SIZE, DISTRIBUTION AND ABUNDANCE OF JUVENILE CHINOOK SALMON OF THE NECHAKO RIVER, 2010

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EXECUTIVE SUMMARY

The distribution and abundance of juvenile chinook salmon (*Oncorhynchus tshawytscha*) in the upper 100 km of the Nechako River, BC in 2010 were evaluated through sampling using electrofishing and rotary screw traps as part of the twenty-second year of the Nechako Fisheries Conservation Program (NFCP), commissioned by Rio Tinto Alcan.

Mean daily water temperatures below the Cheslatta Falls in 2010 were close to, or above, the observed maximum between the years 1987 and 2004 for April but were close to the historic mean from June to mid-August. Flows at Cheslatta Falls in 2010 were lower than the 18-year median (1987-2004) from April to the end of July. Cumulative daily flows for 2010 followed the same pattern as in previous years but were lower than 10 of the 18 years on record.

Based on the data on fish size versus time, emergence of chinook fry in 2010 had ceased by early June. Monthly electrofishing surveys along the length of the upper river in April, May, June, July and November captured 86,000 fish from 12 species or families. Juvenile chinook salmon were the most common species, accounting for 38% of all captures or 32,456 fish (32,232 0+ and 224 1+), of which 61% were captured at night. As in previous years, juvenile chinook captured at night tended to be longer and heavier than daytime-captured fish during the primary growth period of May – July.

The catch-per-unit-effort of electrofished 0+ chinook peaked in May for both day and night catches. Spatial distribution of 0+ chinook along the length of the upper Nechako River reflected a general upstream movement of 0+ chinook from May to July and a large overall drop in abundance of fish residing in the river in November consistent with the historical trend. CPUE of 0+ chinook ranged from 0 to 421

fish/100m^2 and peaked in either May (night) or June (day) and then decreased. CPUE of 1+ chinook ranged from 0 to 11 fish/100 m^2 and decreased with date.

The number of outmigrating 0+ chinook (8,926) captured by rotary screw traps at Diamond Island between April 11 and July 15, 2010, was bimodal, with an initial peak on May 9 and a secondary peak on June 20. Fish captured at night were both longer and heavier thann those captured during the day. Compared to the historic data, the 0+ fish captured in 2010 were larger than the 14-year mean (1991-2004) in April but smaller in May, June and July. Condition indices in 2010 were slightly lower than the historical mean but higher than the historical minimum.

The index of juvenile downstream migration was 154,433 for 0+ chinook and 9,599 for 1+ chinook. The combined estimate (164,032) was the 3rd highest on record. The index of 0+ outmigrants for the years 1992 to 2004 and 2010 was positively and significantly correlated with the number of parent spawners upstream of Diamond Island in the previous year. The 2010 results do not fall outside the data envelope identified in the NFCP 5 year plan (2007-2012) and therefore additional evaluation and changes to the program schedule are not considered necessary.

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1.0 INTRODUCTION

This report describes juvenile chinook salmon (*Oncorhynchus tshawytscha*), distribution and abundance in the upper 100 km of the Nechako River in 2010. The study was part of the twenty-second year of the Nechako Fisheries Conservation Program (NFCP) and was commissioned by Rio Tinto Alcan. The primary objectives of the 2010 juvenile chinook outmigration study were to describe the relative abundance, growth and spatial distribution of juvenile chinook in the upper Nechako River, and to calculate an index of abundance of the number of juvenile chinook migrating downstream of Diamond Island from March to July. The secondary objective was to compare the biological parameters measured in 2010 with those measured over previous years. The juvenile outmigration program was last completed in 2004 and prior to that had been completed yearly since 1990. In 2007, the NFCP changed the outmigration study to a 5 year cycle based on the strength of the statistical relationships and the apparent stability of in-river habitat conditions (NFCP, 2007). In addition, the results of the previous years of study were used to establish upper and lower conservation threshold levels (termed "data envelopes") for the relationship between outmigrants and spawners. It was recommended that if/when future observations fall below the lower data envelopes for the established statistical relationships that this would serve as a trigger for the consideration of additional evaluation (NFCP, 2007). The 2010 program was the first year of study under the revised 5-year schedule.

2.0 METHODS

2.1 Study Sites

The study area included the upper 100 km of the Nechako River from Kenney Dam to Fort Fraser (**Figure 1**). It was divided into four reaches with the following boundaries, as originally defined by Envirocon Ltd. (1984):

Reach	Distance (km) from Kenney Dam
1	9.0-14.5
2	14.6-42.9
3	43.0-66.5
4	66.6-100.6

All longitudinal distances are in kilometres from the center line of Kenney Dam. The first nine kilometres of the river are within the Nechako River Canyon, which was dewatered by the closing of Kenney Dam in October 1952. The majority of the flows in the upper river occur downstream of Cheslatta Falls (km 9.0).

2.2 Temperature and Flow

Mean daily water temperatures were measured by the Water Survey of Canada (WSC) station located at the Nechako River below Cheslatta Falls (station #08JA017). Unfortunately data from the station was not available prior to April 12th, 2010. A Tidbit® datalogger installed at the property of Bert Irvine located approximately 9 km downstream of Cheslatta Falls provided temperature data for the period of March 11th to April 11th, 2010. Spot water temperatures were recorded by hand-held thermometers during electrofishing surveys.

Daily water flows were recorded at Skins Lake Spillway (WSC station 08JA013) and at the Nechako River below Cheslatta Falls (WSC station 08JA017).

2.3 Electrofishing Surveys

2.3.1 History

Between 1990 and 2004, the NFCP conducted electrofishing surveys of the upper Nechako River to measure the relative abundance and spatial distribution of juvenile chinook. The surveys were initiated in 1990 when a downstream trapping fence could not be operated because of high river flows. In subsequent years the surveys have become an important component of the chinook monitoring program due to the capability of the surveys to show spatial variation in juvenile density during spring and summer.

Results from 1990 - 2004 suggested a stable population and as a result no sampling was conducted from 2005 – 2009. Sampling of the historic sites was completed in 2010 to assess if the population has remained stable and if the trends and relationships observed from 1990-2004 are still consistent and representative of stable habitat conditions.

2.3.2 Surveys

The distribution of juvenile chinook salmon was assessed from single-pass electrofishing surveys of Reaches 1-4, as in previous years. Electrofishing surveys were carried out at night and during the day, with night defined as the time period between sunset and sunrise. Surveys began in April and continued in May, June, early July, with the final survey completed in early November. The surveys in April, May, June and July provide information on the abundance and distribution of juvenile chinook during the period of greatest habitat use by juvenile chinook within the upper Nechako River. The November sampling provides information on the juveniles that reside in the river in the fall and winter. Surveys were not conducted in late July and August because of the release of summer cooling flows (under the Summer Temperature Management Program; STMP) resulting in water levels too high to allow safe and effective electrofishing. During this period, large flows are released into the upper river to cool the river to mitigate potential increases in water temperatures during the summer and reduce the risk to sockeye salmon (*Oncorhynchus nerka*) migrating through the lower Nechako River to spawning grounds in the Stuart, Stellako and Nadina River systems.

Surveys of Reaches 1 through 4 were completed in each of the months sampled, except April and November when low river discharge prevented safe boat access to Reach 1 and the upper portion of Reach 4. The survey schedule for 2010 is shown in **Figure 2.**

All electrofishing surveys were conducted over prime juvenile chinook salmon habitat, defined as depth greater than 0.5 m, velocity greater than 0.3 m/s and a substrate of gravel and cobble (Envirocon Ltd. 1984). That habitat is found mainly along the margins of the river, so the electrofishing surveys did not sample the portion of the population that may have occupied the mid-channel. Mid-channel residents are however a minor component of the population of juvenile chinook, as electrofishing surveys conducted by the Department of Fisheries and Oceans (DFO) have shown that mid-channel densities of chinook were 70 times lower than densities along river margins (Nechako River Project 1987). The same study also showed that 97% of observed juvenile chinook were found along river margins.

Fish were captured with a single pass of a Smith-Root model 12B POW backpack electrofisher, identified to species (except for cottids), counted, and released live back into the river. This yielded a measure of catch-per-unit-effort (CPUE) of juvenile chinook, in this case the number of fish caught at a site divided by the area sampled, expressed in units of 100 m^2.

The age of juvenile chinook was recorded as 0+ or 1+, based on fork length and month of capture. During early spring juvenile chinook less than 90 mm long were classified as 0+ and those over 90 mm in length in early spring were classified as 1+. Juvenile chinook over 90 mm long in summer or fall were classified as 0+ because by that time

1+ chinook had migrated out of the upper Nechako River. There can however be an overlap in late spring (early June typically) when larger 0+ and smaller 1+ can be confused. In these cases the classification as 0+ or 1+ was based on professional judgment of the biologist and on a comparison of the fish in question with other fish captured that day.

Fork length and wet weight were measured from a random sub-sample of up to 10 chinook at each site and each day or night sampling event. Fork length was measured to the nearest mm with a fry measuring board, and wet weight was measured to the nearest 0.01 g with an electronic balance.

Lengths and weights of up to 10 of all other salmonids such as rainbow trout and sockeye were also measured but such measurements were not taken for non-salmonid fish other than burbot (*Lota lota*), a rare species in the Nechako River.

Fulton's condition factor (Ricker 1975) was used as an index of physical condition:

$$\text{(1)} \qquad CF = \text{weight (g)} \times 10^5 / [\text{fork length (mm)}]^3$$

Mean daily length and weight of 0+ and 1+ chinook were calculated separately for day and night catches because previous statistical analyses have shown that juvenile chinook lengths and weights are significantly different between night and day (fish caught at night tending to be larger), and also because historical observations have shown that the behaviour of juvenile chinook varies with time of day. Chinook tend to remain near instream cover during the day and emerge between dusk and dawn for behaviours such as feeding and migration.

It is important to note that areas sampled by electrofishing were not isolated with nets, meaning that some fish could avoid capture by leaving a sampling area during a pass. Similarly, fish from outside the sampling area could move into the site during the completion of the pass. Electrofishing catch is therefore likely an underestimate of the total number of fish in a survey area, as fish are more likely to scatter away from a site than be attracted to the site. An accurate estimate of the total number of fish within a survey area would require multi-pass sampling of isolated areas, but the isolation of river margins can be difficult (*e.g.,* in areas of sharp drop-offs or fast water velocities) and time consuming. However, the Nechako River electrofishing survey was not designed to estimate absolute numbers — it was designed to provide an index of relative abundance that could be compared between years.

This sampling strategy is called "semi-quantitative" (Crozier and Kennedy 1995). It has two advantages over the fully quantitative method. First, it is the only electrofishing technique that can be used when it is impractical to enclose a survey area in blocking nets because the area is too large to be enclosed or flows through the area are too strong to allow nets to be installed. For example, almost all electrofishing conducted in lakes and reservoirs (DeVries *et al*. 1995; Van Den Ayle *et al*. 1995; Miranda *et al*. 1996), and in large rivers (R.L. & L. Environmental Services Ltd. 1994), is semi-quantitative.

Second, it is often necessary to use semi-quantitative methods when the region to be surveyed contains many possible survey sites, but the time and resources available for sampling are limited (Crozier and Kennedy 1995). The upper Nechako River is too long (~ 100 km) for cost-effective quantitative sampling of its entire length several times a year.

There are two disadvantages of the semi-quantitative method. First, semi-quantitative electrofishing CPUE cannot be compared to fully quantitative CPUE unless the former are calibrated by the latter. That is, unless total numbers are estimated for a subset of the same areas that are semi-quantitatively surveyed, and a calibration relationship is developed from a comparison of the two types of CPUE (*e.g.*, Serns 1982; Hall 1986; Coble 1992; McInerny and Degan 1993; Edwards *et al*. 1987). Conversion of electrofishing CPUE to absolute CPUE has not been a NFCP objective because the purpose of the electrofishing surveys is to search for among-year variations in relative abundance of juvenile chinook and not to compare it with absolute abundances of other chinook streams.

Second, semi-quantitative sampling assumes that the efficiency of capture, the fraction of total number of fish in a survey area that are caught in a single electrofishing pass, is constant for all sites and species of fish. However, electrofishing catch efficiency varies significantly with fish species, fish body size, type of habitat, time of day, water temperature, and the training and experience of personnel conducting the survey (Bohlin *et al*. 1989, 1990). The NFCP electrofishing project reduces error in estimation of CPUE by sampling only one type of habitat (preferred juvenile chinook habitat), by focusing analysis on only one species (chinook), by analyzing CPUE from night and day surveys separately, and by using the same experienced crew leaders each year. However, the study plan does not account for changes in catch efficiency that may result from seasonal changes in fish size, flow or water temperature.

2.4 Rotary Screw Traps

Rotary screw traps (RSTs) were used to estimate the number of juvenile chinook that migrated downstream past Diamond Island (**Figure 1**). The total number of each species and age class captured in each trap (day and night), as well as the length and weight of a random sub-sample of up to 10 of all sport fish species captured, was recorded.

An RST consists of a floating platform which supports a current-driven rotating cone. In front of the cone is an A-frame with a winch used to set the vertical position of the mouth of the cone, half of which is always submerged. The back of the cone funnels into a live box where captured fish are kept until the trap is emptied. The cone is 1.43 m long and made of 3 mm thick aluminium sheet metal with multiple perforations to allow water to drain. The diameter of the cone tapers from 1.55 m at the mouth to 0.3 m at the downstream end. Inside the cone is an auger or screw, the blades of which are painted black to reduce avoidance by fish. As the current of the river strikes the blades of the screw, it forces the cone to rotate. Any fish entering the cone is trapped in a temporary chamber formed by the screw blades. As the cone rotates, the chamber moves down the cone until its contents are deposited into the live box.

Historically, three RSTs have been suspended from a cable strung across the river channel off Diamond Island: RST 1 near the left bank (left margin), RST 2 in the middle of the river (mid channel), and RST 3 near the right bank (right margin). The 1.5 m space between the right bank of the river and RST 3 was blocked with a wing made of wire mesh fence panels. Although RST 1 was originally installed close to the left margin, the channel gradually changed course and widened during the multiple years of the study, and this RST historically sampled in mid channel. The position of the traps in 2010 was similar to that in previous years of the study. The same cable crossing was able to be used however RST 1 had to be moved closer to the left bank (left of mid channel) due to changes in the river at the trap site. In addition RST 3 was moved approximately 25 m further downstream from its historical location due to a gravel bar and back-eddy that had formed since 2004.

The RSTs were installed on April 10^{th}, once the river was free of ice, and removed in mid-July to avoid high cooling flows in July and August. The live box of each trap was emptied twice each day at 08:00 and 19:00. All fishes were collected from the live box, counted and identified to species. A subsample of 10 chinook salmon was measured for length and weight with the same methods described above for the electrofishing surveys, after which all fish, including the subsampled fish, were released live back into the river approximately 300 m downstream of the trapping site.

An index of the number of juvenile chinook passing Diamond Island was calculated by multiplying the total number of fish caught in an RST in a time period (day or night) by the ratio of the total flow of the river to the flow that passes through the RST:

$$(2) \qquad N_{ij} = n_{ij}(V_j / v_{ij})$$

where N_{ij} = number of juvenile salmon passing Diamond Island on the *jth* date as estimated by the catches of the *ith* trap, n_{ij} = number of chinook salmon caught in the *ith* trap on the *jth* date, V_j = total water flow (m^3/s) of the Nechako River past Diamond Island on the *jth* date, and v_{ij} = water flow (m^3/s) through the *ith* trap on the *jth* date. All analyses of rotary screw trap data were based on the numbers expanded by equation (2) rather than on catches.

V_j was estimated from measurements on a staff gauge located at the trapping site, using a regression equation between river discharge measured upstream of Smith Creek (downstream of the trapping site; **Figure 1)** and the height of the staff gauge ($N = 16$, $R^2 = 0.94$, $P<0.001$):

$$(3) \qquad Flow(m^3/s) = 23.694e^{2.0692(\text{staff height, m})}$$

That regression was calculated for steady flow conditions from April to July, 2010.

Water flow though a trap (v_{ij}) was the product of one half the cross-sectional area (1.77 m^2) of the mouth of the trap (the trap mouth was always half-submerged) and average water velocity in front of the trap. Average water velocity (m/s) was measured with a Swoffer (model 2100) flow meter at three different places in the front of the mouth of the RST. The one exception to this rule was RST 3, where v_{ij} was increased to include the water that flowed between it and the right bank of the river because the fish that would ordinarily have passed through this gap were diverted into RST 3 by the right wing.

