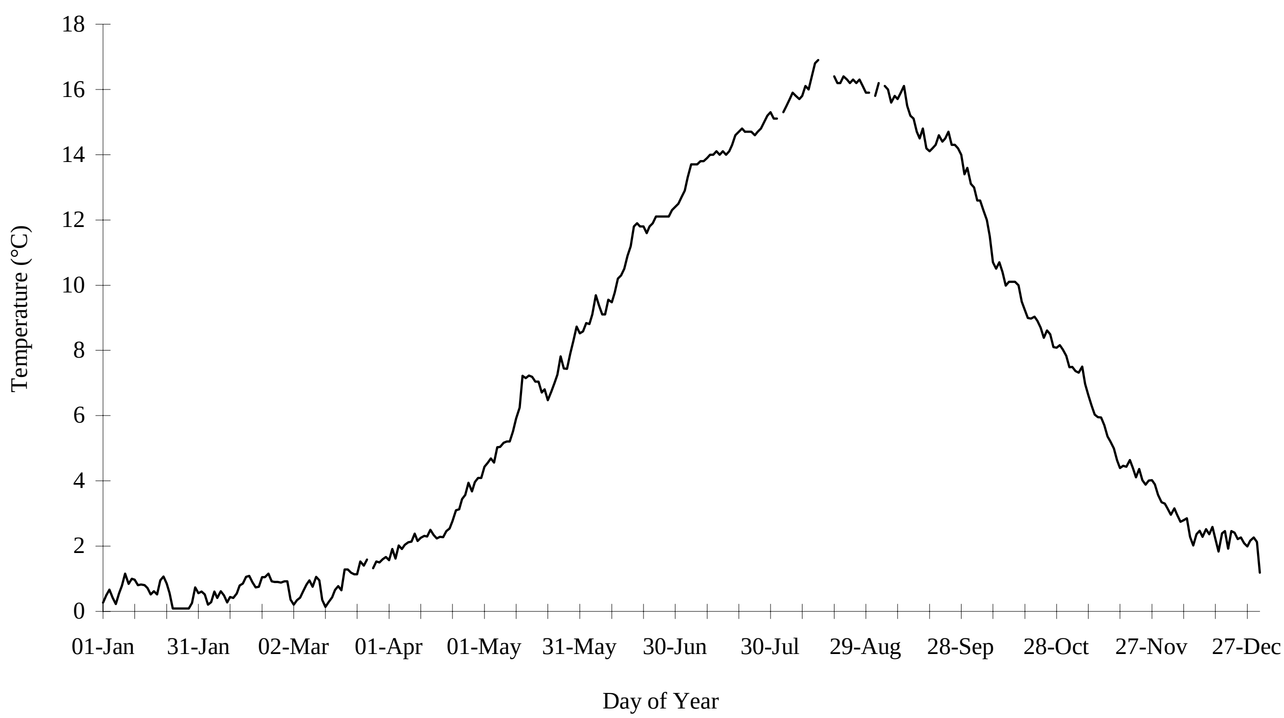
In previous studies the relationship between abundance of chinook 0+ observed in snorkel surveys and the physical parameters of the complex sites was examined through a stepwise multiple regression. The parameters analyzed for each site included cover area, velocity (shear, approach, through and exit), depth (shear, approach, through and exit), substrate, and the extension from the margin. However, in 1997 the low numbers of chinook observed and daily changes in physical parameters due to fluctuating water levels made such statistical comparisons problematic.

RESULTS

Nechako River - Physical Data

Temperatures of the Nechako River Water Survey Canada (WSC) station below Cheslatta Falls (WSC #08JA017), 1997, ranged from 0.6 °C in January to 16.1 °C in August (Figure 3, Appendix 2). The mean monthly temperatures during the April to June sampling periods ranged from 2.6°C (April) to 10.7°C (June). From August to October the observed mean monthly temperatures were generally warmer than previous years and ranged from 16.1°C (August) to

Figure 3
Mean Daily Water Temperatures of the Nechako River Below Cheslattta Falls (WSC 08JA017), 1997



Temperatures for March 26, August 2, August 15-18 and September were unavailable.

10.0°C in October. The mean monthly temperature during November was 5.3°C.

The releases from Skins Lake Spillway and the flows measured below Cheslatta Falls are shown in Figure 4. There was a major forced spill in 1997 due to high reservoir inflows. Spillway release levels were already above normal winter base flows at the beginning of the year. By May 1, 1997, reservoir releases were increased to 72.7 $m^3.s^{-1}$, resulting in flows below Cheslatta Falls of 110 $m^3.s^{-1}$. Releases from the spillway subsequently increased on May 16/17, May 28/29, June 5/6, June 10/11 and June 19, 20 and 21 to an ultimate maximum of 342 $m^3.s^{-1}$. Flows below Cheslatta Falls reached a maximum of 362 $m^3.s^{-1}$ on July 6, 1997 (Appendices 3 and 4). Releases were maintained at approximately 340 $m^3.s^{-1}$ from June 21 until August 20. During September, as a result of high reservoir levels, higher than average releases continued from the spillway. Spillway releases were maintained at approximately 85.0 $m^3.s^{-1}$ until October 29, 1997 when they were decreased to winter base flows of 57.3 $m^3.s^{-1}$. During this time flows below Cheslatta Falls varied from 80.7 $m^3.s^{-1}$ on September 4 to 88.3 $m^3.s^{-1}$ between September 27, and October 5, 1997 (Figure 4).

Chinook (1+)

Snorkel Surveys

No chinook 1+ were observed in any of the sites during the snorkel surveys conducted in 1997. This is similar to results of previous years when very few chinook 1+ were observed during snorkel surveys of the Nechako River (Triton 1996 a - h).

Electrofishing

In 1997, 320 chinook 1+ were sampled by electrofishing in reaches 2 and 4 of the Nechako River. The peak count occurred in April when 256 chinook 1+ were sampled in both reaches (Table 3). Most of these fish were sampled during the night (92 %), and most were found in complex sites in Reach 2 (70 %), and in natural sites in Reach 4 (70 %). By the month of June, most of the chinook 1+ had moved out of reaches 2

Figure 4
Mean Daily Releases from the Skins Lake Spillway (WSC 08JA013) and Below Cheslatta Falls (WSC 08JA017), Nechako River 1997

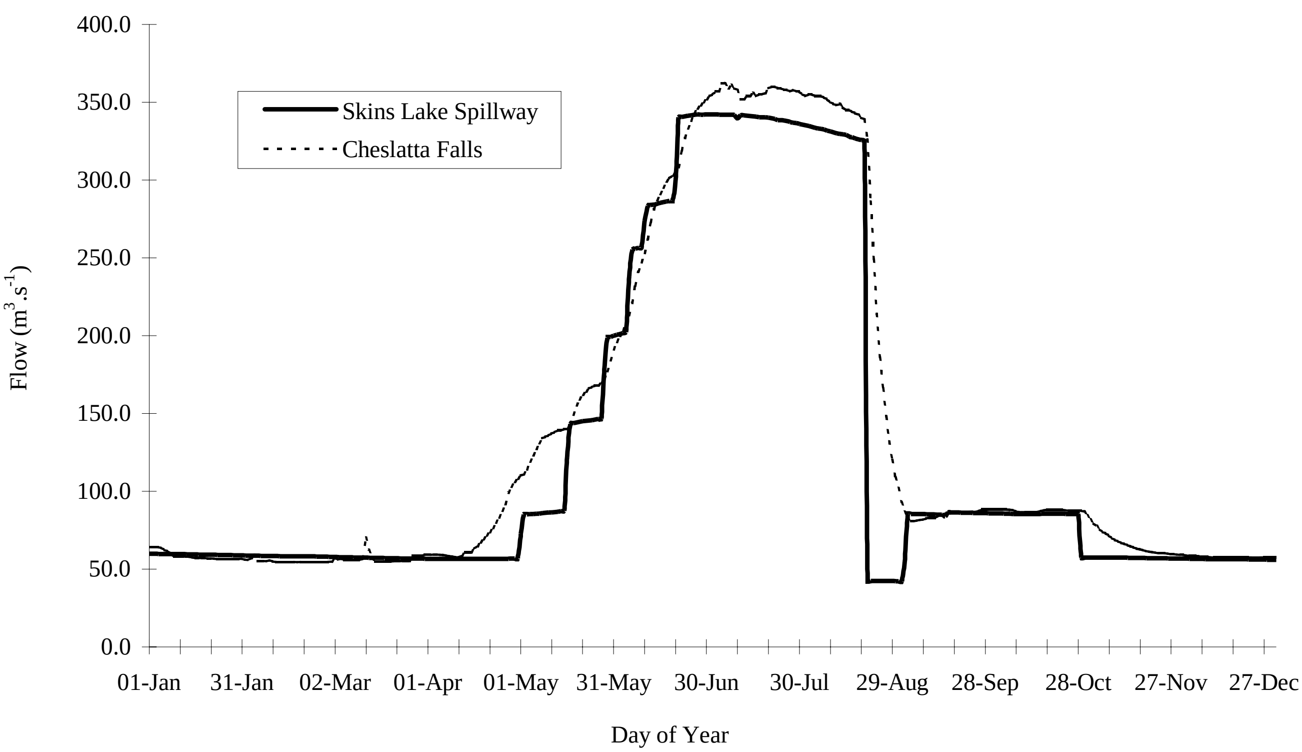


Table 3
Numbers of Chinook Electrofished in Habitat Complexes and Natural Sites from Reaches 2 and 4 of the Nechako River, 1997

Fish	Month	Reach 2							Reach 4					
		Complex[1]		Natural[2]		Others[3]		Total	Complex[1]		Natural[2]		Total	Total
		Day	Night	Day	Night	Day	Night	Reach 2	Day	Night	Day	Night	Reach 4	Reach 2 + 4
Chinook 1+	April	14	105	1	5	2	24	151	3	28	0	74	105	256
	May	2	37	0	14	0	0	53	0	7	1	3	11	64
	June	0	0	0	0	0	0	0	0	0	0	0	0	0
	November	0	0	0	0	0	0	0	0	0	0	0	0	0
	Total	16	142	1	19	2	24	204	3	35	1	77	116	320
Chinook 0+	April	102	198	132	257	7	7	703	5	15	44	36	100	803
	May	576	584	751	665	105	169	2850	40	157	171	405	773	3623
	June	74	516	44	526	16	343	1519	9	43	37	160	249	1768
	November	19	231	14	170	7	39	480	18	44	5	115	182	662
	Total	771	1,529	941	1,618	135	558	5,552	72	259	257	716	1,304	6,856

(1) Does not include samples where complex could not be reached.

(2) Includes samples from complex sites when complexes could not be reached.

(3) Others includes side channel with debris boom, pocket pools and point bars.

and 4, and none were captured from complex or natural sites in Reach 2 or Reach 4.

Complex Use

The variation in monthly chinook CPUE for all sites in Reach 2 is shown in Figure 5. Chinook 1+ use of complex sites at night was consistently greater than for any other type of site or any other time, as evidenced by the CPUE. The mean CPUE +1 values are presented in Appendix 6. There were no significant differences between the mean $\log_{10}$(CPUE +1) among sites sampled during the day. The mean (± 1 SD) $\log_{10}$(CPUE +1) for sites sampled during the day ranged from 0.09 ± 0.52 to 0.66 ± 1.32 in April and from 0.00 to 0.23 ± 0.78 in May. Debris catcher habitat complexes had significantly greater CPUE +1($\log_{10}$) than debris bundles during April and May at night (Appendix 7). The mean (± 1 SD) $\log_{10}$(CPUE +1) in debris catcher sites at night ranged from 2.76 ± 1.61 in April to 2.40 ± 1.52 in May. The mean (± 1 SD) $\log_{10}$(CPUE +1) in debris bundle sites at night ranged from 1.55 ± 1.81 in April to 1.14 ± 1.58 in May. There were no significant differences between the mean (±1 SD) $\log_{10}$(CPUE +1) in debris bundles and catchers during the day in Reach 2.