Since there were three RSTs, there were three estimates of total chinook number each day. The best estimate of the total index number of chinook salmon was the mean of the three estimates weighted by the flow that passed through each trap.

3.0 RESULTS AND DISCUSSION

3.1 Temperature

Mean daily water temperatures below Cheslatta Falls fluctuated from around 0 - 3°C from January to mid-March, to just over 17°C from July 31st to August 18th (**Figure 3**). Temperatures then declined to a daily mean of 7°C by the beginning of November.

Spot temperatures measured during electrofishing surveys are plotted by month as a function of their distance from Kenney Dam in **Figure 4**. Only sites that were sampled during all months (April, May, June, July and November) are shown, and only night time temperatures are plotted to minimize large variations due to time of sampling (*e.g.*, sites sampled in early morning would be expected to have lower temperatures than sites sampled in the afternoon).

In general, April and November water temperatures decrease with increasing distance from Cheslatta Falls as reservoir water is cooled by cold spring and fall air temperatures. Conversely, in May, June and July water temperatures increase with distance from Cheslatta Falls as reservoir water is warmed by summer air. In general this was the trend observed in 2010 with temperatures increasing with distance from the falls in May, June and July and decreasing in November. Results from April were more variable than in the other months, particularly in Reach 2; but also followed the trend with the coldest water temperatures recorded at the downstream end of the sampling area.

The widest range of temperatures was recorded in June when temperatures varied from 9 - 19ºC over the course of the one week sampling period. It should be noted that the sites with temperatures of 19ºC were all sampled together early on the last night of sampling. Prior to that night the maximum temperature recorded was 17 ºC. November had the least variation in temperatures which ranged from 4 - 8ºC.

3.2 Flow

From January 1 to April 22, 2010, releases from Skins Lake Spillway were steady with a slight decrease from 33 m^3/s in January to 31 m^3/s in April (**Figure 5**). From April 22 to 24, releases rose from 31 to 49 m^3/s and then remained stable until July 11, after which they increased as part of the Summer Temperature Management Program (STMP). Peaks in discharge occurred on July 20 (376 m^3/s), July 26 (452 m^3/s), Aug 5 (329 m^3/s) and August 14 (450 m^3/s). There were no fall or winter forced spills as of early November based on the data available at the time of this report. Releases from August 17 to October 31 ranged between 14 - 34 m^3/s.

Flows at Cheslatta Falls varied less rapidly than releases at Skins Lake Spillway due to the buffering effect of the Murray-Cheslatta Lake chain. Flows ranged between 33 m^3/s and 47 m^3/s between April 12[1] and July 11. It should be noted that the difference in average flows between Skins Lake Spillway and Cheslatta Falls was due to the addition of flows from tributaries to the Murray-Cheslatta system. Flows rose rapidly on July 12 in response to STMP releases, and reached a maximum of 298 m^3/s on July 31, 2010, with a secondary peak of 310 m^3/s on August 5, 2010. Flows then declined to an average of 35 m^3/s from September 1 to the end of October. At the beginning of November a flow increase in the hydrograph was the result of heavy precipitation in the region.

In summary, the 2010 flows of the upper Nechako River at Cheslatta Falls were stable for most of the year and exhibited the typical changes in flows associated with the STMP in July and August.

[1] Data from the WSC station at Cheslatta Falls was not available prior to April 12, 2010.

3.3 Size and Growth of Chinook Salmon

3.3.1 Effect of time of day – electroshocking

A total of 32,232 0+ chinook were captured by electrofishing in the Nechako River in 2010, with 19,698 (61%) captured at night and 12,534 (39%) captured during the day (**Table 1**). Factorial ANOVAs of fork length and wet weight (both ln-transformed to respect the assumptions of the test) with time of day (day or night) and time of year (April, May, June, July and November) showed that there was a significant interaction between time of day and time of year (**Table 2**). A significant interaction means that the effect of one independent variable (*e.g.*, 'time of day') on the dependent variable (Fork Length (FL) or Wet Weight (WW) in this case) depends on the level of the other independent variable ('time of year'). In the present case, the significant interaction between time of day and time of year requires one to test whether FL_{night} is greater than FL_{day} for each month sampled rather than grouping all FL_{day} across months. There were also, as expected, significant effects of time of year and time of day on these variables.

Analysis showed that 0+ chinook caught at night were significantly longer than fish caught during the day for April, May, June, and July (p<0.004) (**Figure 6**). Fish caught in November were actually bigger during the day, however the difference was not statistically significant (p=0.67). The size difference between day and night each month never exceeded 10% (maximum of 9.9% in July). Thus while the differences observed in April, May and November were statistically significant, they may not be biologically significant.

Wet weights of 0 + chinook caught at night were heavier on average in all months sampled with the exception of April (**Figure 7**). Significant differences were detected in May, June and July (p<0.001). The percent difference in weight between night and day was highest in June and July (35% and 29% respectively) whereas they were below 5% in April and November. The percent difference in May was 15%.

The large day-night differences in length and weight observed in summer months (June and July) are thought to be related to differences in behaviour that have historically been observed during the two periods. During the day, juvenile fish tend to remain under cover and it is theorized that the larger juvenile chinook will make use of the high value cover forcing the smaller fish to the periphery of the habitat where they are more easily sampled. However, at night the historical sampling results have shown juvenile chinook to be more active, leaving the sheltered areas to feed and migrate resulting in a wider size range of fish potentially available to be sampled.

1+ Chinook Salmon

There were 224 1+ chinook caught by electrofishing in 2010. This is more than in 2004 (123) but less than in 2003 (590). Most of the 1+ chinook (89%) were caught at night (**Table 1**) and the majority (71%) were caught in April. No 1+ chinook were caught during the day in July and only two were caught in June (1 during the day and 1 during the night). No significant day-night differences in fork lengths or wet weights of 1+ chinook captured by electrofishing in 2010 were detected (**Figures 8** and **9**).

3.3.2 0+ Chinook Growth

The growth of 0 + chinook salmon electrofished along the river margins appeared to follow two separate growth stanzas: as in previous years, growth was slow during April and May and then increased in June (**Figures 10** and **11**). However, the apparent slow growth during the first stanza was more likely due to continuous emergence of fry over a period of several weeks as opposed to lack of growth. Specifically, the numbers of emergent fry were large enough to cause the mean size of all fish caught to stay close to the mean size of emergent fry. After emergence ceased, the second stanza began and the true growth rate of juvenile chinook became apparent. Based on the curvature of the relationship between mean length and weight *vs*. date, emergence appeared to have ceased by late early June in 2010.

3.3.3 1+ Chinook Growth

In contrast to 0 + chinook, 1+ chinook did not appear to show any significant growth: their average fork length went from 88 mm in April to 94 mm in July and their average weight went from 8.8 g to 11.3 g during the same period.

3.3.4 0+ and 1+ Chinook Salmon Weight-Length Relationship

The relationship between wet weight and fork length of 0+ and 1+ chinook salmon is shown in **Figure 12**. Although a power function explained 97% of the overall variation (Weight = $2e^{-5}$ Fork Length $^{3.38}$, $R^2 = 0.97$ for all chinook), there were more variations among larger juveniles. Most 0+ chinook above 80 mm were below the predicted weight whereas 1+ chinook above 80 mm showed wide variability in weights.

0+ chinook captured in 2010 began to show increased variation in wet weight at fork lengths of 60 mm and greater (**Figure 13**). 1+ chinook showed more variation in wet weight at fork lengths greater than 85 mm, however, this could partly be due to the relatively small sample size of 1+ chinook. These results likely reflect differences in feeding success and variability in rearing habitat quality in the study area in late summer. Alternatively the lower variations in weight at fork lengths < 60 mm may indicate that there was a suitable availability of fish rearing habitat in early summer.

0+ and 1+ Chinook Salmon Condition

Average condition of 0+ chinook increased from 0.86 g/mm^3 in April (a lower value than the 0.94 g/mm^3 in 2004 but comparable to 0.84 g/mm^3 observed in 2001-2003) to 1.23 g/mm^3 in June and July (1.30 g/mm^3 in 2004; 1.25 g/mm^3 in 2003) and decreased to 1.13 g/mm^3 in November (1.18 g/mm^3 in 2004) (**Figure 14**). There was much less variation in November condition indices (range of 0.9 to 1.6) than in June (0.5 to 2.2).

These results are as expected since condition, which is a reflection of weight per unit length, would tend to increase most during the early growth stanza (i.e., April through July) when both length and weight are increasing steadily. However, between July and November when growth has slowed, condition tends to stabilize with only slight variations being observed primarily as a result of weight fluctuations associated with food availability. Average condition of 1+ chinook salmon remained relatively constant from 1.3 g/mm^3 in April (n = 152) to 1.4 g/mm^3 in July (n = 12; **Figure 15).**

3.3.5 Diamond Island Rotary Screw Traps

Overall, 9,496 juvenile chinook salmon were caught by the rotary screw traps at Diamond Island in 2010 (**Table 3** and **Appendix 1**): 8,926 0+ and 570 1+. This is lower than 2004 (21,547) but comparable to 2003, when 9,174 0 + chinook were caught in the traps. Approximately 84% of all 0+ fish and 98% of all 1+ fish were caught at night. This supports the observation of increased movement at night but could also suggest better avoidance of the traps during the day.

0+ Chinook

The distribution of 0+ chinook catches over time was bimodal, with an initial peak of abundance around May 9, 2010 and a secondary, smaller peak on June 20 (**Figure 16**).

Using the index calculation outlined in Section 2.4, the numbers of 0+ chinook estimated to have passed Diamond Island between April 12 and July 15 ranged from 117,324 for RST #2 to 195,884 for RST #1 (**Appendix 1**). The total index number of 0+ chinook that passed Diamond Island, weighted by the average percent of river flow filtered by each trap, was 154,433.

All analyses of juvenile chinook catch distributions among traps were done on volume-expanded numbers, as they take into account the different water volumes sampled by different traps, and thus standardize the catches among traps. Analyses of morphological parameters were done on sub-sampled fish (not all fish caught were measured, Section 2.4).

There was a significant interaction between time of capture (day or night) and trap position for 0 +chinook (**Table 4**). Therefore, the trap data were analysed separately by night and by day. RST #1 (left margin) caught significantly more fish at night than the two other traps, and RST #3 (right margin trap) caught significantly more fish during the day (**Table 3, Figure 17**). Overall, all traps caught more 0+ chinook at night (**Figure 17**).

The 0 + chinook morphological parameters (fork length, wet weight) also differed among traps (**Figures 18 A & B**). At night, the fish captured in the right margin trap tended to be smaller than the fish caught in mid-channel traps. However, a statistically significant difference was only detected between RST #1 and 3 (p=0.004). A similar trend was observed for weight, but for that parameter fish caught in both RST #1 (p=0.001) and 2 (p=0.04) were found to be significantly larger than those caught in RST #3. During the day, fish captured in RST #1 were still the largest, however, unlike at night RST #2 was found to have the smallest fish. For length, there was a significant difference between RST #1 and 2 (p=0.001) but not between RST #1 and #3 or between #2 and #3. For weight, fish captured from both RST #1 (p<0.001) and 3 (P=0.007) were significantly larger than those caught in RST #2. This trend has been observed in 2000 and 2001 (NFCP 2000, 2001) and is likely a result of the different habitat at each trap. In particular RST #2 is shallower than RST #1 and has less cover than RST #3. The results suggests that during the day the larger fish will either make use of the cover along the shore (sampled by RST #3) or the deeper, faster moving water in the thalweg of the river (sampled by RST #1)forcing the smaller fish to the less desirable habitat sampled by RST #2.

1+ Chinook

The numbers of 1+ chinook estimated to have passed Diamond Island between April 2 and July 20 ranged from 710 for RST #3 to 20,579 for RST #1 (**Appendix 1**). The total index number of 1+ chinook estimated to have passed Diamond Island, weighted by the average percent of river flow filtered by each trap, was 9,599.

There was a significant interaction between time of capture (day or night) and trap position for 1+ chinook (**Table 5**). Specifically, there were significantly more fish caught at night ($p<0.001$) at RST #1 and 2, and the left margin trap (RST #1) caught significantly more fish then either of the other traps (**Table 3**; **Figure 19**). RST #3 (right margin) also caught more 1+ chinook at night (n_{day} = 3, n_{night} = 13), but the difference was not significant ($p=0.05$). There was no significant difference between the captures at any of the traps during the day. The results suggest that 1+ chinook in 2010 tended to use the middle of the river (where the left margin and mid-channel traps are located) more than the margins. This is the same trend than the one observed in 2004, 2003 and 2002, but different from 2001 when 0+ fish were caught in greater numbers along the right margin (NFCP 2001, 2002, 2003, and 2004).

Morphological parameters (fork length, wet weight) of 1+ chinook did not differ among traps (**Figure 20;** tests done on ln-transformed data). Only night catches were tested as there were only 16 fish caught during the day (**Table 3**).

0+ Chinook Salmon Growth

Lengths and weights of 0+ chinook captured at Diamond Island followed seasonal trajectories similar to those of electrofished 0+ chinook (**Figures 21** and **22;** compare with **Figures 10** and **11**). The first growth stanza ran from early April to around May 17-21, at which time the rate of fry emergence had dropped to a level that allowed the true change in body size over time to become apparent.

1+ Chinook Salmon Growth

The fork lengths and weights of 1+ chinook did not vary much with date (**Figures 23** and **24**). Figure 23 shows a slight decrease in fork length of 1+ chinook captured in June as compared to those captured in April and May. This could suggest that the larger fish migrate out of the system sooner then the smaller fish, perhaps because they have achieved a certain size threshold.

0+ and 1+ Chinook Salmon Condition

The trajectory of the average condition of 0+ chinook salmon was similar to that shown for electrofished fish—it hovered between 0.7 and 0.9 g/mm^3 over April and May (emerging fish) and climbed to a peak of 1.1 g/mm^3 in June and July. The average condition index of 0 + chinook in 2010 was comparable to that in 2004 (0.8 – 1.2), 2003 (0.83 - 1.4) and 2002 (0.80 – 1.1). Condition of 1+ chinook also increased slightly with date from 1.03 g/mm^3 in April and May to 1.11 g/mm^3 in June.

In summary, electrofishing surveys and rotary screw trap catches measured similar trends in length, weight and condition of juvenile chinook salmon in the upper Nechako River in 2010. The change in fish size over time of 0+ chinook indicated that emergence had ceased by late May (similar to 2003 and 2004 but earlier than in 2002) and that growth was rapid over June and July.

3.4 Catches

3.4.1 Electrofishing/All Species

In total, 1,254 electrofishing sweeps were made along the margins of the upper Nechako River from April 10 to November 6, 2010: 626 during daylight and 628 at night. The average area covered by a sweep was 133 m^2 (median of 120 m^2, range of 60 - 1,600 m^2). Most of the sweeps were less than 200 m^2 in area. The greatest amount of effort directed to a single site was applied, as in previous years, to RM17.9, the 1,600 m^2 side channel site. Effort at individual sites ranged from 74 seconds (at site RM 26.9) to 1,786 seconds (at the 1,600 m^2 side channel site). The average effort per site was 251 seconds.

Overall, 86,000 fish from 12 species or families were captured and then released in 2010 (**Table 1**). This is a substantial increase from the last year the program was run (2004), when 49,264 fish were caught from 14 species or families. As in the past, chinook were the most common species (N = 32,456) accounting for 38% of the total catch. Compared to previous years, the number of chinook captured in 2010 was higher (N = 25,631 in 2004, N = 10,648 in 2003) although the percent of total decreased (52% in 2004, 58% in 2003) due to the increase in the total number of fish captured. Largescale sucker (N = 18,589 or 22%) and northern pikeminnow (N = 11,210 or 13%) were the next most common while burbot were the least common (N = 14 or 0.1%).

3.4.2 Electrofishing/0+ Chinook

Overall, 32,232 0+ chinook were captured by electrofishing (**Table 1)**, of which 12,534 or 39% were taken during daylight. CPUE of electrofishing catches of 0+ chinook ranged from 0 to 421 fish/100 m^2.

Temporal Distribution of CPUE

Night CPUE of 0+ chinook salmon peaked in May and then decreased through to November (**Table 6**). Day CPUE of 0+ chinook salmon peaked in June and decreased in July and November.

Spatial Distribution of CPUE

Based on the relative distributions of CPUE per month, newly emergent chinook salmon (April) were most abundant in the upper river from kms 10 to 40 **(Figure 25** and **Appendix 2)**, which is consistent with the 2004 observations. The May distribution was bimodal, with two main concentrations around kms 20-40 and 70 – 80, with overall higher CPUEs in all river sections. Relative increases in CPUE in Reach 1 for July were consistent with previous years, which may indicate active upstream migration of juveniles, presumably in search of rearing habitat. Also similar to previous years, there was a decrease in July of all CPUE values for all river sections as compared to June. Although river conditions in Reaches 1 and 4 precluded thorough sampling during November, CPUE values were at their lowest for the rest of the river compared to other months, which is the trend that has historically been observed. Overall, there was a general upstream movement of 0+ chinook from May to July and a large overall drop in abundance of fish residing in the river from July to November.

3.4.3 Electrofishing/1+ Chinook

The majority of the 224 1+ chinook captured by electrofishing were caught at night (N = 200 or 89%; **Table 1**). CPUE of 1+ chinook ranged from 0 to 11 fish/100 m^2, and decreased with date (**Appendix 2**).

3.4.4 Diamond Island Rotary Screw Traps/Incidental Species

Overall, 15,161 fish from 12 species or families were captured by the rotary screw traps in 2010 (**Table 7**). Chinook salmon were the most common species, making up 62.6% of all fishes. The five most common non-salmonid fishes were largescale sucker (13.4%), redside shiner (6.4%), leopard dace (4.4%), mountain whitefish (4.3%), and northern pikeminnow (3.9%). The ranking of the species was slightly different than that reported for the electrofishing surveys however 4 of the top 5 species were the same including the top 2 most abundant species. Both the RST's and electrofishing surveys captured more juveniles than adults and captured more fish during the night then during the day. Coho salmon were the only species captured in the RST's that were not captured during the electrofishing surveys, while burbot were the opposite.

Species evenness is the proportional representation of species within the sampled community, with evenness being greatest when all species have equal representation (Krebs, 1999). Simpson's measure of evenness was applied to the RST and electrofishing results and it was found that electrofishing surveys had higher species evenness (0.37 vs. 0.20 for RST). This difference can be explained by the fact that the electrofishing surveys sample a greater area and more diverse habitats than do the RSTs and are likely more representative of species abundance in the system. Both measures were higher than that of the previous year (2004 RST: 0.14, EF: 0.23; 2003 RST: 0.17, EF: 0.23).

3.5 Comparisons with Previous Years

3.5.1 Temperature

Mean daily water temperatures below the Cheslatta Falls in 2010 were close to or above the maximum observed in the previous 18 years (1987-2004) of the study from mid- to late April (**Figure 3**). By mid-June temperatures had returned to the approximate level of the historic mean, where they remained until mid-August. Temperatures then dipped below the mean through the remainder of August and September. However, by the end of September temperatures had returned to close to the historic maximum through October until mid-November. Daily mean temperatures in the upper Nechako River in 2010 as recorded by the WSC station at Cheslatta falls did not exceeded 18°C although spot temperatures taken during the index sampling trips did exceed 19°C at river kms 81.3-82.1 (June) and km 17.9 (July; see section 3.1).

3.5.2 Flows

Daily flows of the upper Nechako River at Cheslatta Falls in 2010 were lower than the 18-year median (1987-2004) from April to the end of July (**Figure 26**). Flows were above the 18-year median for several days at the beginning of August, but by mid-August had returned to the median value which they paralleled until the end of October. Heavy precipitation in early November resulted in another increase above the median value until the end of the period on record (November 8th, 2010). Cumulative daily flows for 2010 followed the same general pattern as in previous years but were lower than 10 of the 18 years on record (**Figure 27**).

3.5.3 Growth of 0+ Chinook Salmon

Mean fork length of 0+ chinook salmon electrofished in 2010 ranged from 37 mm in April to 84 mm in November, while mean wet weight ranged from 0.45 g in April to 7.1 g in November. April was the only month that fork length and wet weight were greater than the 15-year mean (1989 – 2004) however all months exceeded the 15-year minimum (**Figure 28**). The condition index for 0+ chinook salmon electrofished in 2010 increased from 0.86 in April to 0.94 in May to 1.23 in June and dipped slightly to 1.20 in July. All four months were above the 15-year mean. November condition factor was 1.13 which was slightly lower than the 15-year mean of 1.15. These values suggest that chinook juveniles experienced rearing conditions that were comparable or slightly better than those in 1989-2004. While the condition index is a function of fork length and wet weight (equation 1, Section 2.3.2), it should be noted that it does not vary linearly with these parameters and that the variation in the index is not reflected in Figure 28 (see Figure 14 for a visual estimate of the variation).

Mean fork length of 0+ chinook salmon caught in rotary screw trap catches in 2010 ranged from 38 mm in April to 66 mm in July, while mean wet weight ranged from 0.4 g in April and May to 3.2 g in July (**Figure 29**). Fork length exceeded the 14-year mean

(1991-2004[2]) in April and May but was lower in June and July. Wet weight was equivalent to the mean in April but lower than the mean in May, June and July. The condition index for chinook caught in rotary screw catches at Diamond Island in 2010 ranged from 0.77 in April to 1.08 in July, values that are slightly below the historical mean (but greater than the historical minimum).

3.5.4 Outmigration index

Daily indices (the sum of day and night catches for each day) of chinook outmigration measured at Diamond Island in 2010 were within the range observed in most of the previous 14 years (**Figure 30**). The 2010 index is the third highest index recorded since inception of the program, with only 2002 (largest cohort of outmigrating juvenile chinook on record) and 2004 being higher (**Figure 31**).

The index of outmigration of 0+ chinook that passed by Diamond Island continues to be positively correlated with the number of adults that spawned upstream of Diamond Island the previous year (**Figure 31**). The 2010 data supports this relationship confirming that the index of outmigration reflects real biological processes. In particular the results support a strong relationship for spawner numbers less than 2000. Above that value the relationship is not as clear and in particular is strongly influenced by the results from 2002 and 2004. For example, as a result of those data points the shape of the trendline follows a power function whereas without those points a linear function would better describe the relationship. Therefore while inferences can be made about outmigration numbers with reasonable certainty for spawner numbers less than 2,000, the limited data above that level make prediction of outmigrants in high spawner years difficult. Results from 2002 and 2004 suggest that high spawner years lead to an increase in the number of outmigrants per spawner, but in 2001 and 2003 the number of outmigrants per spawner was lower (**Table 8**). The implications of this are unclear, but in 3 of those 4 years the spawner returns 4 years

[2] For April, May, and June, data only available for 1998-2004. Data for July available for 1991- 2004.

after the year of outmigration were roughly equivalent to the brood size. While this could suggest that increased spawner numbers did not resulted in lower productivity in the system in those years, other factors such as conditions in the marine environment are also likely playing a significant role in the number of returns. Density dependent effects may still be occurring in the system, however the 2010 results suggests a relatively stable rearing environment capable of supporting the population of juvenile chinook that are within the upper and lower thresholds as defined by the NFCP technical committee (NFCP, 2007). Numbers in 2010 exceeded the lower conservation threshold and therefore additional analysis and in particular changes to the proposed project schedule are not considered necessary at this time.

3.5.5 Conclusions

The calculated index of juvenile outmigration for chinook in the upper Nechako River appeared to reflect the biological processes as evidenced by the continued strong relationship between spawners returning to the system and juveniles leaving the system. The strength of the spawner/fry relationship (Triton, 2010), as well as the consistent trends of morphological characteristics of rearing fry, indicate that the rearing environment has remained stable and capable of supporting the population of juveniles resulting from a spawner returns that do not exceed the upper range defining the Conservation Goal. It should be noted that these results do not rule out density dependent effects for juveniles that may occur as a result of spawner returns that exceed the upper range of the Conservation Goal. The 2010 results were within the bounds of the conservation goals set by the NFCP technical committee and therefore changes to the proposed project schedule are likely not necessary at this time.

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FIGURES

FIGURE 1 2010 **Nechako River study area and traps location**

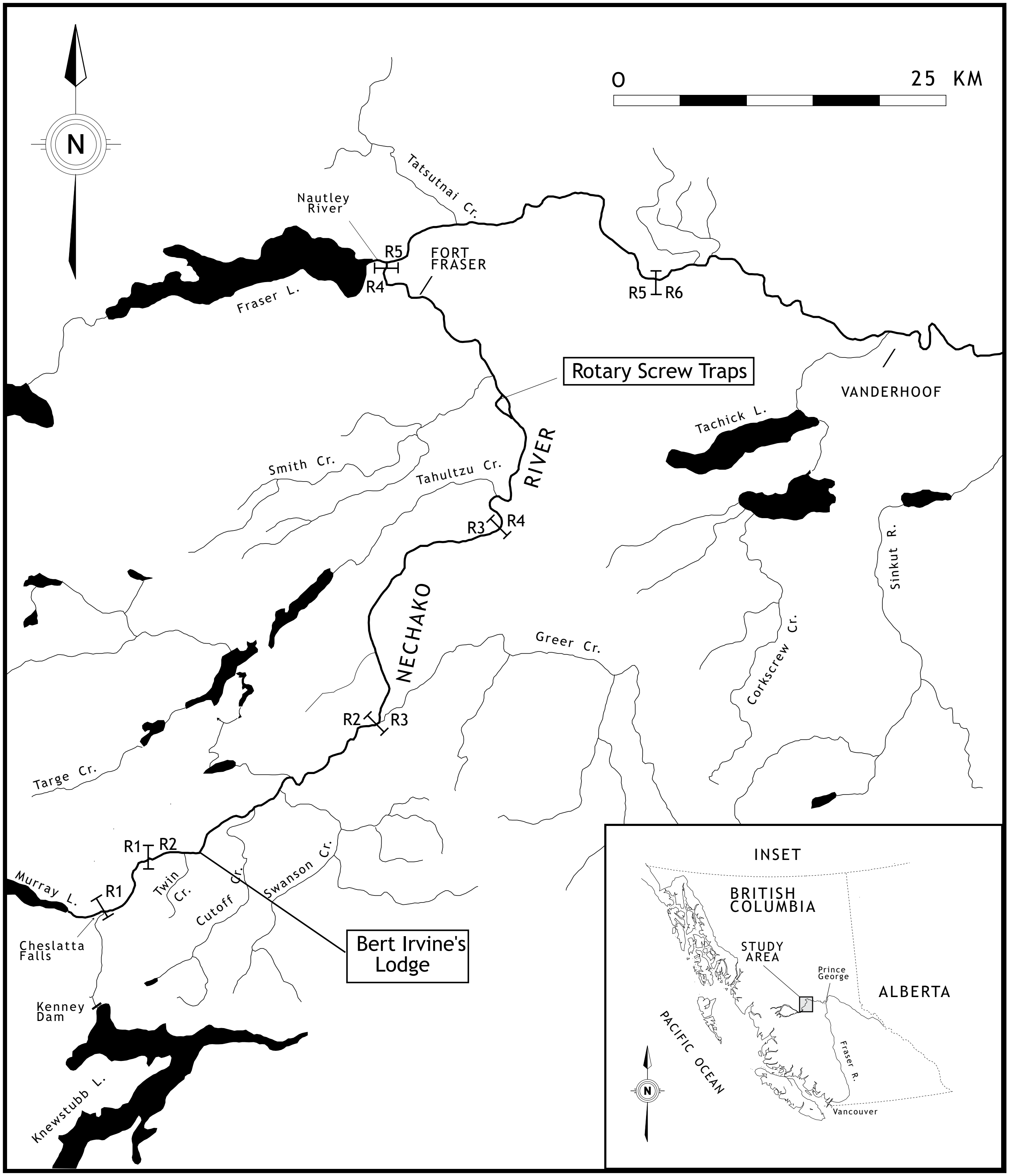


Figure 2. Schedule for 2010 outmigration sampling, Nechako River.

Month	April				May					June				July					August				September				October					November			
Week	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48
Electrofishing, day		X	X				X	X				X	X		X	X																X	X		
Electrofishing, night		X	X				X	X				X	X		X	X																X	X		
Rotary Screw Traps, day		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																			
Rotary Screw Traps, night		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																			

Figure 3. Comparisons of mean daily temperature of the upper Nechako River at Cheslatta Falls in 2010 with the mean, maximum and minimum for the years 1987 to 2004 (data available until Nov 9, 2010).

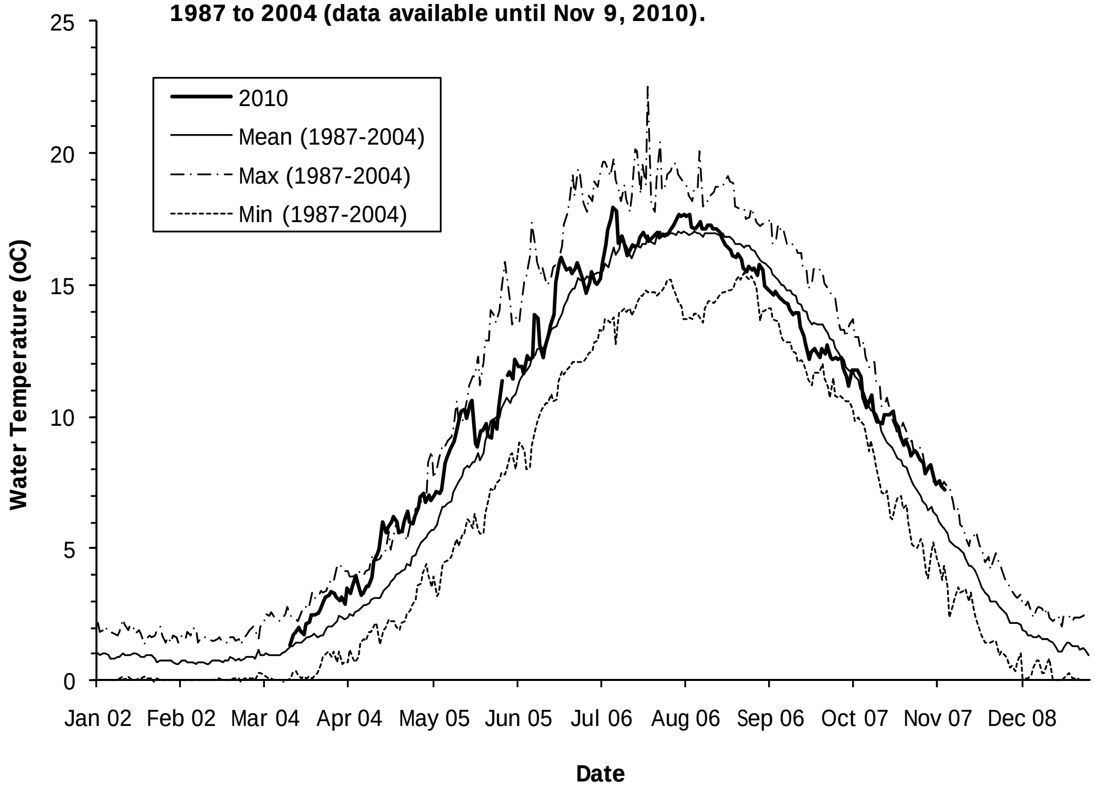
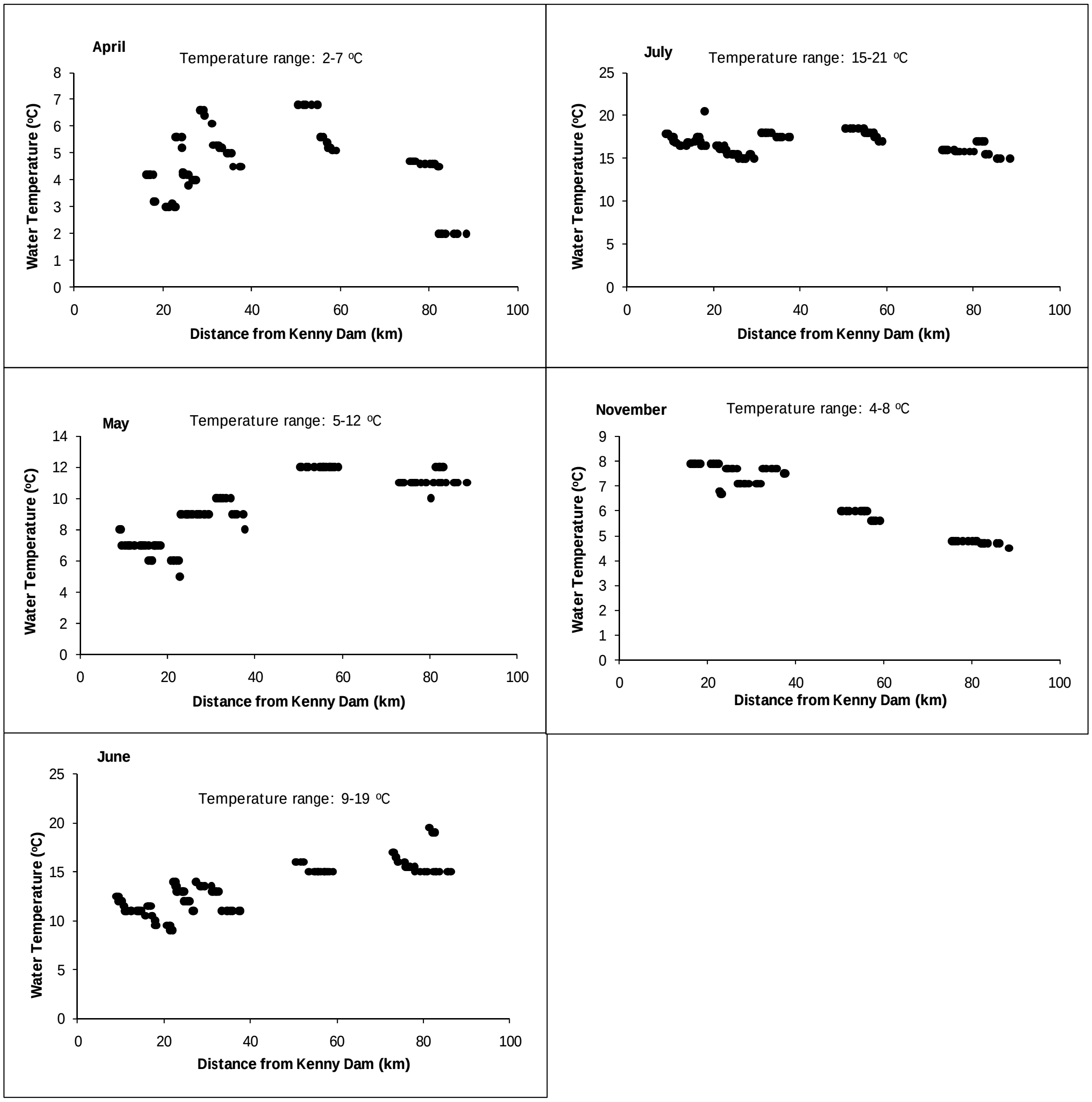


Figure 4. Night time temperatures measured at electrofishing sites in the Nechako River, April to November, 2010. Note: different scale on vertical axis.