In Reach 4, chinook 1+ were also more abundant at night (had a greater CPUE) in complex and natural sites than during the day (Figure 6). Complex and natural site uses were not significantly different during April (Figure 6). In May, however, there were more chinook 1+ in complex sites than in natural sites at night ($\log_{10}$ CPUE). The mean (± 1 SD) $\log_{10}$(CPUE +1) for complexes at night was 1.25 ± 1.61, and for natural sites was 0.28 ± 0.90 in May (Appendix 6). The mean (± 1 SD) $\log_{10}$(CPUE +1) for sites sampled in

Figure 5
Monthly Mean Log_{10}(CPUE+1) of Chinook 0+ and Chinook 1+
Electrofished in Reach 2 of the Nechako River, 1997

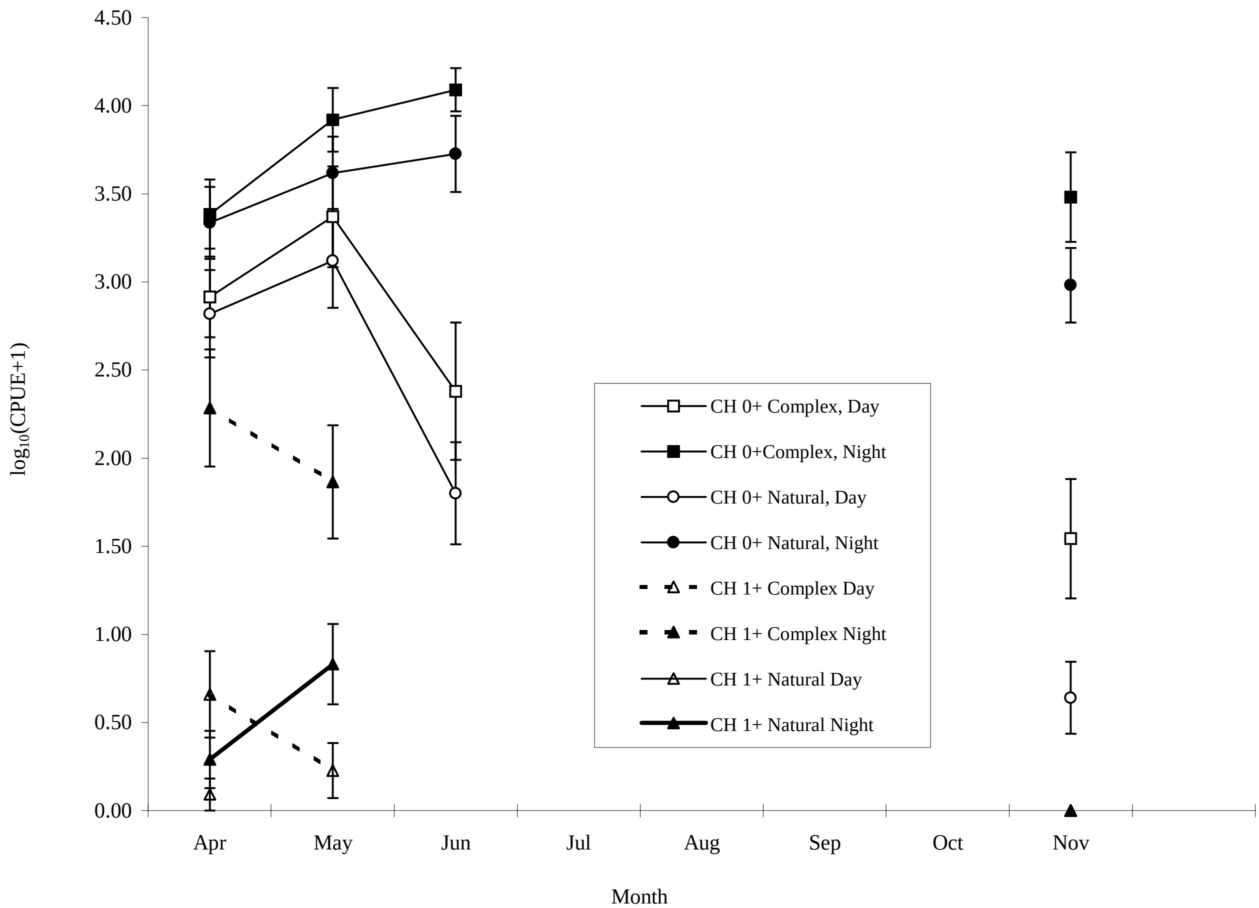
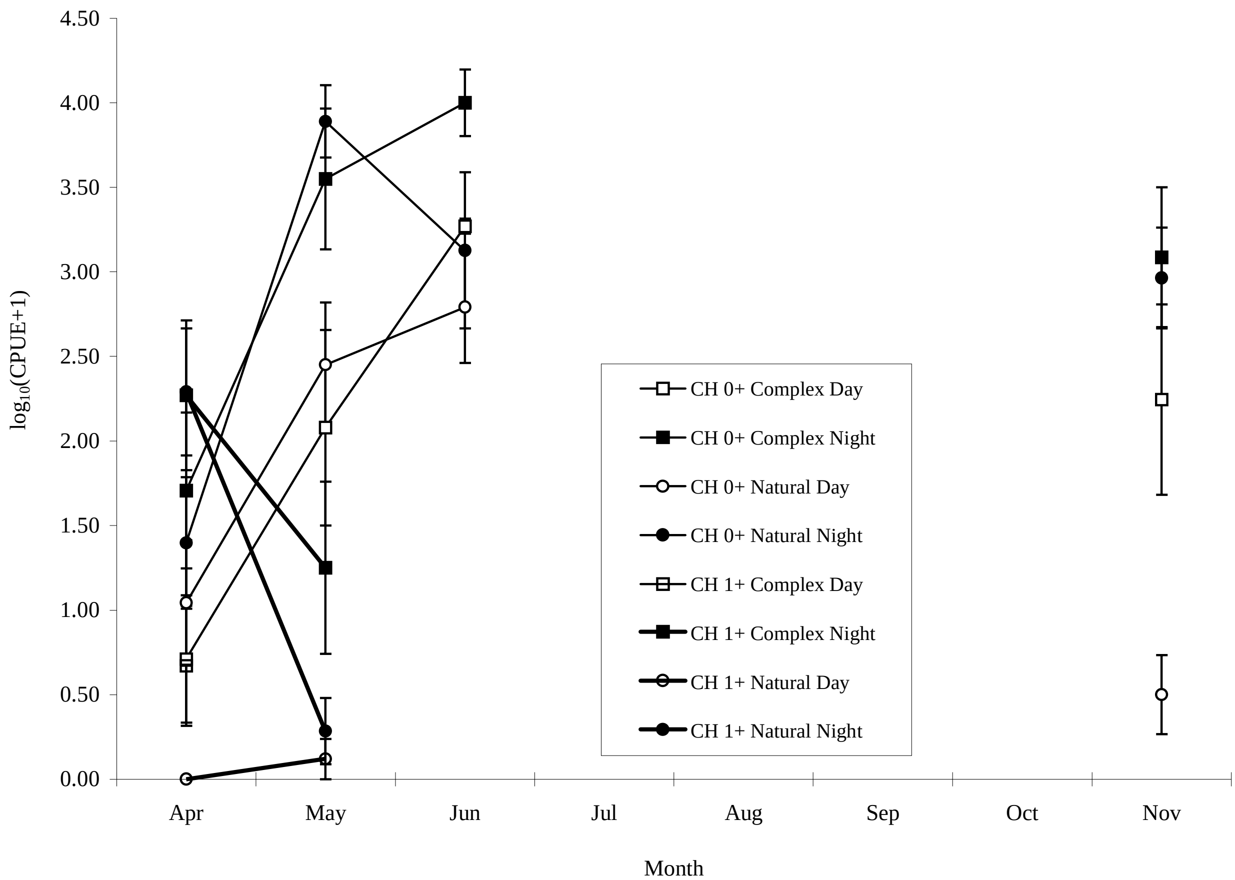


Figure 6
Monthly Mean Log_{10}(CPUE+1) of Chinook 0+ and Chinook 1+
Electrofished in Reach 4 of the Nechako River, 1997



the day ranged from 0.00 to 0.12 ± 0.56 in May. There were no significant differences in CPUE among complexes at any time (Appendix 7).

Length, Weight and Condition Factor

Reach 2

There were no significant differences in fork length, weight or condition factor of chinook 1+ from complex and natural sites within day or night sampling periods (Figures 7, 8 and 9). The mean (± 1 SD) fork lengths for April ranged from 87.0 to 99.3 ± 11.0 mm, and in May from 100.5 ± 2.1 to 104.9 ± 6.2 mm (Appendix 8). The mean (± 1 SD) weights ranged from 10.3 to 12.4 ± 3.9 g in April, and from 13.1 ± 2.8 to 14.8 ± 2.6 g in May (Appendix 9). The range of mean (± 1 SD) condition factors for these months were from 1.2 ± 0.1 to 1.6 $g.mm^{-3}$ in April, and from 1.2 ± 0.2 to 1.3 ± 0.2 $g.mm^{-3}$ in May. (Appendix 10).

Reach 4

A total of 83 chinook 1+ were sampled in Reach 4 in April and May. There were no significant differences in fork length, weight and condition factor of chinook 1+ from complex and natural sites within the sampling periods (Figures 10, 11 and 12). Mean (± 1 SD) fork lengths ranged from 89.3 ± 12.6 to 97.3 ± 8.1 mm in April and from 94.7 ± 13.3 to 113.0 mm in May (Appendix 8). The mean (± 1 SD) weights ranged from 8.3 ± 1.6 to 10.9 ± 2.3 g in April and from 11.9 ± 4.7 to 17.6 g in May (Appendix 9). The mean (± 1 SD) condition factors ranged from 0.9 ± 0.03 to 1.2 ± 0.1 $g.mm^{-3}$ in April and from 1.2 to 1.4 ± 0.1 $g.mm^{-3}$ in May (Appendix 10).

Table 4
Number of Chinook 0+ Observed During Snorkel Surveys in Reach 2, and the Percent Recorded Within Habitat Complexes and Natural Sites in the Nechako River, 1997

Month	Site Types	Area surveyed (m^2)	Sites Sampled Number	Visibility (m)	Chinook 0^+ Number	Chinook 0^+ Percent	Area surveyed (km^2) km^2	Area surveyed (km^2) Percent
June	Complex (1)	548	25	1.0-1.5	176	40.6	0.0005	19.7
	Natural (2)	2,075	40	1.0-1.5	207	47.7	0.0021	74.8
	Point Bar	150	3	1.0-1.5	51	11.8	0.0002	5.4
	TOTAL	2,773	68		434	100	0.0028	100.0
July	Complex (1)	213	23	0.5	423	73.3	0.0002	18.4
	Natural (2)	885	42	0.5	154	26.7	0.0009	76.4
	Point Bar	60	5	0.5	0	0.0	0.0001	5.2
	TOTAL	1,158	70		577	100.0	0.0012	100.0

Side channel in Reach 2 and all of Reach 4 not snorkelled in both months.
Area surveyed is equal to length of site times average visibility

(1) Does not include complex sites where complex could not be reached due to high water.

(2) Includes shoreline of complex sites where complex could not be reached due to high water.

Chinook 0+

Snorkel Surveys

Complex Use

The numbers of chinook 0+ observed by snorkel survey in Reach 2 in June and July, including the percent associated with complex and natural sites, are shown in Table 4.

Reach 2

In Reach 2, a total of 1011 chinook 0+ were observed during the snorkel surveys. (Table 4). Most of these were observed in July (577). The area of habitat complexes represented an average 19 % of the area surveyed, yet yielded 41 % (June) and 73 % (July) of all chinook 0+ observed in the river (Table 4). Visibility was particularly poor in July (0.5 m), and most of the chinook 0+ observed in this month were found in the complex sites (73 %). Natural sites made up 76 % of the total area surveyed, and accounted for 27 % of the chinook 0+ observed.

Fry were observed in 48 % of the complex sites in the peak month of July (Table 5). The number of chinook 0+ observed at the complex sites and the resultant densities for the complex sites are provided in that table. Fry densities were very low in June and July, with means of 0.3 and 1.2 fry per 100 m^2, respectively. There were no significant differences in fry densities within complex types between bundles and catchers in either month (t-test on $\log_{10}$ values, $P < 0.05$).

Electrofishing

Complex Utilization

A total of 6,856 chinook 0+ were sampled by electrofishing in reaches 2 and 4 of the Nechako River in 1997. Chinook 0+ were most abundant in May (3,623 sampled) and in least abundant in November (662 sampled; Table 3).

Reach 2

Chinook 0+ CPUEs tended to be greater at night than during the day from May through November (Figure 5). There were no significant differences in CPUEs between complex and natural sites from April to June. In November the mean daytime CPUE was signifi-

Table 5
Habitat Complex Sites' Cover Areas and Chinook 0+ Densities in Reach 2 of the Nechako River 1997

1997 Sites	Complex Type	June 20 and 21, 1998 Chinook 0+ Observed	June 20 and 21, 1998 Cover Area (m^2)	June 20 and 21, 1998 Density ($fry*m^{-2}$)	June 20 and 21, 1998 Log_{10} Density ($fry*100m^{-2}$)	July 21, 1998 Chinook 0+ Observed	July 21, 1998 Cover Area (m^2)	July 21, 1998 Density ($fry*m^{-2}$)	July 21, 1998 Log_{10} Density ($fry*100m^{-2}$)
LM15.6SWPR	Sweeper	0	15	0.0	0.0	22	15	1.5	2.2
RM16.2SWPR	Sweeper	0	2	0.0	0.0	Complex not surveyed			
RM16.8RDC	Rail Debris Catcher	0	10	0.0	0.0	Complex not surveyed			
RM17.9DB	Debris Boom	0	60	0.0	0.0	4	60	0.1	0.9
LM18.3RDC	Rail Debris Catcher	135	30	4.5	2.7	80	30	2.7	2.4
RM20.65RDC	Rail Debris Catcher	0	50	0.0	0.0	0	50	0.0	0.0
LM21.3RDC	Rail Debris Catcher	10	20	0.5	1.7	65	20	3.3	2.5
LM21.4RDC	Rail Debris Catcher	0	10	0.0	0.0	0	10	0.0	0.0
RM22.0RDC	Rail Debris Catcher	3	15	0.2	1.3	0	15	0.0	0.0
RM22.55RDC	Rail Debris Catcher	0	15	0.0	0.0	120	15	8.0	2.9
LM22.6RDC	Rail Debris Catcher	0	15	0.0	0.0	0	15	0.0	0.0
LM22.85RDC	Rail Debris Catcher	1	15	0.1	0.9	21	15	1.4	2.1
RM23.0RDC	Rail Debris Catcher	0	10	0.0	0.0	1	10	0.1	1.0
LM24.2RDC	Rail Debris Catcher	1	15	0.1	0.9	4	15	0.3	1.4
LM24.3RDC	Rail Debris Catcher	0	10	0.0	0.0	0	10	0.0	0.0
RM24.35RS	Rootwad Sweeper	1	5	0.2	1.3	0	5	0.0	0.0
RM24.4FC	Floating Crib	4	30	0.1	1.2	0	30	0.0	0.0
RM24.6PBL	Pseudo Beaver Lodge	20	10	2.0	2.3	13	10	1.3	2.1
MC25.7RDC	Rail Debris Catcher	0	5	0.0	0.0	0	5	0.0	0.0
RM27.4FC	Floating Crib	1	20	0.1	0.8	3	20	0.2	1.2

Table 5 (continued)
Habitat Complex Sites' Cover Areas and Chinook 0+ Densities in Reach 2 of the Nechako River 1997

		June 20 and 21, 1998				July 21, 1998			
1997 Sites	Complex Type	Chinook 0+ Observed	Cover Area (m^2)	Density ($fry*m^{-2}$)	Log_{10} Density ($fry*100m^{-2}$)	Chinook 0+ Observed	Cover Area (m^2)	Density ($fry*m^{-2}$)	Log_{10} Density ($fry*100m^{-2}$)
RM28.4RDC	Rail Debris Catcher	0	10	0.0	0.0	90	10	9.0	3.0
RM31.4BP	Brushpile	0	3	0.0	0.0	0	3	0.0	0.0
LM32.65SWPR	Sweeper	0	3	0.0	0.0	0	3	0.0	0.0
RM34.7PDC	Pipe Pile Debris Catcher	0	20	0.0	0.0	0	20	0.0	0.0
MC35.4PDC	Pipe Pile Debris Catcher	0	40	0.0	0.0	0	40	0.0	0.0
Complexes	Percent of Complex Utilization			36%		48%			
	Mean (± 1 SD) Density ($fry*m^{-2}$)			0.3 ± 1.0		1.2 ± 2.5			
	Mean (± 1 SD) log_{10} ($fry*100m^{-2}$)			0.5 ± 0.8		0.9 ± 1.1			
	Geometric mean density ($fry*100\ m^{-2}$)			2		3			
Bundles	Mean (± 1 SD) log_{10} ($fry*100m^{-2}$)			0.6 ±0.8		0.8 ± 1.0			
Catchers	Mean (± 1 SD) log_{10} ($fry*100m^{-2}$)			0.5 ± 0.8		1.0 ± 1.2			

cantly greater in complexes than in natural sites (Appendix 11; tests on $\log_{10}$ transformed values).