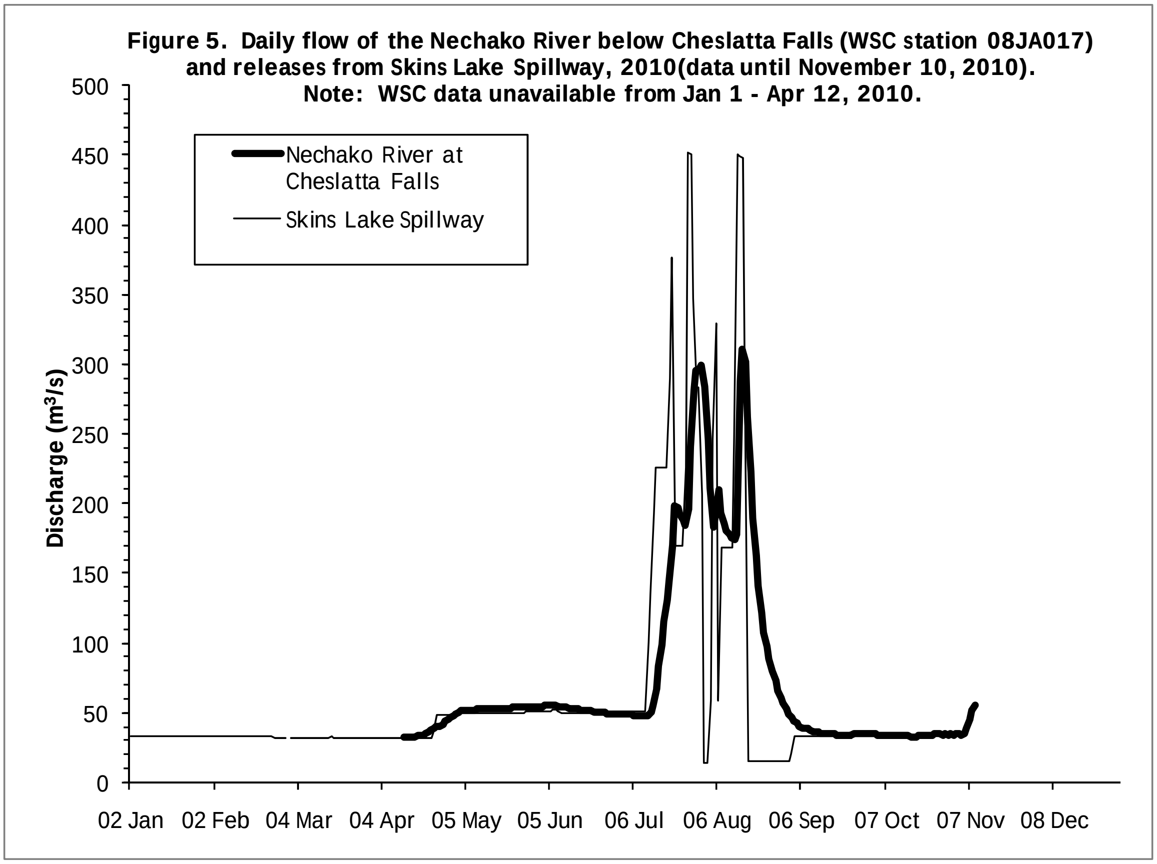


Figure 5. Daily flow of the Nechako River below Cheslatta Falls (WSC station 08JA017) and releases from Skins Lake Spillway, 2010(data until November 10, 2010).
Note: WSC data unavailable from Jan 1 - Apr 12, 2010.
Nechako River at Cheslatta Falls
Skins Lake Spillway
Discharge (m³/s)
500
450
400
350
300
250
200
150
100
50
0
02 Jan
02 Feb
04 Mar
04 Apr
05 May
05 Jun
06 Jul
06 Aug
06 Sep
07 Oct
07 Nov
08 Dec

Figure 6. Mean fork lengths (± SE) of 0+ chinook electrofished in the Nechako River, 2010

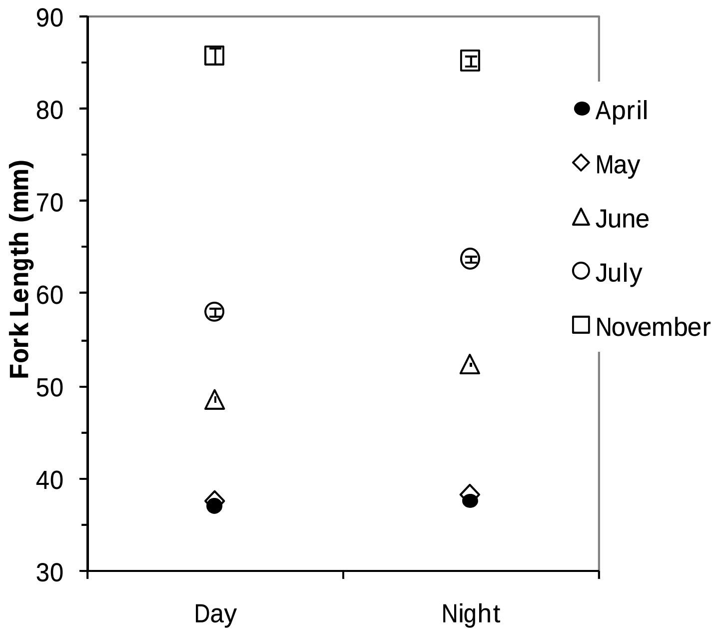


Figure 7. Mean wet weights (± SE) of 0+ chinook electrofished in the Nechako River, 2010.

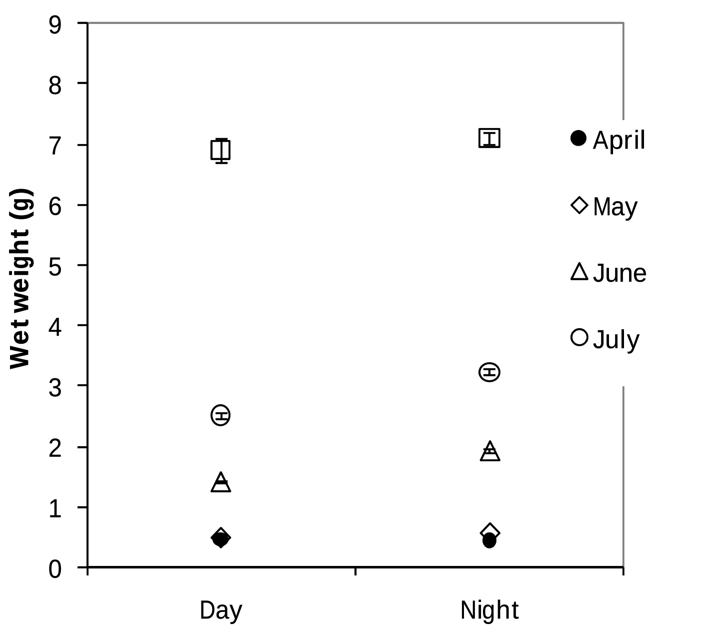


Figure 8. Mean fork lengths (± SE) of 1+ chinook electrofished in the Nechako River, 2010. No fish caught during the day in July and only one fish caught in day and night in June. No fish caught in November.

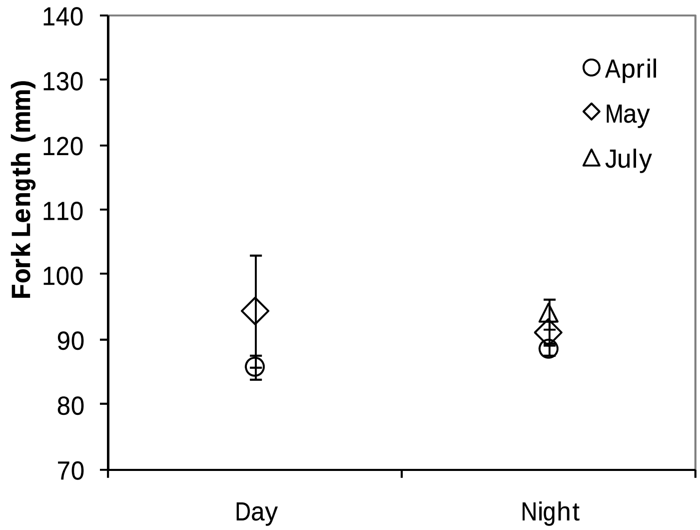
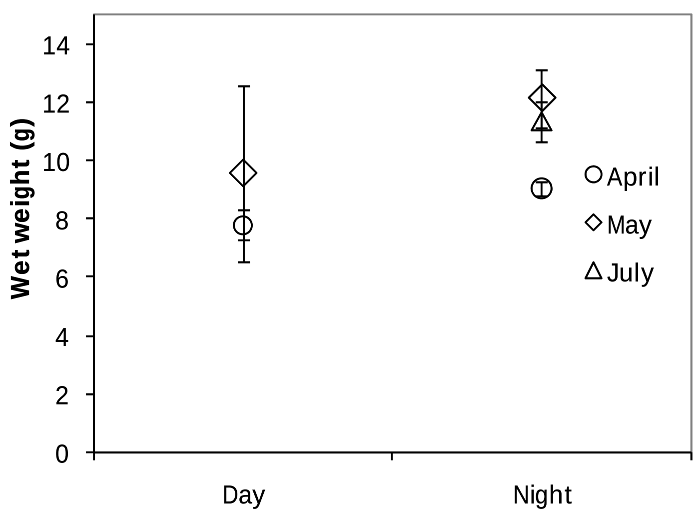


Figure 9. Mean wet weights (± SE) of 1+ chinook electrofished in the Nechako River, 2010. No fish caught during the day in July and only one fish caught in day and night in June. No fish caught in November.



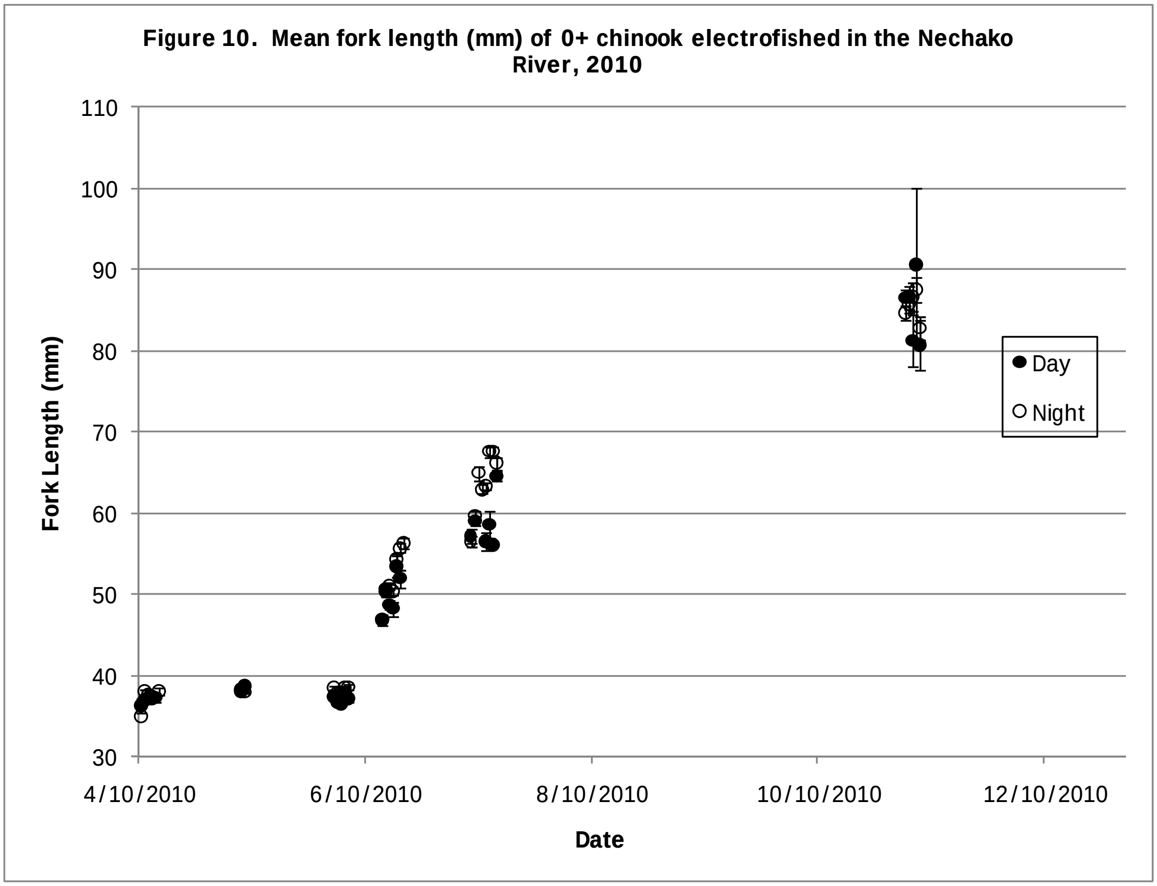


Figure 10. Mean fork length (mm) of 0+ chinook electrofished in the Nechako River, 2010
110
100
90
80
70
60
50
40
30
Fork Length (mm)
4/10/2010
6/10/2010
8/10/2010
10/10/2010
12/10/2010
Date
Day
Night