Within the structures, there were no significant CPUE differences among debris bundles and debris catchers within the day or night at any time of the year (Appendix 12).

The emergent fry structure sites were not sampled in 1997 due to the high flows.

Reach 4

In Reach 4, chinook 0+ CPUE also did not significantly differ between complex and natural sites within either the day or night time from April through June (Figure 6; tests on $\log_{10}$ transformed values). Values are provided in Appendix 11. In November the mean daytime CPUE was significantly greater in complexes than in natural sites ($\log_{10}$ transformed values). There were no significant differences between complex and natural sites sampled at night in that month.

Debris bundles and debris catchers CPUEs did not significantly differ within the day or night at any time of the year (Appendix 12).

Length, Weight and Condition Factor

Reach 2

There were few significant differences between complexes and natural sites in the mean lengths, weights or condition factors of chinook 0+ sampled by electrofishing during the day or night. There were significant differences between the day and night time periods but the number of chinook 0+ sampled at night was generally greater than the number of chinook 0+ sampled during the day.

The chinook 0+ sampled during the day ranged from a mean (± 1 SD) fork length of 36.2 ± 2.2 mm in April to 93.8 ± 4.6 mm in November, while those sampled at night had mean fork lengths from 36.7 ± 1.8 mm (April) to 93.2 ± 7.1 mm (November) (Figure 7, Appendix 8). Chinook sampled at night were significantly larger (mean fork length) than during the day in April.

During November chinook 0+ sampled in natural sites during the day had significantly greater fork length than those in complex sites during the same time period (Figures 7, 8 and 9). However, again there was a difference in the sample size with twice as many chinook 0+ being sampled at complex sites than natural sites.

Chinook 0+ sampled during the day had mean (± 1 SD) weights ranging from 0.38 ± 0.08 g in April to 9.27 ± 1.56 g in November, and those sampled at night ranged from 0.42 ± 0.09 g in April to 9.40 ± 1.91 g in November (Figure 8, Appendix 9). Chinook sampled at night were generally significantly heavier than those sampled during the day in all months except November. In November chinook from natural sites sampled during the day were significantly heavier than those from complex sites during the night.

The mean (± 1 SD) condition factor of chinook 0+ sampled during the day ranged from 0.79 ± 0.10 $g.mm^{-3}$ in April to 1.14 ± 0.13 $g.mm^{-3}$ in November, and that for chinook 0+ sampled at night ranged from 0.83 ± 0.11 in April to 1.16 ± 0.13 $g.mm^{-3}$ in November (Appendix 10). Again chinook 0+ sampled at night had significantly greater condition factors than those sampled during the day in all months except November. During November there were no significant differences in mean chinook 0+ condition factors between groups or time periods (Figure 9).

Reach 4

Mean fork lengths, weights and condition factors of chinook 0+ sampled from complexes and natural sites in Reach 4 are shown in Figures 10, 11 and 12.

The mean (± 1 SD) daytime fork lengths of chinook 0+ ranged from 35.1 ± 1.5 mm in April to 88.9 ± 3.3 mm in November and at night they ranged from 35.5 ± 1.7 mm in April to 90.8 ± 8.6 mm in November (Figure 10, Appendix 8). The only significant differences were in April, during daytime, when mean fork lengths of chinook 0+ sampled from natural sites were significantly greater than those from chinook 0+ sampled from complex sites (Appendix 8).

The mean (± 1 SD) daytime weights of chinook 0+ ranged from 0.29 ± 0.004 g in April to 7.75 ± 1.01 g in November and at night they ranged from 0.37 ± 0.05 g in April to 8.52 ± 2.13 g in November (Figure 11, Ap-

Figure 7
Monthly Mean Fork Length (mm) of Chinook 0+ and Chinook 1+
Electrofished in Reach 2 of the Nechako River, 1997

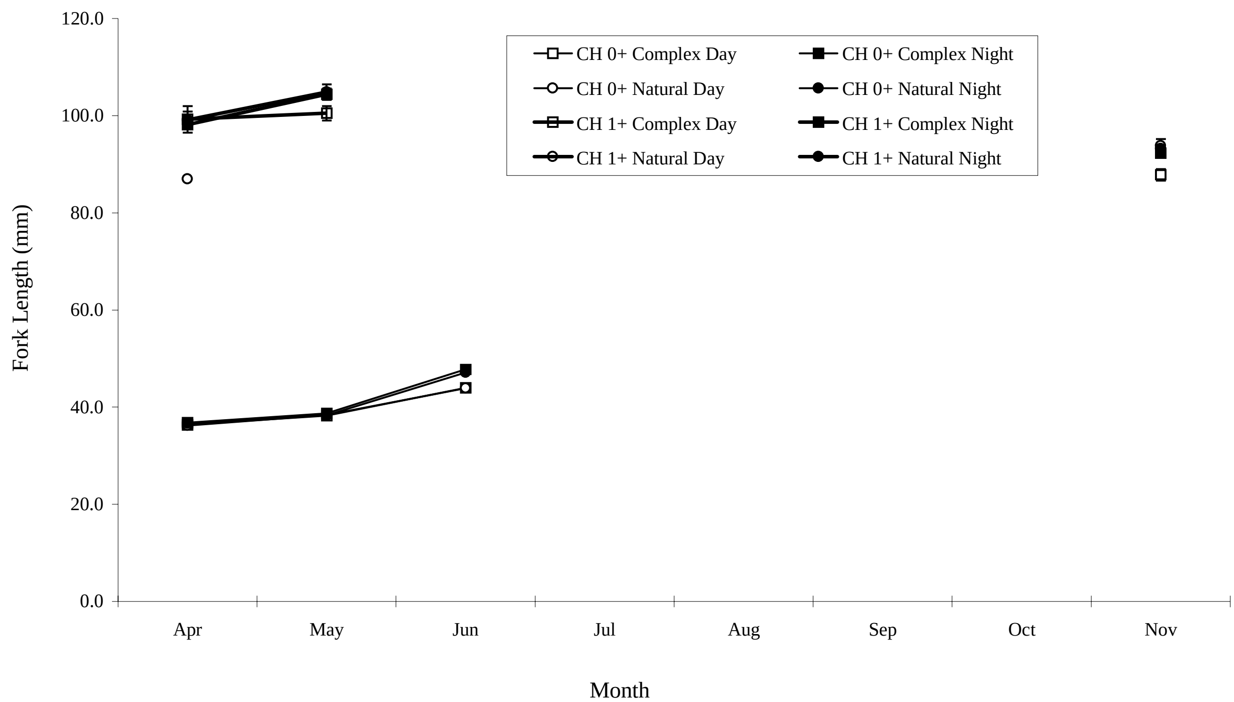


Figure 8
Monthly Mean Wet Weight (g) of Chinook 0+ and Chinook 1+
Electrofished in Reach 2 of the Nechako River, 1997

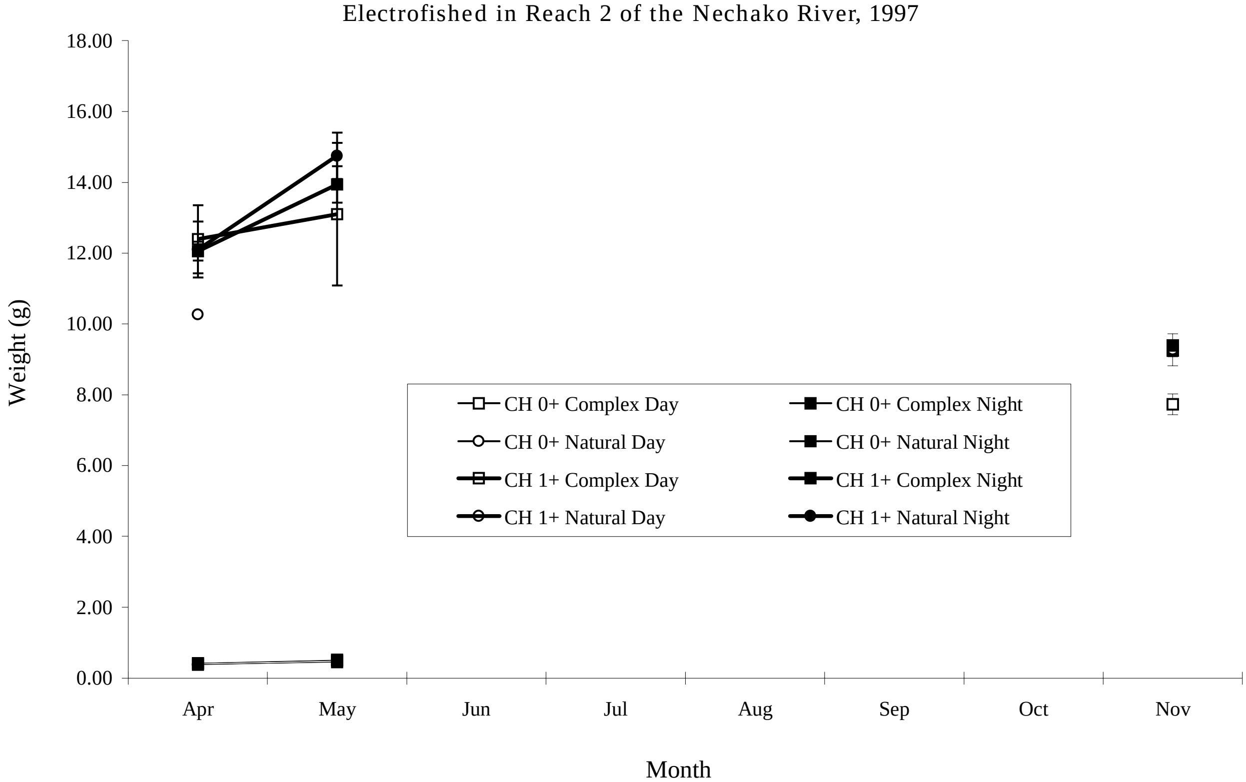


Figure 9
Monthly Mean Condition Factor (g.mm^{-3}) of Chinook 0+ and Chinook 1+
Electrofished in Reach 2 of the Nechako River, 1997

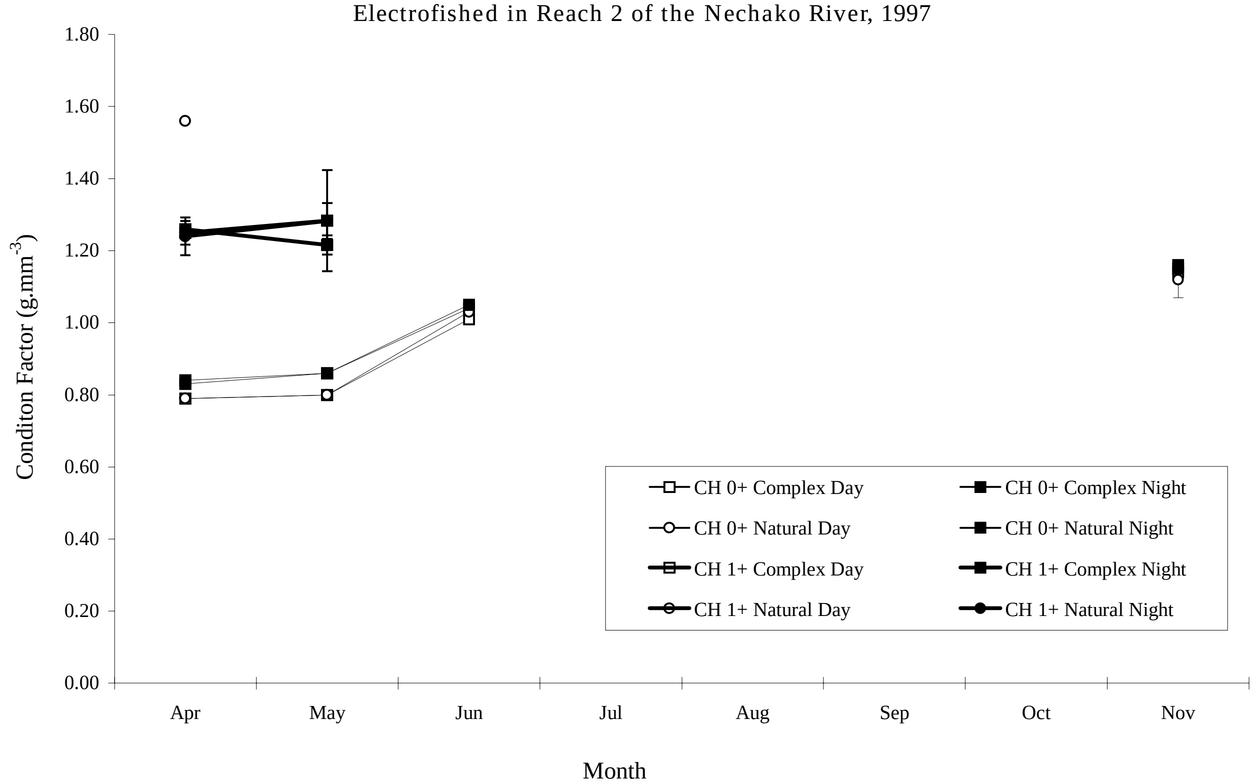


Figure 10
Monthly Mean Fork Length (mm) of Chinook 0+ and Chinook 1+
Electrofished in Reach 4 of the Nechako River, 1997

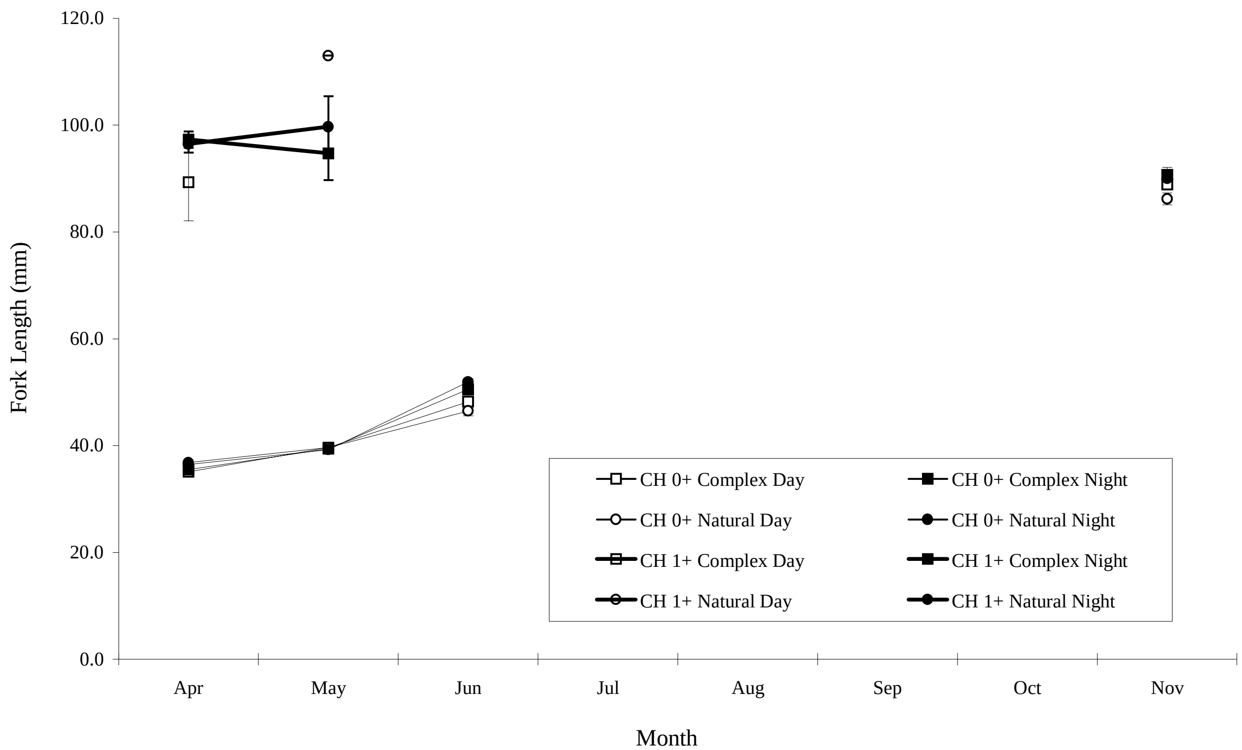


Figure 11
Monthly Mean Wet Weight (g) of chinook 0+ and Chinook 1+
Electrofished in Reach 4 of the Nechako River, 1997

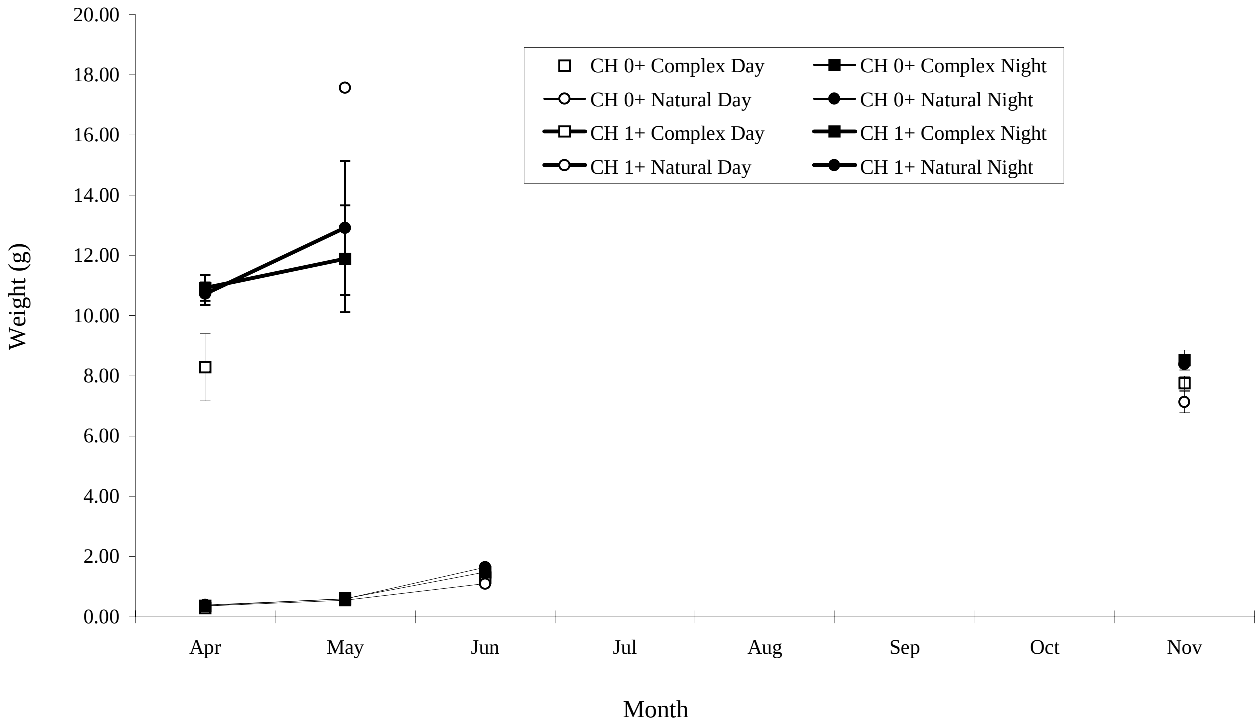
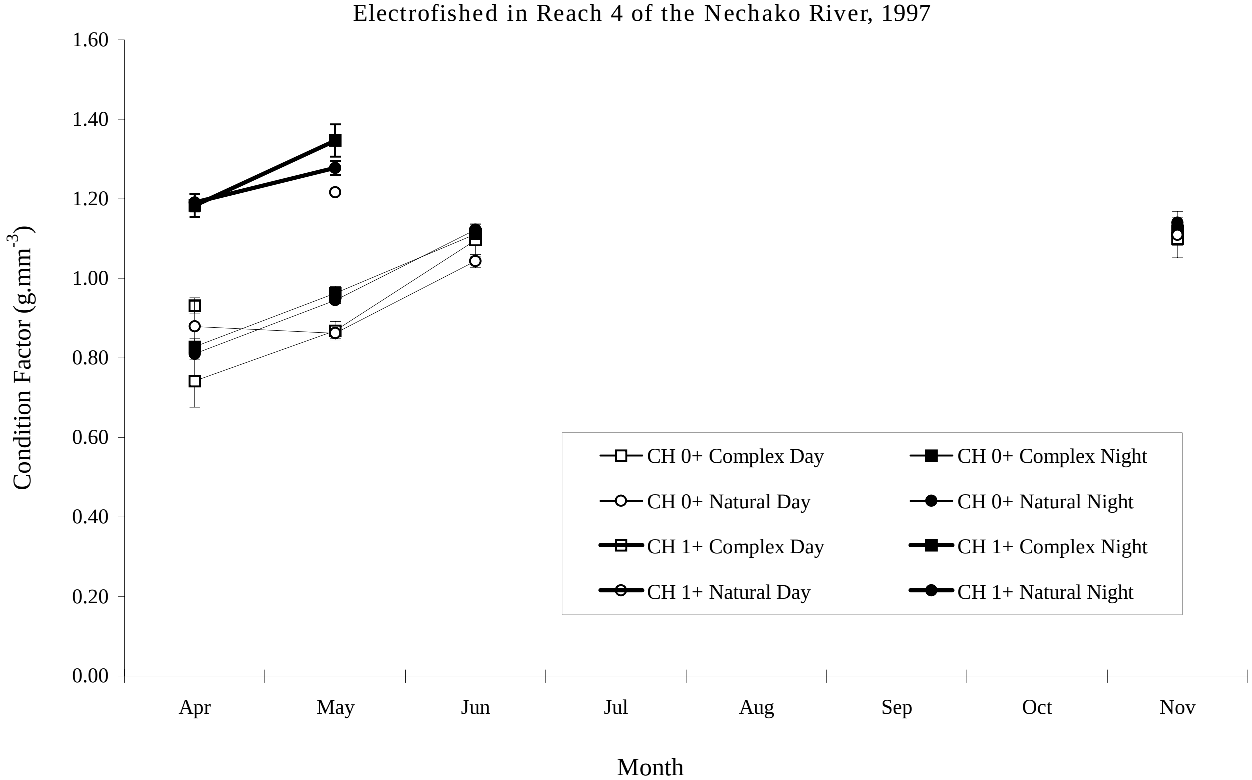


Figure 12
Monthly Mean Condition Factor (g.mm^{-3}) of Chinook 0+ and Chinook 1+
Electrofished in Reach 4 of the Nechako River, 1997



pendix 9). There were no significant weight differences among sites or time of day in any month.

The mean (± 1 SD) daytime condition factors of chinook 0+ ranged from 0.74 ± 0.09 in April to 1.11 ± 0.13 $g.mm^{-3}$ in November and at night they ranged from 0.81 ± 0.07 in April to 1.14 ± 0.13 $g.mm^{-3}$ in November (Figure 12, Appendix 10). There were no significant differences between groups in any month or any time period.

Other Species Identified

Snorkel Surveys

Most of the fish observed by snorkel surveys in Reach 2 were chinook 0+, followed by cyprinids, salmonids, other than chinook, and suckers. The cyprinidae observed included redside shiners (*Richardsonius balteatus*), northern squawfish (*Ptychocheilus oregonensis*) and peamouth chubb (*Mylocheilus caurinus*), as well as longnose and leopard dace (*Rhinichthys cataractae and R. falcatus*). Salmonids other than chinook included rainbow trout (*Oncorhynchus mykiss*), mountain whitefish (*Prosopium williamsoni*), and sockeye salmon (*O. nerka*). Suckers observed included both largescale and longnose suckers (*Catostomus macrocheilus and C. catostomus*).

Reach 2

In Reach 2, chinook 0+ were the most commonly observed fish in habitat complexes, contributing from 94% to 98% of all fish observed, followed by other salmonids and cyprinids (Table 6). In natural sites chinook contributed from 50% to 91% of all fish observed and were followed by cyprinids. The percent of cyprinids observed in natural sites varied from 49% in June to 4% in July. This is due to one school of 200 cyprinids observed in one natural site in June, which accounted for 94% of all cyprinids observed in natural sites during 1997.

Table 6
Relative Percentage of Fish Observed by Snorkel Surveys of Habitat Complexes and Natural Sites in Reach 2 of the Nechako River, 1997

Species	Complex (1)		Natural (2)	
	June	July	June	July
Total number of fish observed	*188*	*431*	*411*	*170*
Chinook 0+	93.6	98.1	50.4	90.6
Chinook 1+	0.0	0.0	0.0	0.0
Salmonidae*	4.3	0.9	0.5	1.8
Cyprinidae	0.5	0.7	48.7	4.1
Catostomidae	1.6	0.2	0.5	3.5
Cottidae	0.0	0.0	0.0	0.0
Gadidae	0.0	0.0	0.0	0.0

(1) Does not include complex sites where complex could not be reached due to high water
(2) Includes shoreline of complex sites where complex could not be reached due to high water

Species List

Chinook	
Chinook salmon	*Oncorhynchus tshawytscha*
(*) Salmonidae	
Sockeye salmon	*Oncorhynchus nerka*
Rainbow trout	*Oncorhynchus mykiss*
Rocky Mountain whitefish	*Prosopium williamsoni*
Lake Trout	*Salvelinus namaycush*
Castomidae	
Largescale sucker	*Catostomus macrocheilus*
Longnose sucker	*Catostomus catostomus*
Cyprinidae	
Leopard dace	*Rhinichthys falcatus*
Longnose dace	*Rhinichthys cataractae*
Northern squawfish	*Ptychocheilus oregonensis*
Redside shiner	*Richardsonius balteatus*
Chubb sp.	*Mylocheilus sp.*
Cottidae	
Sculpins	*Cottus sp.*
Gadidae	
Burbot	*Lota lota*

Electrofishing

Reach 2

Cyprinids were predominant at both complexes and natural sites in most months during day and night. Chinook 0+ were frequently the next most common fish, and showed up in increasing percentages at night from April through June in both complex and natural sites (Table 7). They showed the same trend in complex and natural sites during the day from April through May before decreasing slightly in June. During November chinook 0+ were the third most common species during both day and night in complex and natural sites.