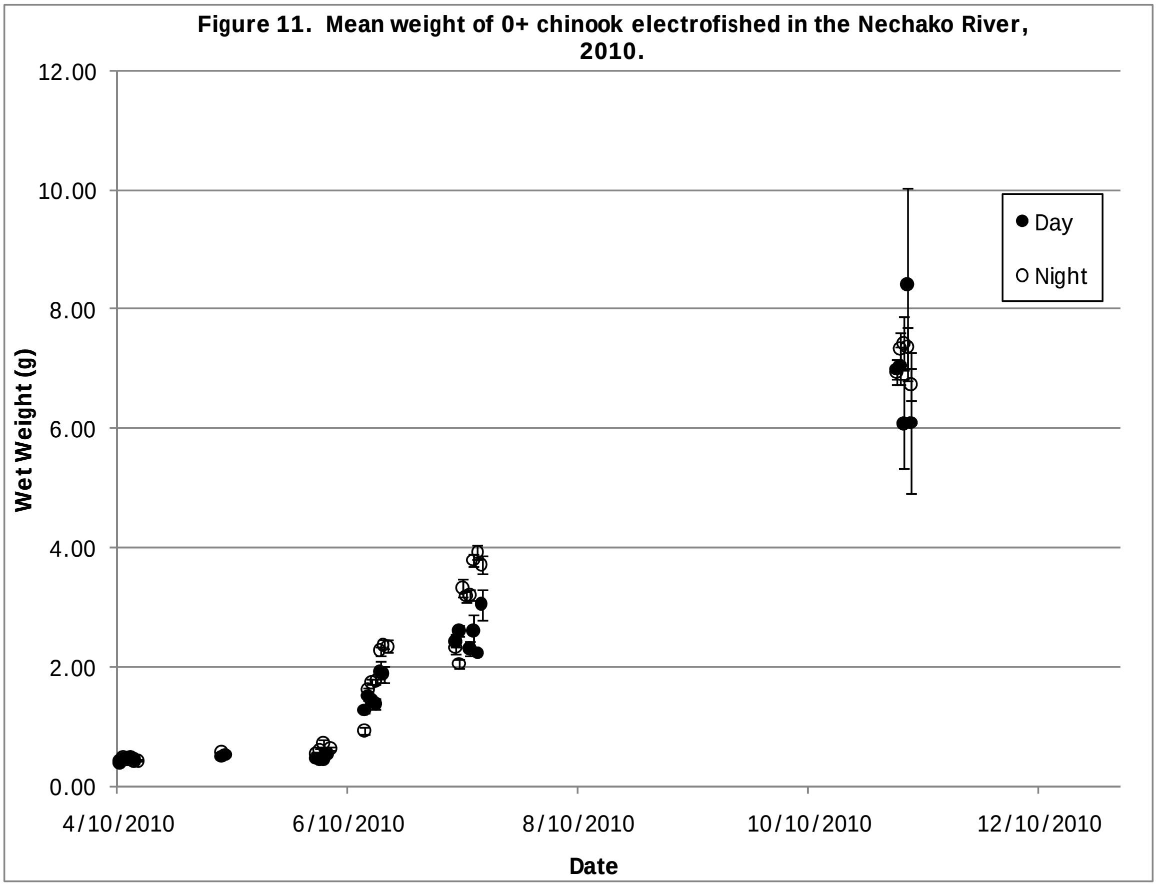


Figure 11. Mean weight of 0+ chinook electrofished in the Nechako River, 2010.
12.00
10.00
8.00
6.00
4.00
2.00
0.00
Wet Weight (g)
4/10/2010
6/10/2010
8/10/2010
10/10/2010
12/10/2010
Date
Day
Night

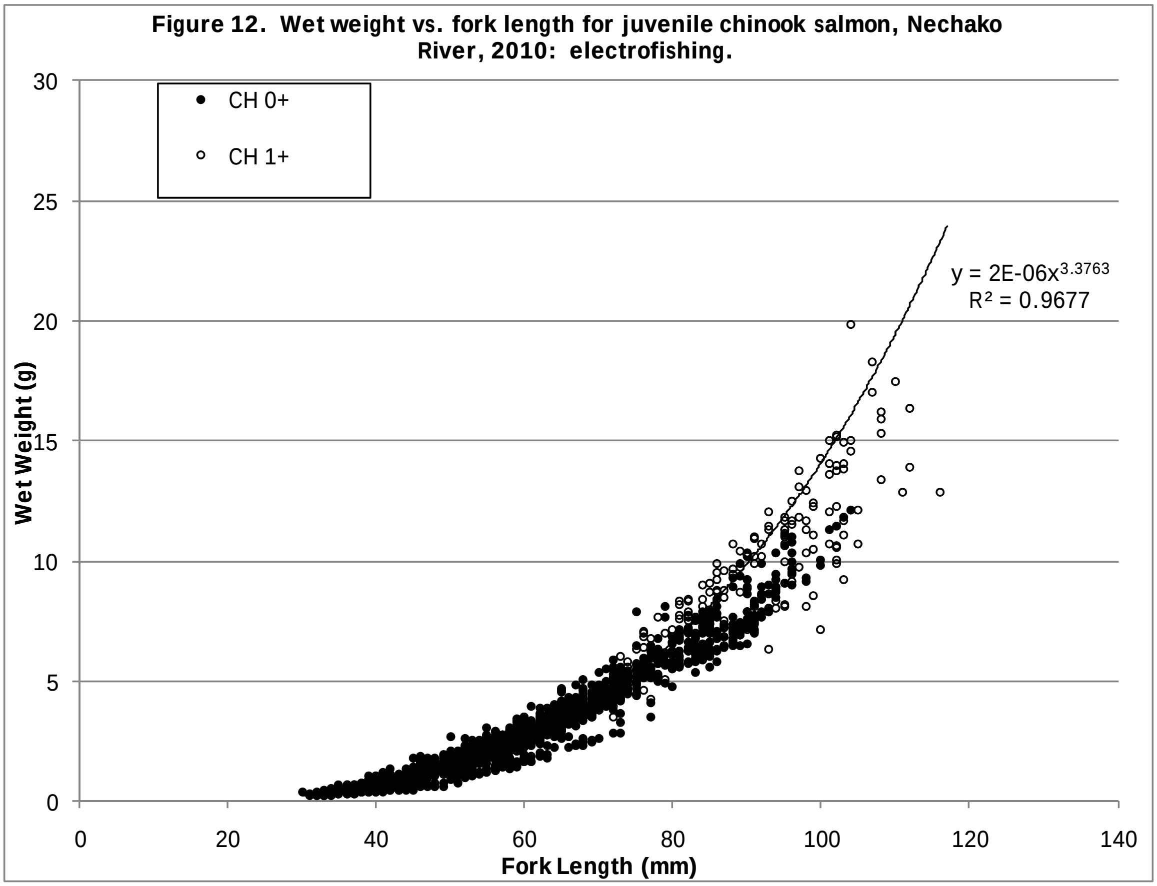


Figure 12. Wet weight vs. fork length for juvenile chinook salmon, Nechako River, 2010: electrofishing.
CH 0+
CH 1+
y = 2E-06x^3.3763
R² = 0.9677
Wet Weight (g)
Fork Length (mm)
0
5
10
15
20
25
30
0
20
40
60
80
100
120
140

Figure 13. Variance in juvenile chinook wet weight per fork length. Fork lengths sorted per day. Fish caught electrofishing, Nechako River, 2010.

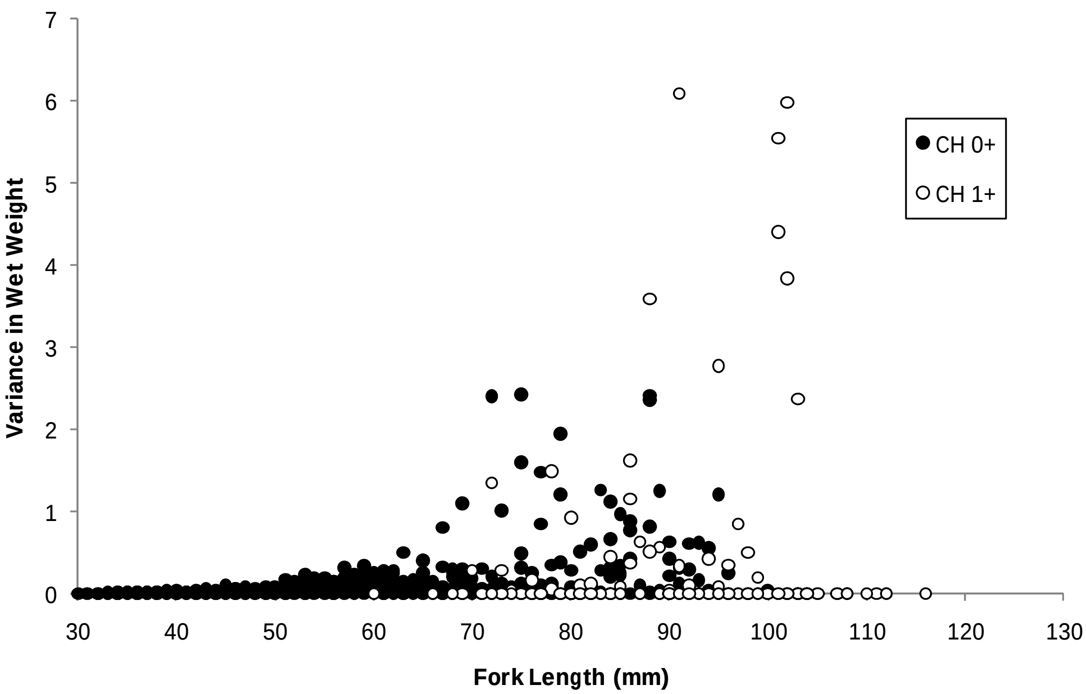


Figure 14. Condition indices of juvenile 0+ chinook caught by electrofishing in the Nechako River, 2010.

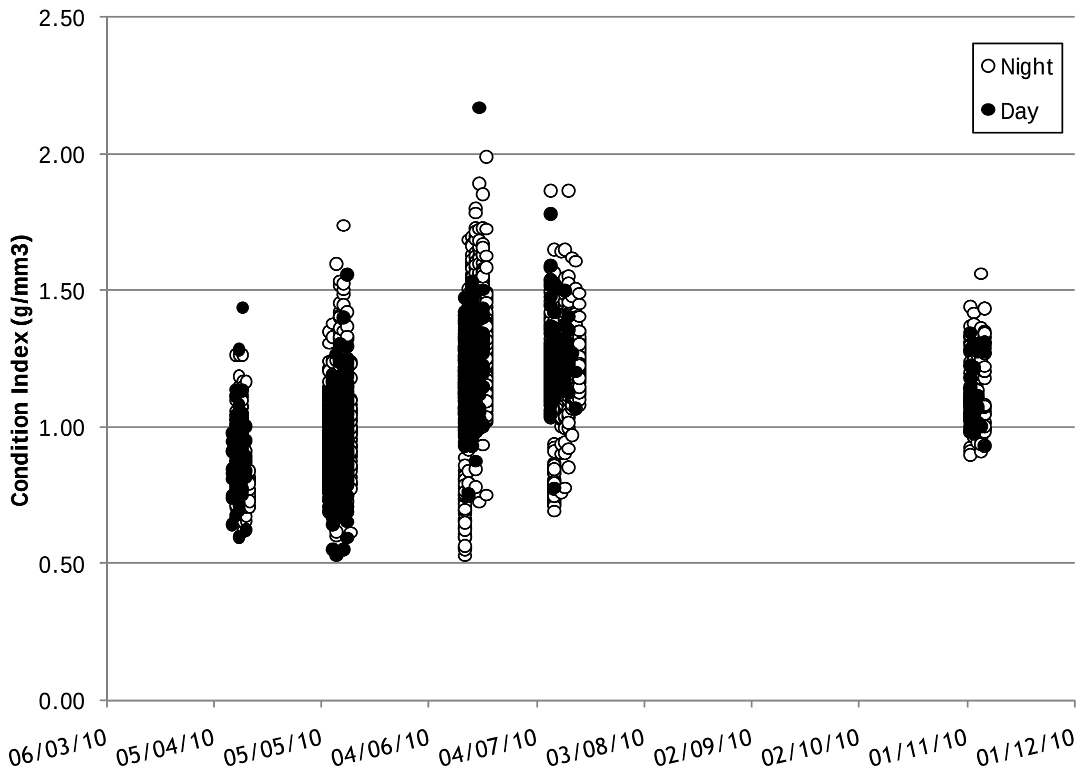
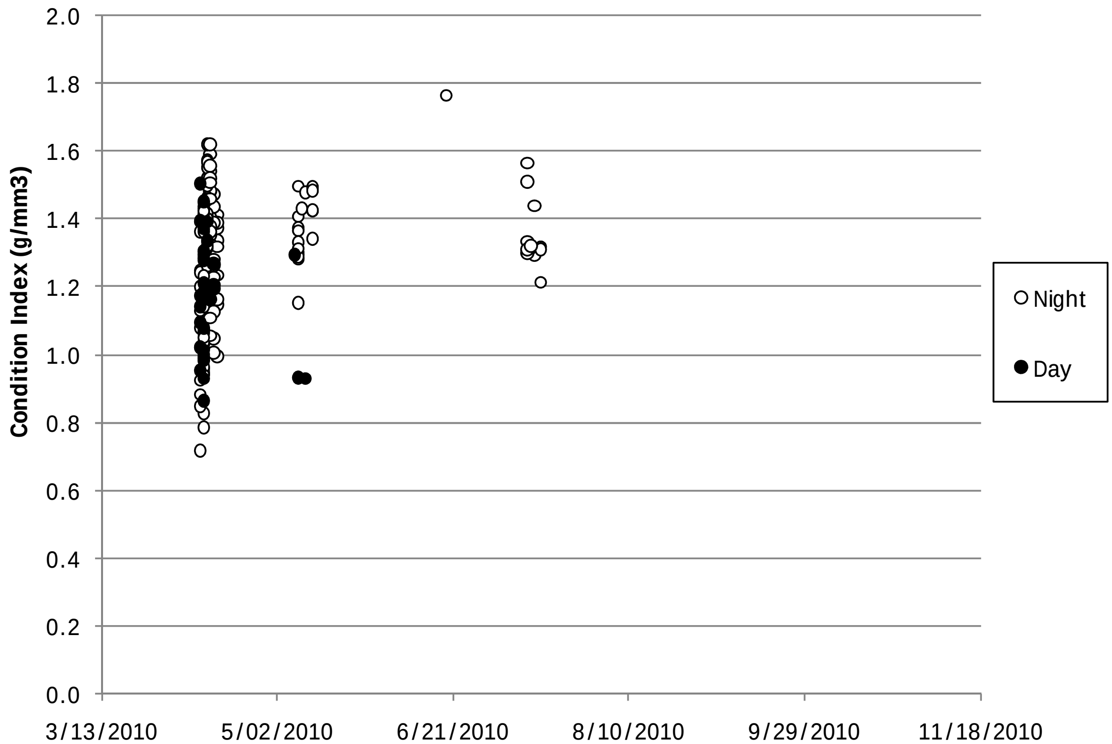


Figure 15. Condition indices of juvenile 1+ chinook caught by electrofishing in the Nechako River, 2010.



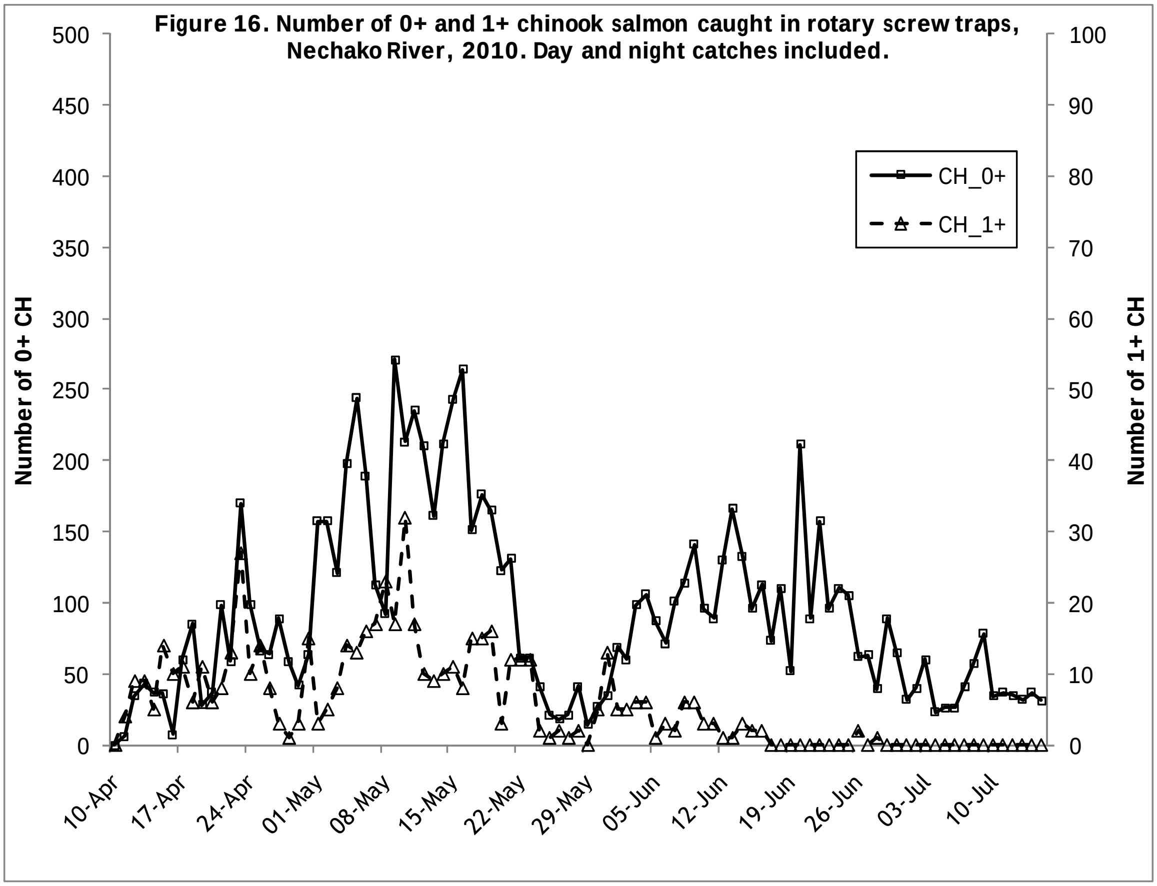


Figure 16. Number of 0+ and 1+ chinook salmon caught in rotary screw traps, Nechako River, 2010. Day and night catches included.
Number of 0+ CH
Number of 1+ CH
CH_0+
CH_1+
0
50
100
150
200
250
300
350
400
450
500
10
20
30
40
50
60
70
80
90
100
10-Apr
17-Apr
24-Apr
01-May
08-May
15-May
22-May
29-May
05-Jun
12-Jun
19-Jun
26-Jun
03-Jul
10-Jul

Figure 17. Mean numbers (SE) of 0+ chinook caught in rotary screw traps, Nechako River, April 12- July 15 2010. Same letters are not significantly different, Day or Night. Night and day catches are significantly different for left margin and mid channel traps (*).