Table 7
Relative Percentage of Fish Sampled by Electrofishing at Habitat Complexes and Natural Sites in Reaches 2 and 4 of the Nechako River, 1997

Month		Reach 2				Reach 4			
		Complex(1)		Natural(2)		Complex(1)		Natural(2)	
		Day	Night	Day	Night	Day	Night	Day	Night
April	*Fishes observed*	*468*	*1,607*	*409*	*1,524*	*36*	*107*	*139*	*671*
	Chinook 1+	3.4	8.0	0.2	0.3	8.3	26.2	0.0	11.0
	Chinook 0+	23.3	12.8	32.3	16.9	13.9	14.0	31.7	5.4
	Salmonidae*	0.6	2.1	0.2	3.3	0.0	4.7	1.4	13.1
	Cyprinidae	58.5	66.8	57.9	70.0	41.7	50.5	59.7	61.4
	Catostomidae	14.1	10.3	9.3	9.4	36.1	4.7	7.2	9.1
May	*Fishes observed*	*1,240*	*1,876*	*2,027*	*1,345*	*72*	*199*	*407*	*545*
	Chinook 1+	0.2	2.0	0.0	1.0	0.0	3.5	0.2	0.6
	Chinook 0+	54.9	40.1	37.0	49.4	55.6	78.9	42.0	74.3
	Salmonidae*	0.4	1.8	0.8	1.9	2.8	10.6	2.5	2.4
	Cyprinidae	37.8	52.5	56.5	44.6	37.5	7.0	52.1	20.4
	Catostomidae	6.7	3.6	5.6	3.0	4.2	0.0	3.2	2.4
June	*Fishes observed*	*218*	*1,110*	*116*	*765*	*33*	*60*	*157*	*212*
	Chinook 1+	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Chinook 0+	41.3	77.4	37.9	68.8	27.3	71.7	23.6	75.5
	Salmonidae*	0.9	2.7	0.0	0.5	0.0	0.0	0.0	1.4
	Cyprinidae	50.9	15.7	54.3	29.0	69.7	25.0	75.8	17.5
	Catostomidae	6.9	4.2	7.8	1.7	3.0	3.3	0.6	5.7
November	*Fishes observed*	*705*	*3,625*	*707*	*2,754*	*34*	*123*	*332*	*766*
	Chinook 1+	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Chinook 0+	3.7	7.4	2.0	6.2	52.9	35.8	1.5	15.0
	Salmonidae*	0.1	9.2	0.0	23.3	0.0	57.7	0.9	30.5
	Cyprinidae	85.2	68.6	87.7	60.3	47.1	3.3	88.9	38.5
	Catostomidae	10.9	14.8	10.3	10.2	0.0	3.3	8.7	15.9

(1) Does not include complex sites where complex could not be reached due to high water.

(2) Includes shoreline of complex sites where complex could not be reached due to high water.

Species List

Chinook
Chinook salmon — *Oncorhynchus tshawytscha*

(*) Salmonidae
Sockeye salmon — *Oncorhynchus nerka*
Rainbow trout — *Oncorhynchus mykiss*
Rocky Mountain whitefish — *Prosopium williamsoni*
Lake Trout — *Salvelinus namaycush*

Castomidae
Largescale sucker — *Catostomus macrocheilus*
Longnose sucker — *Catostomus catostomus*

Cyprinidae
Leopard dace — *Rhinichthys falcatus*
Longnose dace — *Rhinichthys cataractae*
Northern squawfish — *Ptychocheilus oregonensis*
Redside shiner — *Richardsonius balteatus*
Peamouth Chub — *Mylocheilus caurinus*
Chubb sp. — *Mylocheilus sp.*

Reach 4

As in Reach 2¸ cyprinids were dominant during most months in both complexes and natural sites. The percent of chinook 0+ in complex and natural sites increased from April to May and declined slightly in June (Table 7). During November at night salmonids other than chinook were the dominant species in complex sites followed by chinook 0+. During the day cyprinids were the dominant species in complexes followed by chinook 0+. These fish were generally the third most common species in natural sites during both day and night time periods (Table 7).

DISCUSSION

Habitat complexes were installed in Reaches 2 and 4 of the Nechako River between 1988 and 1991 to test the feasibility of creating habitat for juvenile chinook throughout the year. Monitoring of the use of these complexes from 1989 to 1997 has generally shown that the complexes were at least as well utilized as the natural sites during both the spring rearing period and the overwintering period. The 1997 sampling program supported these general observations.

The temperature in the Nechako River during early 1997 was generally cooler than in previous years (1989 - 1996). This temperature pattern is consistent with the buffering effect on temperatures that would be expected from the forced spills from the Nechako Reservoir to the Nechako River in 1997.

The observed flows in the Nechako River in 1997 were higher earlier in the summer than in previous years, as releases were made from the Skins Lake Spillway to control reservoir elevations. Part of these flows coincided with the summer cooling releases, but increased flows did affect all sampling periods during 1997. Not enough sites could be sampled in July to allow comparisons between complex and natural sites, and several sites were inaccessible during May and June. As well, visibility during snorkel surveys was restricted so that only individual sites could be surveyed. Greater than normal releases were also made from the Skins Lake Spillway from September through October. Winter base flows were set at approximately double normal winter flows. The fall forced spill however did not limit the number of sites that could be sampled.

Both survey methods used to assess chinook abundance, underwater counts and electrofishing, have been shown to provide accurate indices of relative fish abundance. However, underwater counts of salmon fry, when water temperatures are low, have been reported as less reliable than electrofishing. Hillman et al. (1992) reported that at temperatures less than 14°C only 50 % of a known number of fish were seen while below 9°C only 20 % were detected. They also mention that, when small fish (<40 mm) or groups of fish greater than 40 are sampled, their true abundance tends to be underestimated. Juveniles may move deep into cover and be underestimated at sites with complex cover, particularly at temperatures below 9°C (Hillman et al. 1992, Thurrow 1994). Consequently, the Nechako River snorkel surveys have been modified over the years to survey only during months when water temperatures, visibility and fry size are favorable to yield accurate indices of chinook abundance.

Electrofishing has also been shown to be an effective technique for fish enumeration (Zalewski and Cowx 1990), especially in shallow areas, with coarse substrate and high water velocities (Heggenes et al. 1990). As with snorkel surveys, however, electrofishing has been found to be less reliable when temperatures are low. Several studies have shown that fish tend to move deep into cover at low water temperatures (Bjorn 1971, Bustard and Narver 1975a and 1975b, and Cunjak and Power 1986), particularly during the daytime. Juveniles deep into the cover are difficult to electroshock as they move only a short distance before galvanonarcosis is achieved, therefore reducing the ability to draw fish out of the cover to be sampled (Zalewski and Cowx 1990).

In previous May and June studies, snorkel surveys sampled more juvenile chinook within complex and natural sites than electrofishing (Triton 1996 a-h). However only 434 juvenile chinook were sampled by snorkeling in Reach 2 during June, compared to 1,385 chinook sampled at night by electrofishing. This may be due to several factors. Snorkel observations are more accurate than electroshocking in deep waters (Zalewski and Cowx 1990, Thurrow 1994). In addition, divers in the Nechako River have noted that, when large schools are encountered at complexes, they tend to congregate near the shear zone created by the debris and the fright response of schooling fish has been shown to make capture of large schools by electroshocking more difficult (Zalewski and Cowx 1990). Nevertheless restricted visibility made 1997 observations of juvenile chinook difficult.

Juvenile chinook have consistently used habitat complexes as much or more than natural areas in the Nechako River (Triton 1996 a-h). In 1997, snorkel surveys showed that up to 48% of the complexes were used in Reach 2 during July. In previous years, this percentage ranged from 72 % in 1994 to 97 % in 1993. Habitat complexes also harboured 75% of the total number of chinook observed by snorkel during July, in spite of contributing only 18% of the area surveyed. In previous years, from 47 to 74% of all chinook observed were in habitat complexes in Reach 2.

The 1997 electrofishing CPUE from complexes was generally greater than that of natural sites, although not significantly different. In past years, the electrofishing CPUE for habitat complexes has at times been significantly greater than at natural sites.

Most of the pre-smolt chinook (0+ and 1+) sampled by electrofishing in Reaches 2 and 4 during November and April were found in complex sites, which suggests that the artificial structures might be selected by juvenile chinook as overwintering habitat. During April and May, the night CPUE of chinook 1+ in complex sites was significantly greater than that in natural sites. Chinook are thought to move deep into cover and to become relatively dormant during the winter (Hillman and Griffith 1987, Cunjak and Power 1986). This is also consistent with previous results (Triton 1996 a- h).

Chinook 0+ sampled in complexes and natural sites within same time of day did not significantly differ in length, weight and condition factor. Fish measured at night were however slightly larger than those sampled during the day.

The fish communities structure within complex and natural sites varied with season, time of day and sampling method. Snorkel surveys indicated that chinook were the predominant members of the community of complex sites in Reach 2 during the spring, followed by salmonids, cyprinids and suckers. Natural sites in reaches 2 were predominantly composed of chinook and cyprinids. Electrofishing indicated that cyprinids were generally the most abundant species throughout the season, followed by chinook 0+ and suckers. These differences are probably due to the large numbers of smaller (<50 mm) cyprinids sampled by shocking and their tendency to occupy shallow habitats less accessible to divers (Hillman et al. 1992). The proportion of chinook 0+ in the community was relatively high from April to June, then dropped in November, reflecting the outmigration of chinook juveniles after the spring.

In summary, the 1997 results are consistent with previous years results and show that habitat complexes are at least as much used as the natural sites in the Nechako River. The complexes also appear to provide overwintering habitat for chinook. Although species composition in the complexes and natural sites varied monthly and, according to method of observation, electrofishing results showed no consistent differences among sites. Chinook in complexes and natural sites were of similar fork length, weight and condition factor.

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Appendix 1

Site List for the Biological Assessment of Habitat Complexing, Nechako River 1997

Appendix 1
Site List for the Biological Assessment of Habitat Complexing, Nechako River 1997

Site Name	Site Type	Reach	Position	Margin	Description
Reach 2					
LM15.6SWPR	Complex	2	15.6	Left Margin	Rail Anchored Sweeper
MC15.7PP	Complex	2	15.7	Mid Channel	Pocket Pool
RM16.2SWPR	Complex	2	16.2	Right Margin	Rail Anchored Sweeper
RM16.3CONTROL	Natural	2	16.3	Right Margin	Natural Site near RM16.2SWPR
RM16.5RDC	Complex	2	16.5	Right Margin	Rail Debris Catcher
RM16.8RDC	Complex	2	16.8	Right Margin	Rail Debris Catcher
LM17.0CONTROL	Natural	2	17	Left Margin	Natural Site near RM17.0PB
RM17.0PB	Complex	2	17	Right Margin	Point Bar
RM17.15PB	Complex	2	17.15	Right Margin	Point Bar
RM17.3PB	Complex	2	17.3	Right Margin	Point Bar
RM17.9DB	Complex	2	17.9	Right Margin	Debris Boom
RM17.9SC	Complex	2	17.9	Right Margin	Side Channel
LM18.3RDC	Complex	2	18.3	Left Margin	Rail Debris Catcher
RM20.65RDC	Complex	2	20.65	Right Margin	Rail Debris Catcher
LM21.3RDC	Complex	2	21.3	Left Margin	Rail Debris Catcher
LM21.35CONTROL	Natural	2	21.35	Left Margin	Natural Site near LM21.3RDC
LM21.4RDC	Complex	2	21.4	Left Margin	Rail Debris Catcher
RM22.0RDC	Complex	2	22	Right Margin	Rail Debris Catcher
RM22.1NAT	Natural	2	22.1	Right Margin	Natural Site
RM22.55RDC	Complex	2	22.55	Right Margin	Rail Debris Catcher
LM22.6RDC	Complex	2	22.6	Left Margin	Rail Debris Catcher
LM22.7CONTROL	Natural	2	22.7	Left Margin	Natural Site near LM22.7RDC
LM22.75CONTROL	Natural	2	22.75	Left Margin	Natural Site near LM22.8RDC
LM22.85RDC	Complex	2	22.85	Left Margin	Rail Debris Catcher
RM22.9NAT	Natural	2	22.9	Right Margin	Natural Site
RM22.95NAT	Natural	2	22.95	Right Margin	Natural Site
RM23.0RDC	Complex	2	23	Right Margin	Rail Debris Catcher
RM23.2NAT	Natural	2	23.2	Right Margin	Natural Site
LM24.15CONTROL	Natural	2	24.15	Left Margin	Natural Site near LM24.2RDC
LM24.2RDC	Complex	2	24.2	Left Margin	Rail Debris Catcher
LM24.3RDC	Complex	2	24.3	Left Margin	Rail Debris Catcher
RM24.3CONTROL	Natural	2	24.3	Right Margin	Natural Site near RM24.35RS
RM24.35RS	Complex	2	24.35	Right Margin	Rootwad Sweeper
RM24.4FC	Complex	2	24.4	Right Margin	Floating Crib
RM24.5CONTROL	Natural	2	24.5	Right Margin	Natural Site near RM24.6PBL
RM24.6PBL	Complex	2	24.6	Right Margin	Pseudo Beaver Lodge
RM24.8CONTROL	Natural	2	24.8	Right Margin	Natural Site near RM24.6PBL
RM25.4RDC	Complex	2	25.4	Right Margin	Rail Debris Catcher
MC25.7RDC	Complex	2	25.7	Mid Channel	Rail Debris Catcher
RM25.8NAT	Natural	2	25.8	Right Margin	Natural Site
LM26.6NAT	Natural	2	26.6	Left Margin	Natural Site
RM26.8CONTROL	Natural	2	26.8	Right Margin	Natural Site near RM26.9SWPR
RM26.9SWPR	Complex	2	26.9	Right Margin	Rail Anchored Sweeper
RM27.3CONTROL	Natural	2	27.3	Right Margin	Natural Site near RM27.4FC
RM27.4FC	Complex	2	27.4	Right Margin	Floating Crib
LM27.5NAT	Natural	2	27.5	Left Margin	Natural Site

Appendix 1 (continued)
Site List for the Biological Assessment of Habitat Complexing, Nechako River 1997

Site Name	Site Type	Reach	Position	Margin	Description
RM28.3NAT	Natural	2	28.3	Right Margin	Natural Site
RM28.4RDC	Complex	2	28.4	Right Margin	Rail Debris Catcher
LM28.6NAT	Natural	2	28.6	Left Margin	Natural Site
LM29.3CONTROL	Natural	2	29.3	Left Margin	Natural Site near LM29.4SWPR
LM29.4SWPR	Complex	2	29.4	Left Margin	Rail Anchored Sweeper
RM31.0CONTROL	Natural	2	31	Right Margin	Natural Site near LM31.1PBL
RM31.1PBL	Complex	2	31.1	Right Margin	Pseudo Beaver Lodge
RM31.4BP	Complex	2	31.4	Right Margin	Brush Pile
RM32.0NAT	Natural	2	32	Right Margin	Natural Site
RM32.05NAT	Natural	2	32.05	Right Margin	Natural Site
LM32.6CONTROL	Natural	2	32.6	Left Margin	Natural Site near LM32.65SWPR
LM32.65SWPR	Complex	2	32.65	Left Margin	Hand Anchored Sweeper
LM33.3NAT	Natural	2	33.3	Left Margin	Natural Site
LM33.4NAT	Natural	2	33.4	Left Margin	Natural Site
RM34.5CONTROL	Natural	2	34.5	Right Margin	Natural Site near RM34.7PDC
RM34.7PDC	Complex	2	34.7	Right Margin	Pipe-pile Debris Catcher
MC35.4PDC	Complex	2	35.4	Mid Channel	Pipe-pile Debris Catcher
RM35.8NAT	Natural	2	35.8	Right Margin	Natural Site
LM37.3NAT	Natural	2	37.3	Left Margin	Natural Site
LM37.35NAT	Natural	2	37.35	Left Margin	Natural Site
LM37.7NAT	Natural	2	37.7	Left Margin	Natural Site
Reach 4					
LM72.9SWPR	Complex	4	72.9	Left Margin	Hand Anchored Sweeper
LM72.95CONTROL	Natural	4	72.95	Left Margin	Natural Site near LM72.9SWPR
LM73.0SWPR	Complex	4	73	Left Margin	Hand Anchored Sweeper
LM73.1NAT	Natural	4	73.1	Left Margin	Natural Site
LM73.5NAT	Natural	4	73.5	Left Margin	Natural Site
LM73.6NAT	Natural	4	73.6	Left Margin	Natural Site
RM74.0NAT	Natural	4	74	Right Margin	Natural Site
RM74.1NAT	Natural	4	74.1	Right Margin	Natural Site
LM75.6CONTROL	Natural	4	75.6	Left Margin	Natural Site near LM75.9SWPR
LM75.9SWPR	Complex	4	75.9	Left Margin	Hand Anchored Sweeper
LM75.95NAT	Natural	4	75.95	Left Margin	Natural Site
LM76.4NAT	Natural	4	76.4	Left Margin	Natural Site
LM76.9NAT	Natural	4	76.9	Left Margin	Natural Site
LM78.0SWPR	Complex	4	78	Left Margin	Hand Anchored Sweeper
MC78.0NAT	Natural	4	78	Mid Channel	Natural Site
LM79.2NAT	Natural	4	79.2	Left Margin	Natural Site
LM80.2SWPR	Complex	4	80.2	Left Margin	Hand Anchored Sweeper
LM80.9RDC	Complex	4	80.9	Left Margin	Rail Debris Catcher
RM81.3NAT	Natural	4	81.3	Right Margin	Natural Site
LM82.1SWPR	Complex	4	82.1	Left Margin	Rail Anchored Sweeper
RM82.1NAT	Natural	4	82.1	Right Margin	Natural Site
LM82.15CONTROL	Natural	4	82.15	Left Margin	Natural Site near LM82.2SWPR
LM82.2SWPR	Complex	4	82.2	Left Margin	Rail Anchored Sweeper

Appendix 1 (continued)
Site List for the Biological Assessment of Habitat Complexing, Nechako River 1997

Site Name	Site Type	Reach	Position	Margin	Description
LM82.3SWPR	Complex	4	82.3	Left Margin	Hand Anchored Sweeper
LM82.7NAT	Natural	4	82.7	Left Margin	Natural Site
LM82.9CONTROL	Natural	4	82.9	Left Margin	Natural Site near LM83.0RDC
LM83.0RDC	Complex	4	83	Left Margin	Rail Debris Catcher
RM83.7NAT	Natural	4	83.7	Right Margin	Natural Site
MC85.6NAT	Natural	4	85.6	Mid Channel	Natural Site
RM85.7SWPR	Complex	4	85.7	Right Margin	Rail Anchored Sweeper
RM86.35RDC	Complex	4	86.35	Right Margin	Rail Debris Catcher
RM86.375RDC	Complex	4	86.375	Right Margin	Rail Debris Catcher
LM88.5NAT	Natural	4	88.5	Left Margin	Natural Site

Appendix 2

Preliminary Mean Daily Water Temperatures (°C) Recorded from Nechako River Below Cheslatta Falls (WSC 08JA017), 1997

Appendix 2

Preliminary Mean Daily Water Temperatures (°C) Recorded from Nechako River Below Cheslatta Falls (WSC 08JA017), 1997

Day	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
1	0.26	0.61	0.36	1.57	4.44	8.58	12.5	15.1	15.8	13.1	7.48	3.31
2	0.49	0.51	0.2	1.91	4.55	8.84	12.7		16.2	13	7.49	3.15
3	0.66	0.2	0.34	1.62	4.69	8.8	12.9	15.3		12.6	7.37	2.96
4	0.42	0.28	0.42	2.02	4.56	9.1	13.3	15.5	16.1	12.6	7.32	3.16
5	0.23	0.61	0.63	1.91	5.03	9.69	13.7	15.7	16	12.3	7.5	2.95
6	0.55	0.41	0.82	2.04	5.04	9.38	13.7	15.9	15.6	12	6.97	2.74
7	0.78	0.62	0.95	2.11	5.17	9.1	13.7	15.8	15.8	11.5	6.63	2.79
8	1.16	0.49	0.76	2.14	5.2	9.1	13.8	15.7	15.7	10.7	6.32	2.85
9	0.84	0.27	1.05	2.38	5.21	9.55	13.8	15.8	15.9	10.5	6.03	2.28
10	1	0.44	0.95	2.16	5.52	9.47	13.9	16.1	16.1	10.7	5.95	2.02
11	0.97	0.41	0.35	2.25	5.92	9.77	14	16	15.5	10.4	5.94	2.36
12	0.8	0.55	0.13	2.31	6.25	10.2	14	16.4	15.2	9.99	5.71	2.47
13	0.83	0.79	0.28	2.3	7.22	10.3	14.1	16.8	15.1	10.1	5.37	2.29
14	0.8	0.85	0.43	2.5	7.15	10.5	14	16.9	14.7	10.1	5.21	2.52
15	0.71	1.05	0.65	2.34	7.23	10.9	14.1		14.5	10.1	4.99	2.37
16	0.52	1.09	0.77	2.24	7.19	11.2	14		14.8	10	4.63	2.59
17	0.62	0.89	0.64	2.28	7.04	11.8	14.1		14.2	9.49	4.39	2.23
18	0.52	0.73	1.29	2.27	7.04	11.9	14.3		14.1	9.23	4.46	1.84
19	0.95	0.76	1.29	2.46	6.71	11.8	14.6	16.4	14.2	9	4.43	2.39
20	1.07	1.04	1.18	2.54	6.8	11.8	14.7	16.2	14.3	8.98	4.64	2.46
21	0.85	1.04	1.14	2.77	6.47	11.6	14.8	16.2	14.6	9.03	4.4	1.92
22	0.56	1.16	1.14	3.1	6.73	11.8	14.7	16.4	14.4	8.91	4.11	2.46
23	0.09	0.92	1.53	3.13	7	11.9	14.7	16.3	14.5	8.7	4.36	2.41
24	0.09	0.9	1.4	3.44	7.26	12.1	14.7	16.2	14.7	8.39	4.02	2.22
25	0.09	0.9	1.58	3.57	7.82	12.1	14.6	16.3	14.3	8.61	3.88	2.26
26	0.09	0.88		3.94	7.45	12.1	14.7	16.2	14.3	8.49	4.01	2.09
27	0.09	0.92	1.32	3.68	7.43	12.1	14.8	16.3	14.2	8.1	4.02	1.99
28	0.09	0.92	1.53	3.96	7.9	12.1	15	16.1	14	8.08	3.89	2.17
29	0.25		1.5	4.09	8.3	12.3	15.2	15.9	13.4	8.16	3.57	2.26
30	0.73		1.6	4.09	8.73	12.4	15.3	15.9	13.6	8.03	3.34	2.13
31	0.56		1.66		8.53		15.1			7.84		1.18
Mean	0.57	0.72	0.93	2.64	6.50	10.74	14.18	16.06	14.89	9.96	5.28	2.41
Minimum	0.09	0.20	0.13	1.57	4.44	8.58	12.50	15.10	13.40	7.84	3.34	1.18
Maximum	1.16	1.16	1.66	4.09	8.73	12.40	15.30	16.90	16.20	13.10	7.50	3.31
S.D.	0.33	0.27	0.48	0.75	1.25	1.32	0.71	0.42	0.82	1.61	1.34	0.44

Appendix 3

Preliminary Flow Data for the Nechako Fisheries Conservation Program, from Skins Lake Spillway, Nechako River (WSC 08JA013), 1997

Appendix 3
Preliminary Flow Data for the Nechako Fisheries Conservation Program,
from Skins Lake Spillway, Nechako River (WSC 08JA013), 1997

	Flow below Skins Lake Spillway ($m^3 \cdot s^{-1}$)											
Day	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
1	59.7	58.7	57.7	56.6	72.7	201	342	335	42.2	85.8	57.3	56.7
2	59.7	58.7	57.7	56.6	85.0	201	342	335	54.9	85.8	57.3	56.7
3	59.7	58.6	57.6	56.6	85.1	202	342	334	85.4	85.8	57.3	56.6
4	59.6	58.6	57.6	56.6	85.2	202	342	334	85.5	85.7	57.3	56.5
5	59.6	58.6	57.5	56.6	85.4	238	342	333	85.3	85.7	57.4	56.5
6	59.6	58.5	57.5	56.6	85.6	255	342	333	85.3	85.7	57.4	56.5
7	59.5	58.5	57.5	56.6	85.7	256	342	333	85.2	85.5	57.4	56.5
8	59.5	58.5	57.4	56.5	85.9	256	342	332	85.2	85.3	57.3	56.4
9	59.5	58.4	57.4	56.5	86.1	257	342	331	85.1	85.4	57.3	56.4
10	59.5	58.4	57.3	56.5	86.3	274	340	331	85.0	85.3	57.3	56.3
11	59.5	58.4	57.3	56.5	86.4	283	342	330	85.0	85.3	57.3	56.3
12	59.5	58.3	57.3	56.5	86.6	284	342	330	84.9	85.2	57.3	56.3
13	59.4	58.3	57.2	56.5	86.8	284	341	329	84.8	85.3	57.2	56.3
14	59.4	58.3	57.2	56.5	87.1	285	341	329	84.9	85.3	57.2	56.3
15	59.4	58.2	57.1	56.5	87.5	285	341	328	83.9	85.3	57.2	56.3
16	59.3	58.2	57.1	56.5	122.0	286	341	328	86.3	85.6	57.1	56.3
17	59.2	58.2	57.1	56.5	143.1	286	341	327	86.3	85.6	57.1	56.3
18	59.2	58.2	57.0	56.5	143.8	287	340	326	86.3	85.6	57.1	56.2
19	59.2	58.1	57.0	56.5	144.2	287	340	326	86.3	85.6	57.0	56.2
20	59.1	58.1	56.9	56.5	144.6	300	340	325	86.2	85.6	57.0	56.2
21	59.1	58.1	56.9	56.5	145.0	340	340	42	86.2	85.6	57.0	56.2
22	59.1	58.0	56.9	56.5	145.2	341	339	42	86.1	85.6	56.9	56.1
23	59.0	58.0	56.8	56.5	145.5	341	339	42	86.1	85.6	56.9	56.1
24	59.0	57.9	56.8	56.5	145.8	341	339	42	86.0	85.5	56.9	56.1
25	59.0	57.9	56.8	56.5	146.1	342	338	42	86.0	85.5	56.9	56.1
26	58.9	57.8	56.8	56.5	146.4	342	338	42	86.0	85.5	56.8	56.0
27	58.9	57.8	56.7	56.6	146.7	342	337	42	85.9	85.5	56.8	56.0
28	58.8	57.7	56.7	56.7	180.0	342	337	42	85.9	85.5	56.8	55.9
29	58.8	2077	56.7	56.7	198.6	342	337	42	85.8	57.3	56.7	55.9
30	58.8	2077	56.7	56.8	199.2	342	336	42	85.8	57.3	56.7	55.9
31	58.8	2077	56.6		200.0		336	42		57.3		55.8