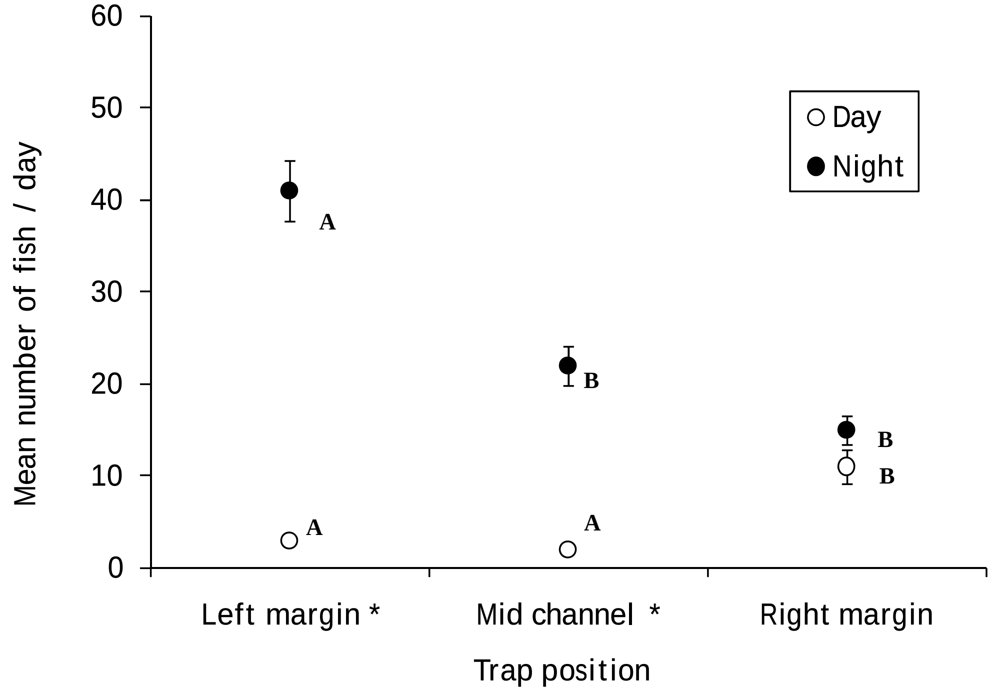


Figure 18. Mean fork length (A) and wet weight (B) (SE) of 0+ chinook caught in rotary screw traps, Nechako River, 2010. Results significantly different between day and night for all traps for both length and weight.

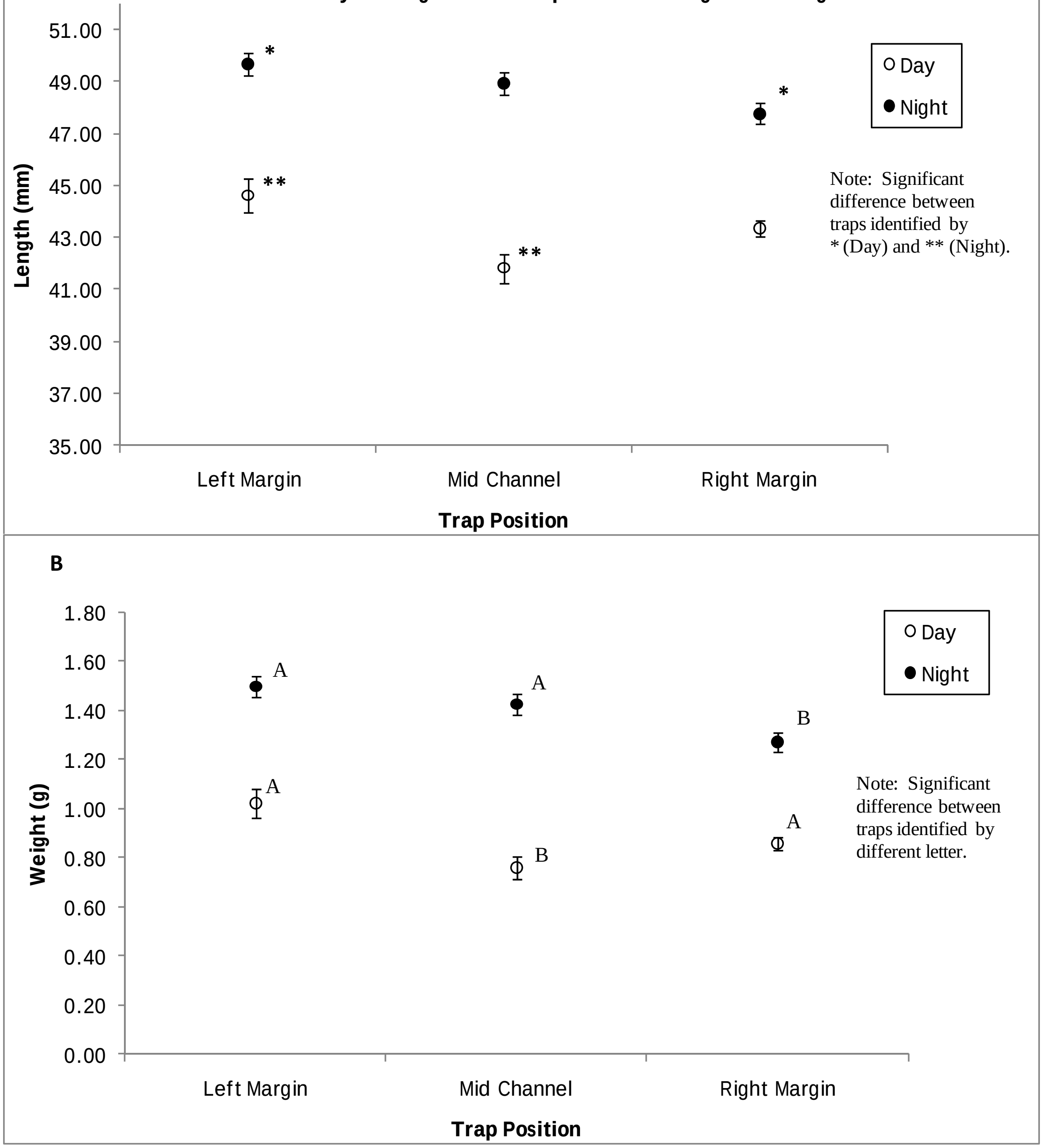


Figure 19. Mean numbers (SE) of 1+ chinook caught in rotary screw traps, Nechako River, April 12- July 15 2010. Same letters are not significantly different, Day or Night.

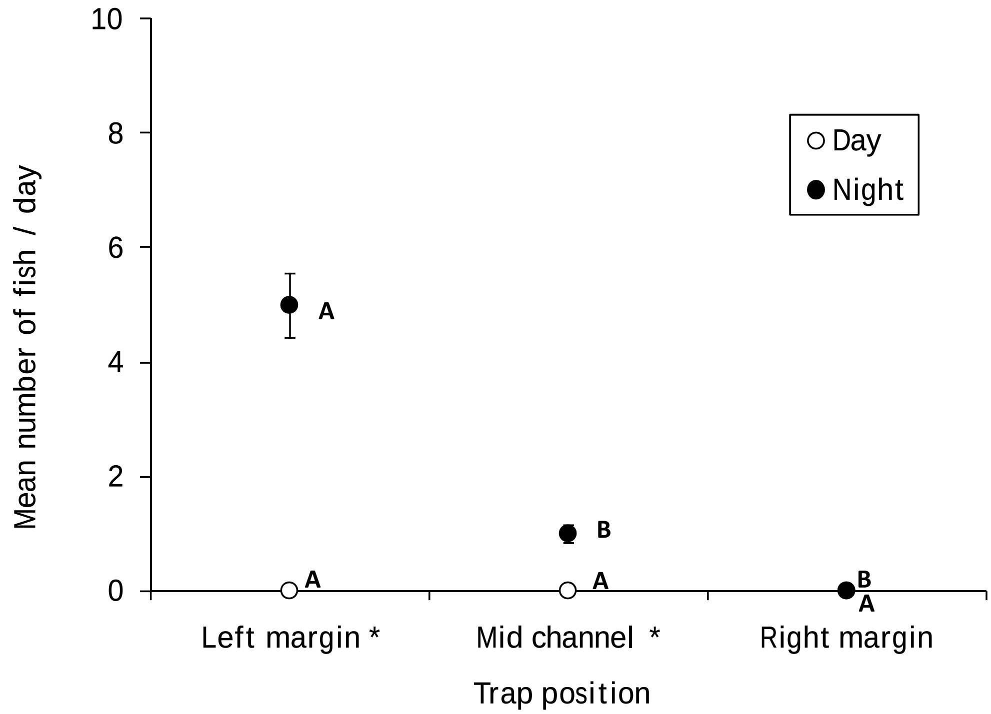


Figure 20. Mean fork length and weight (SE) of 1+ chinook caught in rotary screw traps at night, Nechako River, 2010. No significant differences were detected for either parameter day vs night or between traps.

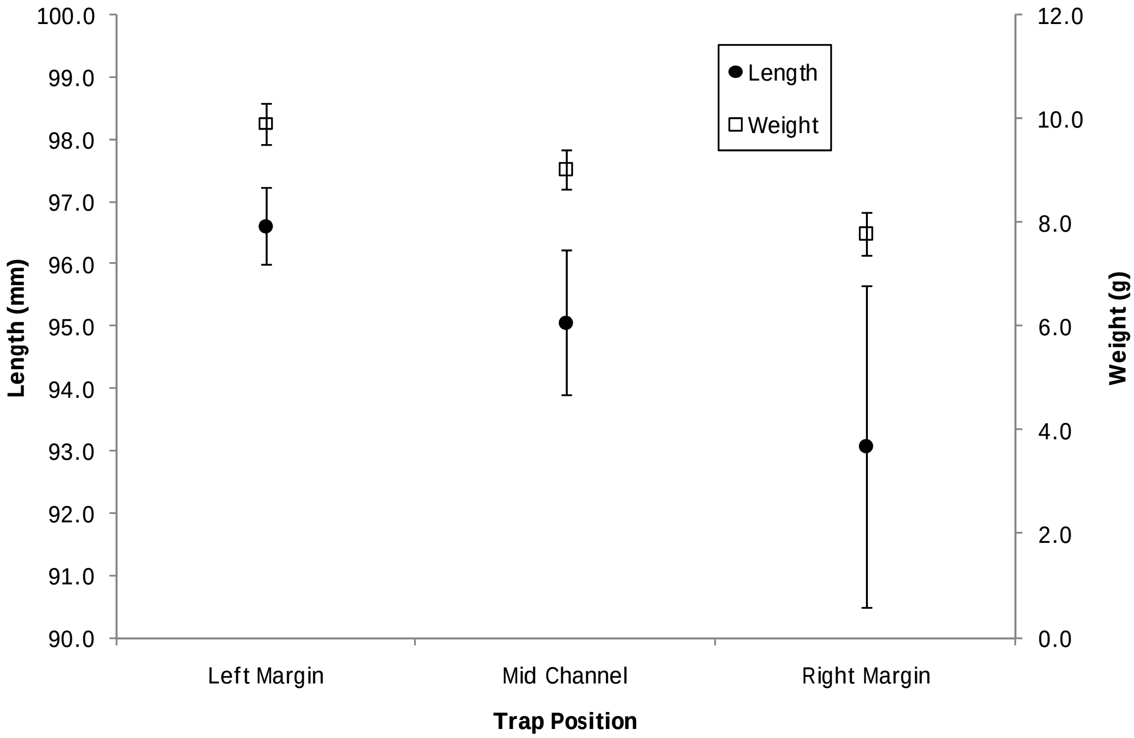


Figure 21. Mean length (SE) of 0+ chinook salmon caught in rotary screw traps, Nechako River, 2010.

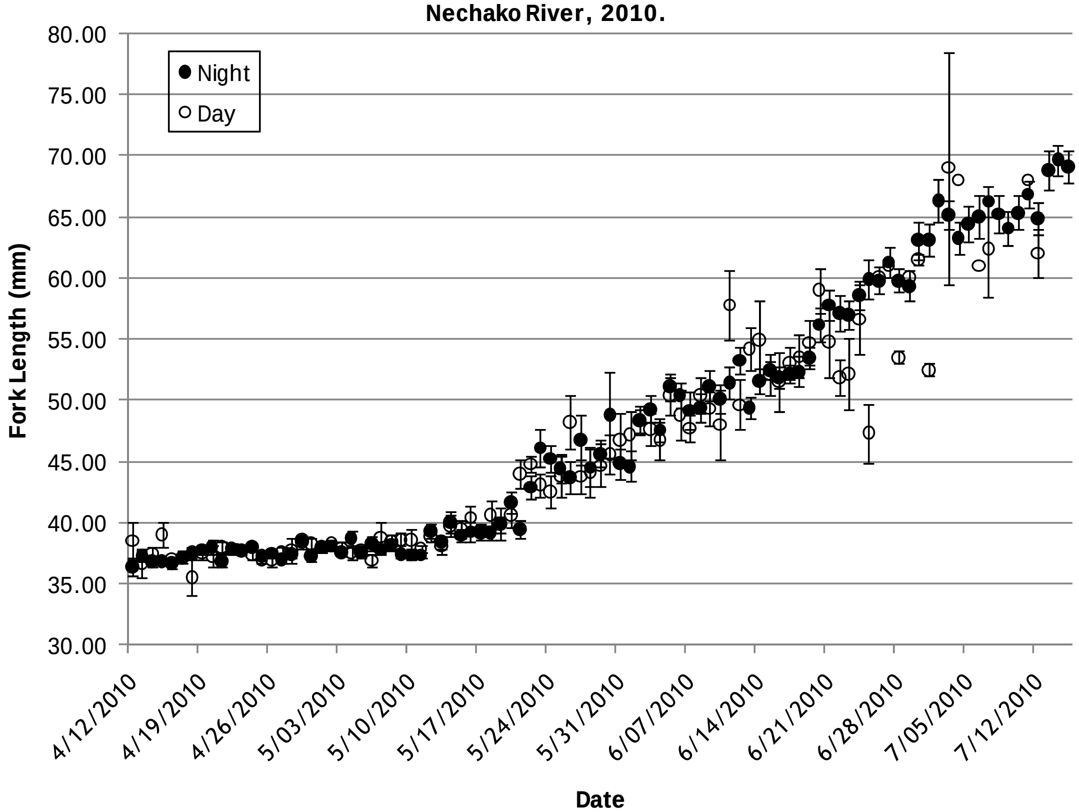


Figure 22. Mean weight (SE) of 0+ chinook salmon caught in rotary screw traps, Nechako River, 2010.