Appendix 4

Preliminary Flow Data for the Nechako Fisheries Conservation Program, from the Nechako River Below Cheslatta Falls (WSC 08JA017), 1997

Appendix 4
Preliminary Flow Data for the Nechako Fisheries Conservation Program,
from the Nechako River Below Cheslatta Falls (WSC 08JA017), 1997

	Flow below Cheslatta Falls (m^3/s)											
Day	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
1	127.0	56.0	54.8	59.2	110	196	354	354	92.9	88.3	81.7	59.1
2	81.3	55.8	56.9	59.2	111	200	355	355	86.8	88.3	79.6	58.7
3	67.4	56.9	56.0	59.4	114	203	357	355	82.8	88.3	77.6	58.4
4	64.0	59.1	56.5	59.4	119	208	357	354	80.7	88.3	75.4	58.4
5	63.7	55.2	55.8	59.2	123	213	362	354	80.7	88.3	73.7	58.4
6	62.1	55.2	55.8	44.3	127	221	362	354	81.1	88.0	72.8	58.2
7	61.5	55.2	55.8	n/a	131	232	359	353	81.5	87.8	71.4	57.9
8	59.9	55.0	55.8	n/a	134	241	361	352	81.8	87.0	69.8	57.9
9	58.1	55.7	55.8	n/a	135	247	359	350	82.4	86.7	68.6	57.9
10	58.1	54.8	55.8	n/a	136	253	358	349	82.8	86.5	67.7	57.5
11	58.1	54.5	56.5	57.5	137	262	352	348	82.8	86.7	66.7	57.4
12	58.1	54.5	70.3	58.7	138	273	352	349	82.8	86.8	66	57.4
13	57.9	54.5	62.3	60.8	139	281	354	347	84.3	86.8	65.2	57.4
14	57.9	54.5	56.9	60.9	139	287	354	345	84.6	86.8	64.5	57.4
15	57.5	54.5	54.8	60.9	140	291	356	345	85.4	86.8	63.8	57.4
16	57.2	54.5	54.8	63.0	140	295	354	-	86.3	87.2	63.1	57.4
17	57.2	54.5	54.8	64.8	143	299	355	-	85.7	87.6	62.6	57.4
18	57.0	54.3	54.8	67.2	149	301	355	342	86.7	88.0	62.1	57.4
19	56.9	54.5	54.8	69.1	155	303	356	340	86.3	88.0	61.6	57.4
20	56.7	54.5	54.8	71.6	159	305	359	339	86.5	88.0	61.3	57.4
21	56.7	54.5	55.0	73.7	162	308	360	326	86.5	88.0	60.9	57.4
22	56.5	54.5	55.0	76.1	164	319	360	286	86.5	88.0	60.4	57.4
23	56.4	54.5	55.0	79.8	166	327	359	249	86.7	88.0	60.1	57.5
24	66.6	54.5	55.2	83.0	167	333	359	214	87	87.6	60.1	57.5
25	38.4	54.5	55.2	87.2	168	338	358	186	86.8	87.4	60.1	57.5
26	100.0	54.5	55.2	91.5	168	343	358	166	87.2	87.4	59.9	57.5
27	334.0	54.5	58.4	99.0	170	346	357	148	88.3	87.4	59.6	57.4
28	280.0	54.5	58.4	103.0	172	348	358	132	88.3	87.4	59.6	57.4
29	132.0	4662	58.4	106.0	177	350	357	120	88.3	87.4	59.4	57.4
30	60.1	2122	58.4	108.0	184	352	357	109	88.3	87.0	59.2	57.4
31	56.5	1995	59.2		191		355	102		84.6		

Appendix 5

List of Sites Incompletely Electrofished During the Day and Night in Reaches 2 and 4, Nechako River 1997

Appendix 5
List of Sites Incompletely Electrofished During the Day and Night in Reaches 2 and 4, Nechako River 1997

	April		May		June		November	
Reach 2	Day	Night	Day	Night	Day	Night	Day	Night
LM15.6SWPR								
MC15.7PP			X	X	X	X		
RM16.2SWPR								
RM16.3CONTROL								
RM16.5RDC								
RM16.8RDC					*	X		
LM17.0CONTROL								
RM17.0PB								
RM17.15PB								
RM17.3PB								
RM17.9DB			*	*	*	*		
RM17.9SC	X	X						
LM18.3RDC			/		*	*		
RM20.65RDC					/	/		
LM21.3RDC								
LM21.35CONTROL								
LM21.4RDC			*	*	*	*		
RM22.0RDC								
RM22.1								
RM22.55RDC								
LM22.6RDC								
LM22.7CONTROL								
LM22.75CONTROL								
LM22.85RDC								
RM22.9NAT								
RM22.95								
RM23.0RDC			*	*	*	*		
RM23.2NAT								
LM24.15CONTROL	Ice				/	X		
LM24.2RDC	Ice				*	*		
LM24.3RDC	Ice		*	*	*	*		
RM24.3CONTROL								
RM24.35RS	Ice							
RM24.4FC								
RM24.5CONTROL						X		
RM24.6PBL								
RM24.8CONTROL								
RM25.4RDC	Ice		*	*	*	X		
MC25.7RDC					X	X		
RM25.8NAT					X	X		
LM26.6NAT					X	X		
RM26.8CONTROL								
RM26.9SWPR								
RM27.3CONTROL					X	X		
RM27.4FC								
LM27.5NAT								
RM28.3NAT								
RM28.4RDC								
LM28.6NAT								
LM29.3CONTROL					X	X		
LM29.4SWPR								
RM31.0CONTROL					X	X		
RM31.1PBL					X	X		
RM31.4BP					X	X		
RM32.0NAT								

Appendix 5 (continued)

List of Sites Incompletely Electrofished During the Day and Night in Reaches 2 and 4, Nechako River 1997

RM32.05NAT								
LM32.6CONTROL						/		
LM32.65SWPR								
LM33.3NAT								
LM33.4NAT								
RM34.5CONTROL					X	X		
RM34.7PDC						/		
MC35.4PDC		X						
RM35.8NAT								
LM37.3NAT					X	X		
LM37.35NAT					X	X		
LM37.7NAT								
Reach 4								
LM72.9SWPR								
LM72.95CONTROL								
LM73.0SWPR								
LM73.1NAT								
LM73.5NAT								
LM73.6NAT								
RM74.0NAT								
RM74.1NAT								
LM75.6CONTROL								
LM75.9SWPR								
LM75.95NAT								
LM76.4NAT								
LM76.9NAT								
LM78.0SWPR					/	X		
MC78.0NAT					X	X		
LM79.2NAT								
LM80.2SWPR			X		X	X		
LM80.9RDC			*	X	X	X		
RM81.3NAT					X	X		
LM82.1SWPR					X	X		
RM82.1NAT		Ice			X	X		
LM82.15CONTROL					X	X		
LM82.2SWPR					X	X		
LM82.3SWPR					X	X		
LM82.7NAT				/		/		
LM82.9CONTROL								
LM83.0RDC			*	*	*	*		
RM83.7NAT		X			X	X		
MC85.6NAT					X	X		
RM85.7SWPR					X	X		
RM86.35RDC	/			/	X	X		
RM86.375RDC				X	X	X		
LM88.5NAT				/	X	X	X	X

X= Site not shocked

/ = Site not fully shocked

*=Did not reach complex

Bold Site Names were changed to Natural sites in Novemeber due to loss of debris.

Appendix 6

Mean, Maximum and Minimum Log_{10}(CPUE +1) for Chinook 1+ Electrofished During Day and Night from Habitat Complex and Natural Sites in Reaches 2 and 4 of the Nechako River, 1997

Appendix 6

Mean, Maximum and Minimum Log_{10}(CPUE +1) for Chinook 1+ Electrofished During Day and Night from Habitat Complex and Natural Sites in Reaches 2 and 4 of the Nechako River, 1997

		Reach 2				Reach 4				Pooled	
		Complex Sites		Natural Sites		Complex Sites		Natural Sites			
Month	Statistics	Day	Night	Day	Night	Day	Night	Day	Night	Reach 2	Reach 4
April	Mean	0.66	2.28	0.09	0.29	0.67	2.27	0.00	2.29	0.79	1.26
	n	29	28	32	32	13	13	20	19	121	65
	Maximum	3.70	4.20	2.92	3.40	2.92	3.92	0.00	4.32	4.20	4.32
	Minimum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	SD	1.32	1.76	0.52	0.92	1.28	1.60	0.00	1.64	1.45	1.62
May	Mean	0.23	1.86	0.00	0.83	0.00	1.25	0.12	0.28	0.68	0.33
	n	25	26	37	36	10	10	22	21	124	63
	Maximum	2.92	3.62	0.00	3.62	0.00	3.40	2.62	3.05	3.62	3.40
	Minimum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	SD	0.78	1.64	0.00	1.36	0.00	1.61	0.56	0.90	1.30	0.96

Appendix 7

Mean, Maximum and Minimum Log_{10}(CPUE +1) for Chinook 1+ Electrofished During Day and Night from Debris Bundle and Debris Catcher Habitat Complex Sites in Reaches 2 and 4 of the Nechako River, 1997

Appendix 7

Mean, Maximum and Minimum Log_{10}(CPUE +1) for Chinook 1+ Electrofished During Day and Night from Debris Bundle and Debris Catcher Habitat Complex Sites in Reaches 2 and 4 of the Nechako River, 1997

		Reach 2				Reach 4				Pooled	
		Bundles		Catchers		Bundles		Catchers			
Month	Statistics	Day	Night	Day	Night	Day	Night	Day	Night	Reach 2	Reach 4
April	Mean	0.60	1.55	0.69	2.76	0.97	2.25	0.00	2.31	1.46	1.47
	n	11	11	18	17	9	9	4	4	57	26
	Maximum	3.70	3.78	3.40	4.20	2.92	3.92	0.00	3.40	4.20	3.92
	Minimum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	SD	1.35	1.81	1.34	1.61	1.46	1.72	0.00	1.56	1.74	1.64
May	Mean	0.00	1.14	0.40	2.40	0.00	1.06	0.00	2.92	1.06	0.62
	n	11	11	14	15	8	9	2	1	51	20
	Maximum	0.00	3.52	2.92	3.62	0.00	3.40	0.00	2.92	3.62	3.40
	Minimum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.92	0.00	0.00
	SD	0.00	1.58	1.03	1.52	0.00	1.59	0.00	na	1.53	1.28

Appendix 8

Mean, Maximum and Minimum fork length (mm) for Chinook 0+ and 1+ Electrofished During Day and Night from Habitat Complex and Natural Sites in Reaches 2 and 4 of the Nechako River, 1997

Appendix 8
Mean, Maximum and Minimum fork length (mm) for Chinook 0+ and 1+ Electrofished During Day and Night from Habitat Complex and Natural Sites in Reaches 2 and 4 of the Nechako River, 1997

		Reach 2				Reach 4				Pooled	
		Complex		Natural		Complex		Natural			
Month	Statistics	Day	Night	Day	Night	Day	Night	Day	Night	Reach 2	Reach 4
Chinook 1+											
April	Mean	99.3	98.2	87.0	99.2	89.3	97.3	No catch	96.5	98.25	96.5
	n	16	112	1	6	3	28	No catch	41	135.00	72
	Maximum	125.0	119.0	87.0	104.0	101.0	115.0	No catch	118.0	125.00	118.0
	Minimum	78.0	67.0	87.0	93.0	76.0	85.0	No catch	75.0	67.00	75.0
	SD	11.0	8.0	n/a	4.1	12.6	8.1	No catch	10.3	8.26	9.6
May	Mean	100.5	104.4	No catch	104.9	No catch	94.7	113.0	99.7	104.4	97.7
	n	2	40	No catch	15	No catch	7	1	3	57	11
	Maximum	102.0	118.0	No catch	115.0	No catch	112.0	113.0	110.0	118.0	113.0
	Minimum	99.0	89.0	No catch	95.0	No catch	78.0	113.0	90.0	89.0	78.0
	SD	2.1	7.4	No catch	6.2	No catch	13.3	N/A	10.0	6.9	12.5
Chinook 0+											
April	Mean	36.4	36.8	36.2	36.7	35.1	35.5	36.8	36.4	36.6	36.2
	n	97	161	113	180	9	15	24	27	551	75
	Maximum	40.0	41.0	48.0	41.0	38.0	39.0	42.0	40.0	48.0	42.0
	Minimum	32.0	32.0	29.0	32.0	33.0	32.0	32.0	32.0	29.0	32.0
	SD	1.7	1.8	2.2	1.8	1.5	1.7	2.4	1.7	1.9	2.0
May	Mean	38.3	38.7	38.4	38.3	39.6	39.4	39.6	39.2	38.4	39.4
	n	179	249	216	243	27	70	78	171	887	346
	Maximum	44.0	48.0	48.0	46.0	45.0	46.0	49.0	48.0	48.0	49.0
	Minimum	34.0	32.0	32.0	32.0	36.0	31.0	33.0	34.0	32.0	31.0
	SD	1.9	2.9	2.3	2.5	2.6	2.9	2.6	2.9	2.5	2.8
June	Mean	44.0	47.8	43.9	47.2	48.2	50.5	46.5	51.9	46.7	50.3
	n	75	197	44	217	9	25	35	89	533	158
	Maximum	58.0	64.0	53.0	72.0	59.0	59.0	63.0	68.0	72.0	68.0
	Minimum	35.0	36.0	35.0	32.0	38.0	41.0	37.0	37.0	32.0	37.0
	SD	4.8	5.3	4.2	5.4	6.9	4.5	5.5	5.7	5.4	6.0
Nov	Mean	87.8	92.3	93.8	93.2	88.9	90.8	86.2	90.0	92.4	90.0
	n	26	182	12	162	18	40	5	110	382	173
	Maximum	100.0	121.0	100.0	111.0	95.0	114.0	88.0	108.0	121.0	114.0
	Minimum	78.0	74.0	85.0	74.0	80.0	65.0	83.0	76.0	74.0	65.0
	SD	6.0	8.0	4.6	7.1	3.3	8.6	2.5	6.7	7.5	6.9