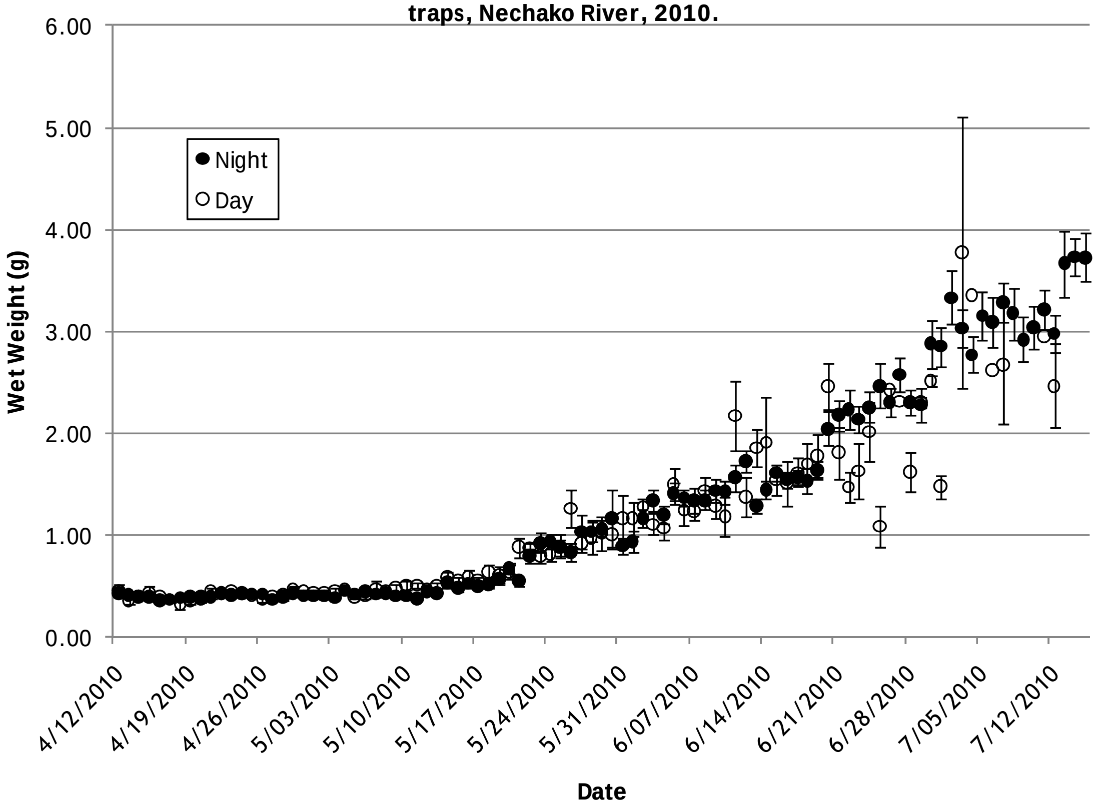


Figure 23. Mean length (SE) of 1+ chinook captured in rotary screw traps, Nechako River, 2010

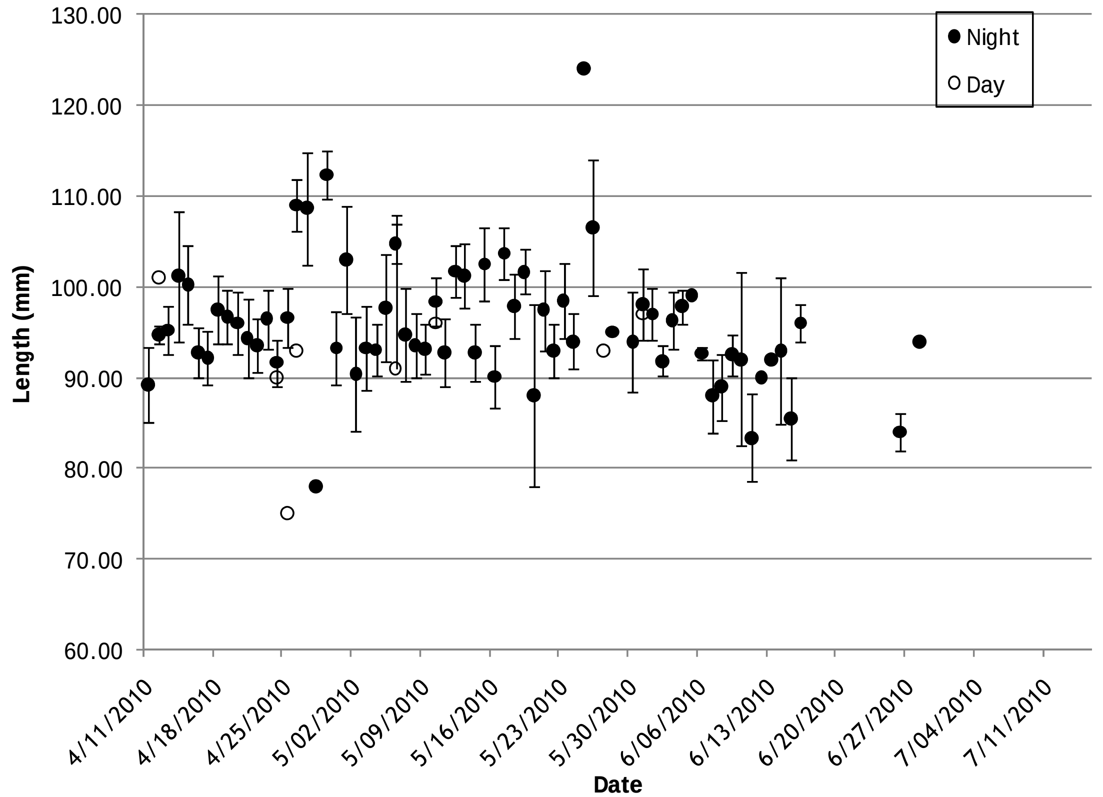


Figure 24. Mean weight (SE) of 1+ chinook captured in rotary screw traps, Nechako River, 2010

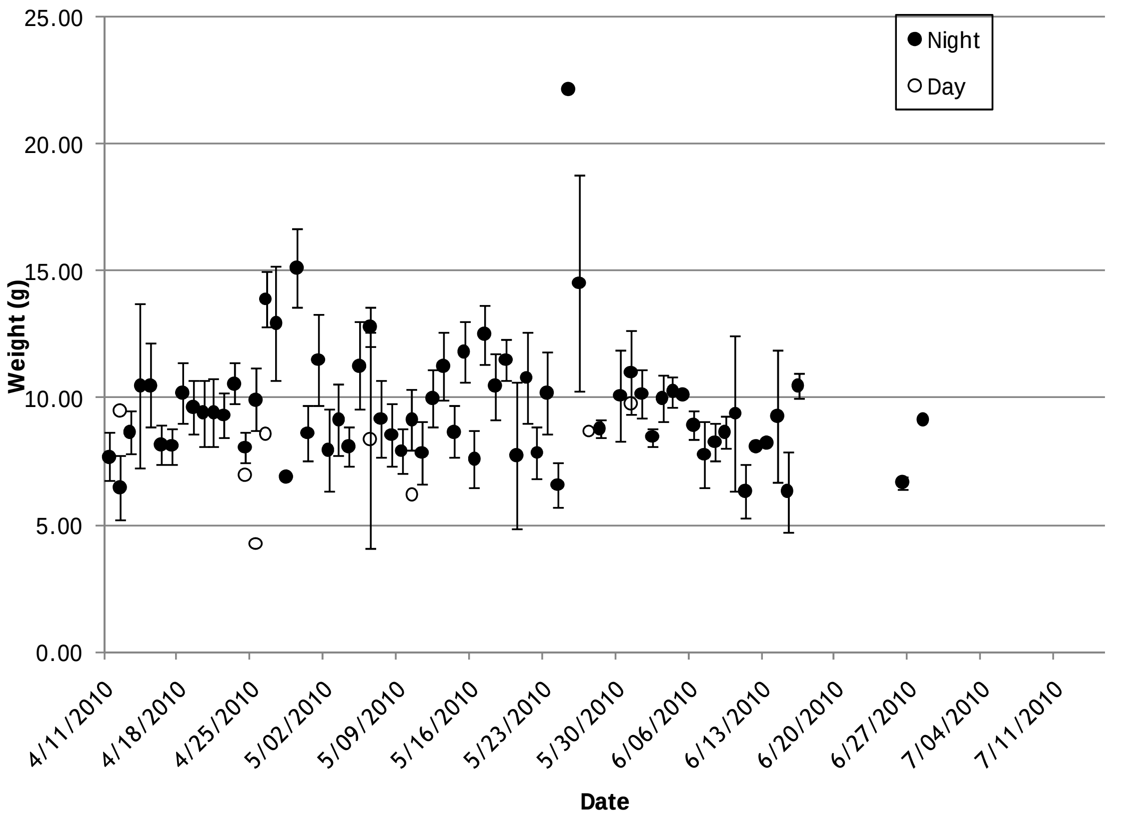


Figure 25. Mean (+ 1 SD) monthly catch-per-unit-effort (CPUE, in fish caught per 100 m^2) of 0+ chinook salmon, Nechako River, 2010: electrofishing. No sampling in the 40-49.9 km area. Note different axes between months.

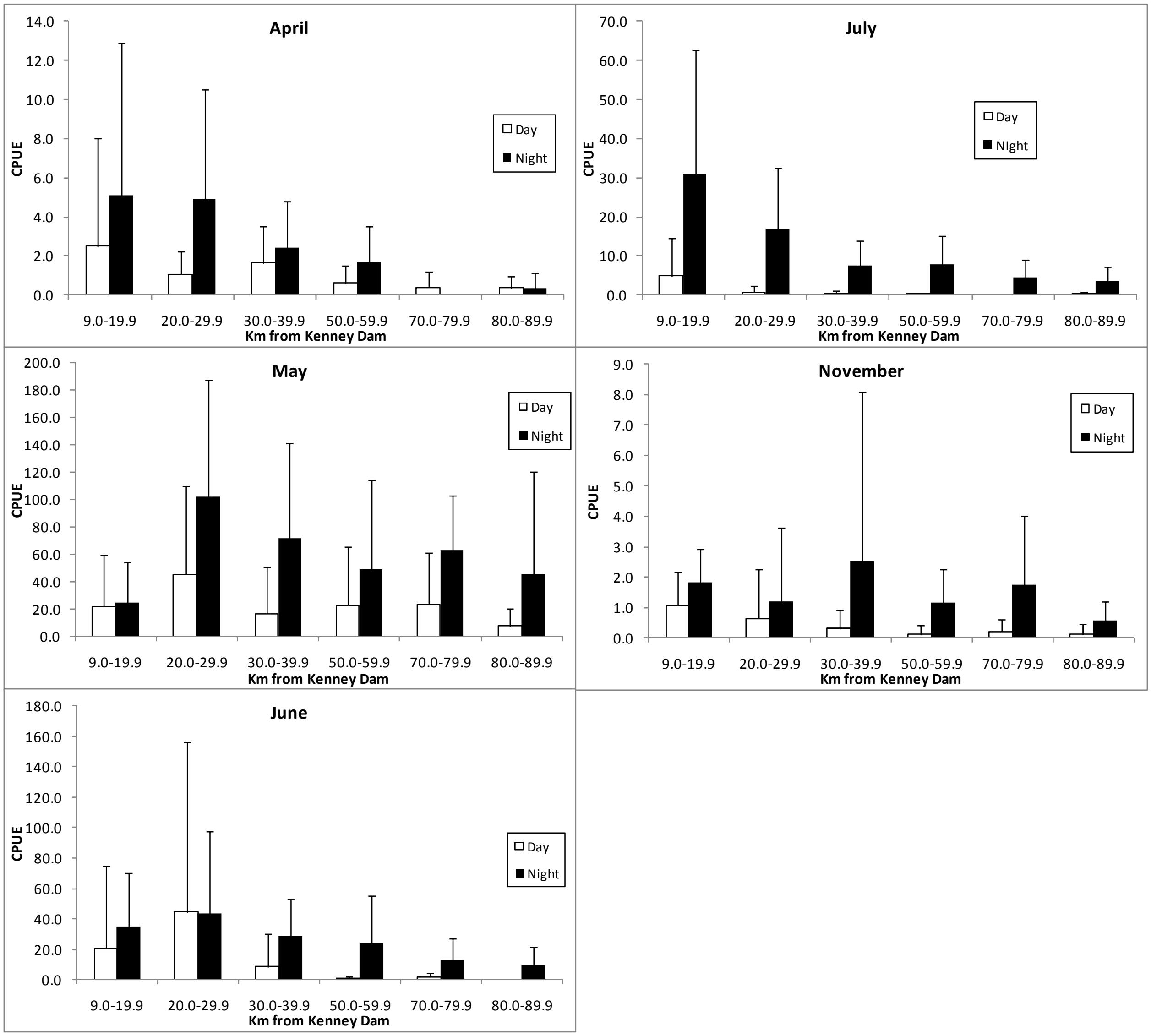
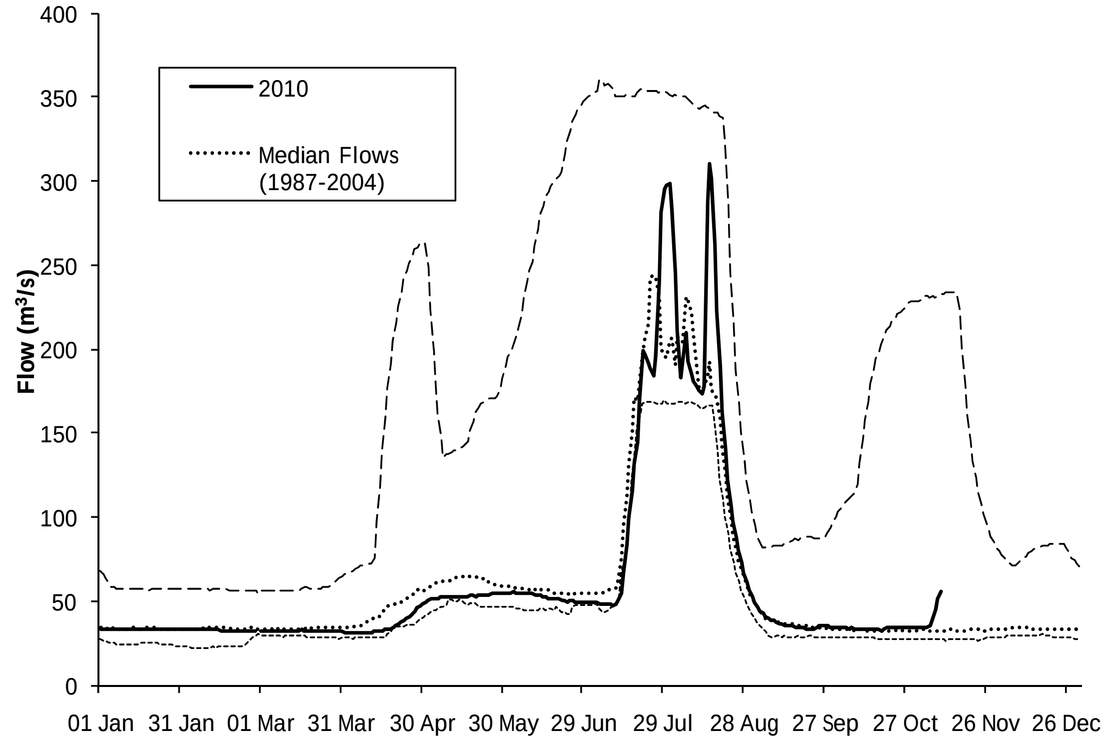


Figure 26. **Comparisons of mean, maximum and minimum daily flow of the Nechako River at Cheslatta Falls in 2010 with flows for the years 1987 to 2004, 2010.**