Appendix 9

Mean, Maximum and Minimum Wet Weight (g) for Chinook 0+ and 1+ Electrofished During Day and Night from Habitat Complex and Natural Sites in Reaches 2 and 4 of the Nechako River, 1997

Appendix 9

Mean, Maximum and Minimum Wet Weight (g) for Chinook 0+ and 1+ Electrofished During Day and Night from Habitat Complex and Natural Sites in Reaches 2 and 4 of the Nechako River, 1997

		Reach 2				Reach 4				Pooled	
		Complex		Natural		Complex		Natural			
Month	Statistics	Day	Night	Day	Night	Day	Night	Day	Night	Reach 2	Reach 4
Chinook 1+											
April	Mean	12.39	12.05	10.27	12.10	8.29	10.92	No catch	10.72	12.08	10.73
	n	16	112	1	6	2	28	No catch	41	135	71
	Maximum	22.82	19.43	10.27	15.72	9.40	18.30	No catch	16.27	22.82	18.30
	Minimum	7.66	3.60	10.27	10.39	7.17	6.49	No catch	5.08	3.60	0.00
	SD	3.85	2.80	n/a	1.93	1.58	2.27	No catch	2.43	2.89	2.36
May	Mean	13.10	13.94	No catch	14.75	No catch	11.89	17.56	12.91	14.12	12.68
	n	2	40	No catch	15	No catch	7	1	3	57	11
	Maximum	15.11	22.77	No catch	19.06	No catch	19.68	17.56	16.84	22.77	19.68
	Minimum	11.09	8.06	No catch	9.97	No catch	7.12	17.56	9.15	8.06	7.12
	SD	2.84	3.24	No catch	2.55	No catch	4.70	n/a	3.85	3.04	4.37
Chinook 0+											
April	Mean	0.38	0.42	0.38	0.42	0.29	0.37	0.36	0.39	0.40	0.38
	n	97.00	161.00	113.00	180.00	2	15	2	27	551	46
	Maximum	0.58	0.68	0.71	0.69	0.29	0.45	0.37	0.56	0.71	0.56
	Minimum	0.23	0.20	0.20	0.25	0.29	0.29	0.35	0.30	0.20	0.00
	SD	0.07	0.09	0.08	0.08	0.00	0.05	0.01	0.06	0.08	0.06
May	Mean	0.45	0.51	0.46	0.49	0.55	0.60	0.55	0.59	0.48	0.58
	n	179	249	216	243	27	70	78	171	887	346
	Maximum	0.77	1.08	1.06	1.05	0.91	1.04	1.06	1.22	1.08	1.22
	Minimum	0.20	0.24	0.21	0.25	0.33	0.27	0.19	0.29	0.20	0.19
	SD	0.11	0.17	0.12	0.13	0.15	0.17	0.16	0.18	0.14	0.17
June	Mean	0.90	1.19	0.90	1.17	1.30	1.48	1.10	1.64	1.11	1.48
	n	75	197	44	217	9	25	35	89	533	158
	Maximum	1.90	3.11	1.58	4.87	2.16	2.71	3.07	3.29	4.87	3.29
	Minimum	0.37	0.34	0.37	0.23	0.60	0.60	0.50	0.54	0.23	0.50
	SD	0.35	0.46	0.30	0.51	0.57	0.46	0.47	0.59	0.47	0.58
Nov	Mean	7.73	9.24	9.27	9.40	7.75	8.52	7.13	8.38	9.21	8.31
	n	26	182	12	162	18	40	5	110	382	173
	Maximum	10.53	17.58	12.37	15.12	9.03	15.73	7.90	15.20	17.58	15.73
	Minimum	5.35	4.37	7.01	5.11	5.27	3.75	5.78	4.73	4.37	3.75
	SD	1.49	2.30	1.56	1.91	1.01	2.13	0.80	1.92	2.10	1.89

Appendix 10

Mean, Maximum and Minimum Condition Factor (g.mm^{-3}) for Chinook 0+ and 1+ Electrofished During Day and Night from Habitat Complex and Natural Sites in Reaches 2 and 4 of the Nechako River, 1997

Appendix 10

Mean, Maximum and Minimum Condition Factor (g.mm^{-3}) for Chinook 0+ and 1+ Electrofished During Day and Night from Habitat Complex and Natural Sites in Reaches 2 and 4 of the Nechako River, 1997

		Reach 2				Reach 4				Pooled	
		Complex		Natural Sites		Complex		Natural Sites			
Month	Statistics	Day	Night	Day	Night	Day	Night	Day	Night	Reach 2	Reach 4
Chinook 1+											
April	Mean	1.25	1.26	1.56	1.24	0.93	1.18	No catch	1.19	1.26	1.18
	n	16	112	1	6	2	28	No catch	41	135	71
	Maximum	1.61	1.55	1.56	1.40	0.95	1.45	No catch	1.39	1.61	1.45
	Minimum	1.07	0.97	1.56	1.10	0.91	0.81	No catch	0.87	0.97	0.81
	SD	0.13	0.12	n/a	0.13	0.03	0.15	No catch	0.14	0.12	0.15
May	Mean	1.28	1.22	No catch	1.28	No catch	1.35	1.22	1.28	1.24	1.32
	n	2	40	No catch	15	No catch	7	1	3	57	11
	Maximum	1.42	1.50	No catch	1.54	No catch	1.50	1.22	1.31	1.54	1.50
	Minimum	1.14	0.78	No catch	0.79	No catch	1.22	1.22	1.26	0.78	1.22
	SD	0.20	0.17	No catch	0.19	No catch	0.11	n/a	0.03	0.18	0.10
Chinook 0+											
April	Mean	0.79	0.83	0.79	0.84	0.74	0.83	0.88	0.81	0.82	0.82
	n	97	161	113	180	2	15	2	27	551	46
	Maximum	1.07	1.15	1.23	1.09	0.81	0.95	0.94	1.02	1.23	1.02
	Minimum	0.59	0.56	0.51	0.65	0.68	0.68	0.82	0.67	0.51	0.67
	SD	0.08	0.11	0.10	0.09	0.09	0.08	0.09	0.07	0.10	0.08
May	Mean	0.80	0.86	0.80	0.86	0.87	0.96	0.86	0.95	0.83	0.92
	n	179	249	216	243	27	70	78	171	887	346
	Maximum	1.06	1.23	1.10	1.15	1.17	1.50	1.20	1.31	1.23	1.50
	Minimum	0.49	0.58	0.49	0.61	0.70	0.71	0.48	0.72	0.49	0.48
	SD	0.10	0.11	0.10	0.10	0.12	0.13	0.13	0.11	0.11	0.13
June	Mean	1.01	1.04	1.03	1.05	1.10	1.11	1.04	1.12	1.04	1.10
	n	75	197	44	217	9	25	35	89	533	158
	Maximum	1.61	1.51	1.58	1.54	1.26	1.32	1.24	1.58	1.61	1.58
	Minimum	0.75	0.49	0.73	0.68	0.92	0.86	0.86	0.84	0.49	0.84
	SD	0.13	0.14	0.15	0.12	0.12	0.12	0.10	0.12	0.13	0.12
Nov	Mean	1.14	1.16	1.12	1.15	1.10	1.12	1.11	1.14	1.15	1.13
	n	26	182	12	162	18	40	5	110	382	173
	Maximum	1.37	1.51	1.54	1.43	1.24	1.39	1.33	1.43	1.54	1.43
	Minimum	0.93	0.89	0.91	0.81	0.97	0.98	1.01	0.86	0.81	0.86
	SD	0.13	0.13	0.17	0.12	0.07	0.12	0.13	0.13	0.13	0.12

Appendix 11

Mean, Maximum and Minimum Log_{10}(CPUE +1) for Chinook 0+ Electrofished During Day and Night from Habitat Complex and Natural Sites in Reaches 2 and 4 of the Nechako River, 1997

Appendix 11

Mean, Maximum and Minimum Log_{10}(CPUE +1) for Chinook 0+ Electrofished During Day and Night from Habitat Complex and Natural Sites in Reaches 2 and 4 of the Nechako River, 1997

		Reach 2				Reach 4				Pooled	
		Complex Sites		Natural Sites		Complex Sites		Natural Sites			
Month	Statistics	Day	Night	Day	Night	Day	Night	Day	Night	Reach 2	Reach 4
April	Mean	2.91	3.38	2.82	3.34	0.71	1.71	1.04	1.40	3.11	1.21
	n	29	28	32	32	13	13	20	19	121	65
	Maximum	4.15	4.32	4.44	4.51	3.40	3.77	4.38	4.20	4.51	4.38
	Minimum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	SD	1.23	1.04	1.41	1.16	1.36	1.66	1.66	1.70	1.23	1.62
May	Mean	3.37	3.92	3.12	3.62	2.08	3.55	2.45	3.89	3.48	3.05
	n	25	26	37	36	10	10	22	21	124	63
	Maximum	5.07	5.04	5.44	4.75	4.28	4.75	4.92	4.55	5.44	4.92
	Minimum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	SD	1.43	0.92	1.62	1.23	1.83	1.32	1.73	0.98	1.36	1.63
June	Mean	2.38	4.09	1.80	3.73	3.27	4.00	2.79	3.13	2.91	3.08
	n	19	19	32	28	4	3	14	14	98	35
	Maximum	4.28	5.11	3.70	4.76	3.40	4.28	4.00	4.38	5.11	4.38
	Minimum	0.00	2.75	0.00	0.00	3.22	3.62	0.00	0.00	0.00	0.00
	SD	1.70	0.53	1.63	1.14	0.09	0.34	1.23	1.73	1.65	1.36
Nov	Mean	1.54	3.48	0.64	2.98	2.25	3.09	0.50	2.96	2.06	1.97
	n	22	22	39	39	9	9	24	23	122	65
	Maximum	3.52	4.43	3.40	4.22	3.62	4.10	3.22	4.12	4.43	4.12
	Minimum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	SD	1.59	1.19	1.28	1.32	1.69	1.24	1.14	1.43	1.76	1.75

Appendix 12

Mean, Maximum and Minimum Log_{10}(CPUE +1) for Chinook 0+ Electrofished During Day and Night from Debris Bundle and Debris Catcher Habitat Complex Sites in Reaches 2 and 4 of the Nechako River, 1997

Appendix 12

Mean, Maximum and Minimum Log_{10}(CPUE +1) for Chinook 0+ Electrofished During Day and Night from Debris Bundle and Debris Catcher Habitat Complex Sites in Reaches 2 and 4 of the Nechako River, 1997

		Reach 2				Reach 4				Pooled	
		Bundles		Catchers		Bundles		Catchers			
Month	Statistics	Day	Night	Day	Night	Day	Night	Day	Night	Reach 2	Reach 4
April	Mean	2.77	3.35	3.00	3.41	0.70	2.14	0.73	0.73	3.15	1.21
	n	11	11	18	17	9	9	4	4	57	26
	Maximum	3.70	4.32	4.15	4.20	3.40	3.77	2.92	2.92	4.32	3.77
	Minimum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	SD	1.40	1.17	1.15	0.98	1.40	1.62	1.46	1.46	1.16	1.57
May	Mean	3.20	3.95	3.51	3.90	2.60	3.57	0.00	3.40	3.65	2.82
	n	11	11	14	15	8	9	2	1	51	20
	Maximum	4.81	5.04	5.07	4.64	4.28	4.75	0.00	3.40	5.07	4.75
	Minimum	0.00	3.22	0.00	0.00	0.00	0.00	0.00	3.40	0.00	0.00
	SD	1.24	0.55	1.60	1.14	1.67	1.40	0.00	N/A	1.22	1.73
June	Mean	2.30	4.24	2.45	3.96	3.27	4.00	N/A	N/A	3.24	3.58
	n	9	9	10	10	4	3	N/A	N/A	38	7
	Maximum	4.12	5.11	4.28	4.45	3.40	4.28	N/A	N/A	5.11	4.28
	Minimum	0.00	3.40	0.00	2.75	3.22	3.62	N/A	N/A	0.00	3.22
	SD	1.77	0.56	1.74	0.50	0.09	0.34	N/A	N/A	1.52	0.44
Nov	Mean	1.23	3.93	1.64	3.35	3.40	3.43	0.81	2.66	2.51	2.67
	n	5	5	17	17	5	5	4	4	44	18
	Maximum	3.22	4.34	3.52	4.43	3.62	3.77	3.22	4.10	4.43	4.10
	Minimum	0.00	3.22	0.00	0.00	3.22	2.92	0.00	0.00	0.00	0.00
	SD	1.69	0.45	1.60	1.32	0.18	0.46	1.61	1.84	1.70	1.50