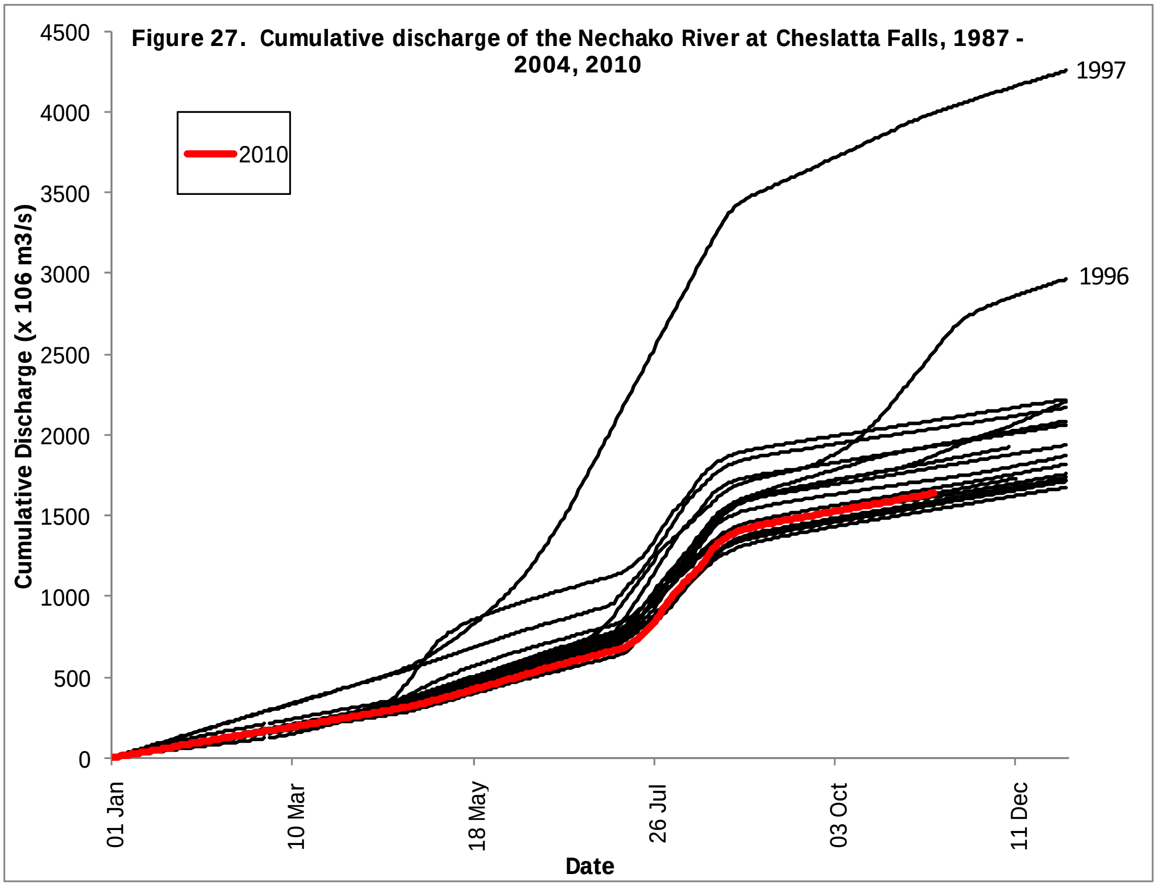


Figure 27. Cumulative discharge of the Nechako River at Cheslatta Falls, 1987 - 2004, 2010
Cumulative Discharge (x 106 m3/s)
4500
4000
3500
3000
2500
2000
1500
1000
500
0
2010
1997
1996
01 Jan
10 Mar
18 May
26 Jul
03 Oct
11 Dec
Date

Figure 28. Comparisons of mean size of 0+ chinook in the upper Nechako River in 2010 with mean, minimum and maximum size for 1989 to 2004 (electrofishing).

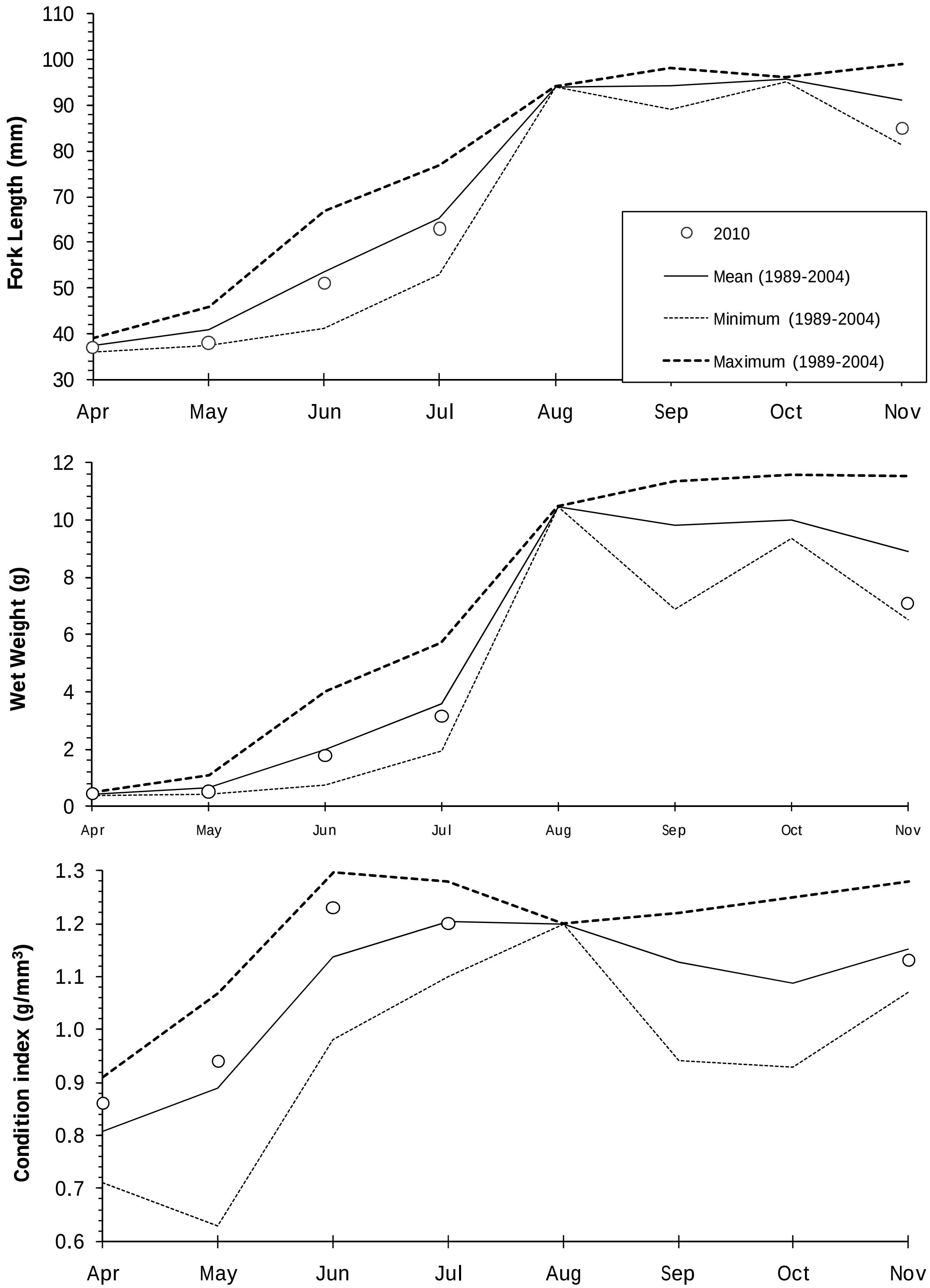


Figure 29. Comparisons of mean size of 0+ chinook in the upper Nechako River in 2010 with mean, minimum and maximum size for 1991 to 2004 (Rotary Screw Traps).

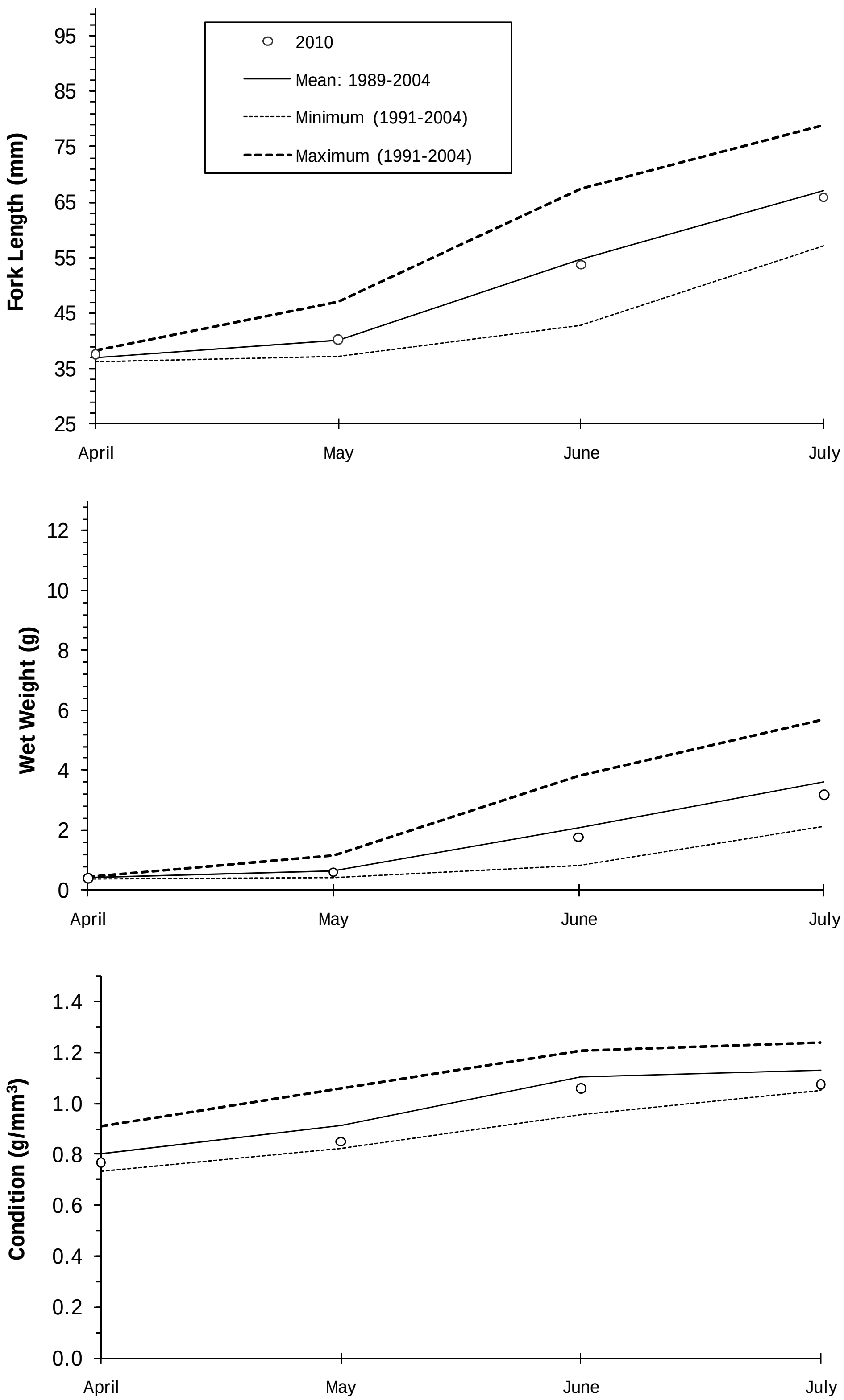


Figure 30. Daily indices of chinook 0+ outmigrants, Diamond Island, Nechako River, 1991 to 2004, 2010.

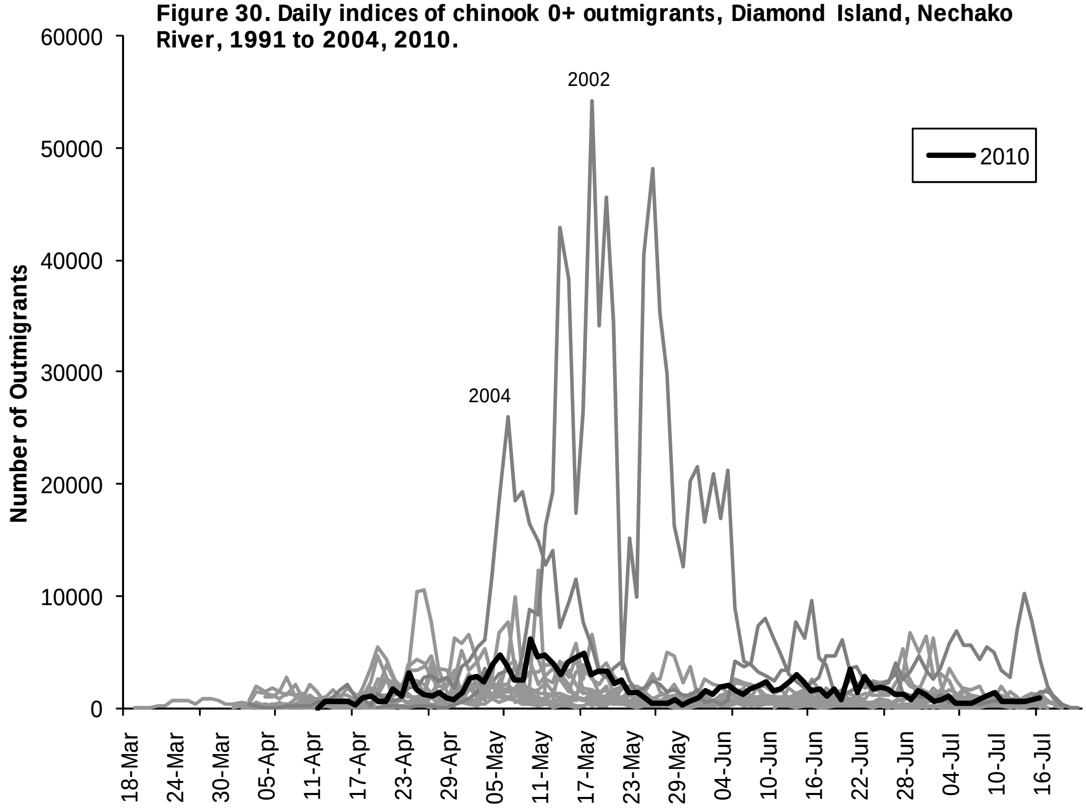
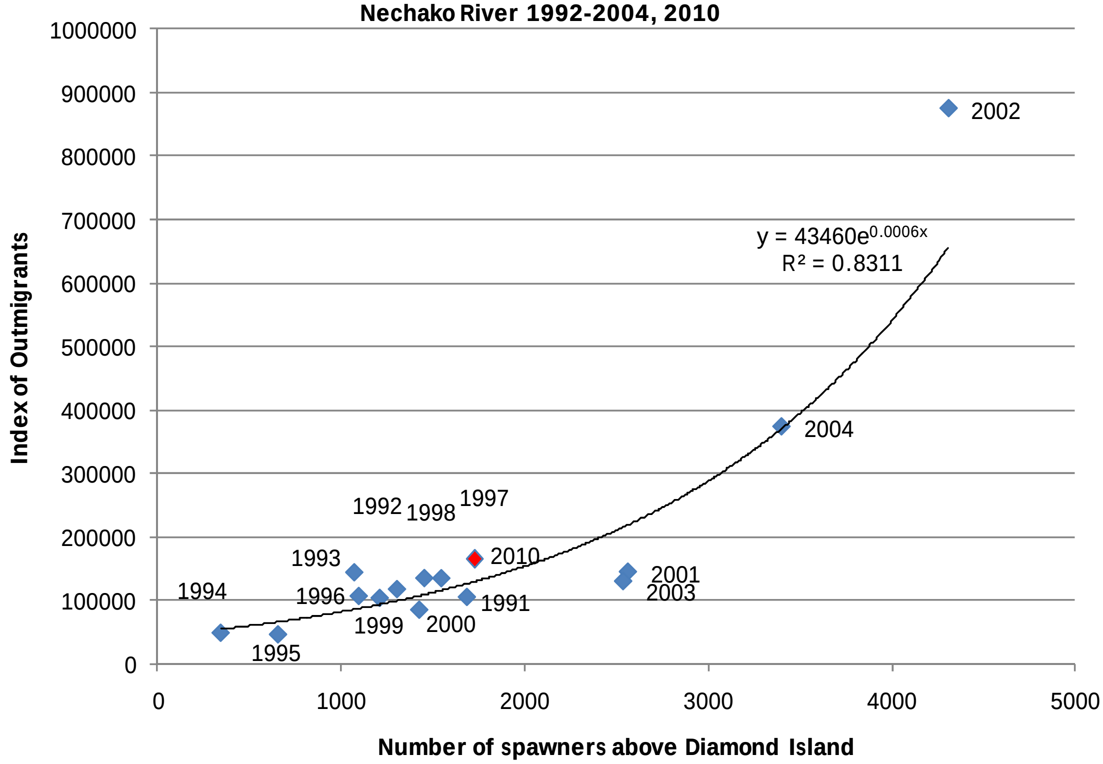


Figure 31. Index of chinook salmon outmigrants based on rotary screw trap captures vs. the number of spawners above Diamond Island the previous year, Nechako River 1992-2004, 2010



TABLES

Table 1. Fishes captured by electrofishing in the upper Nechako River, 2010.

Common Name	Scientific Name	Adult (1+ for salmon)				Juvenile (0+ for salmon)				Total			
		Day	Night	Total	Percent	Day	Night	Total	Percent	Day	Night	Total	Percent
Chinook salmon	*Oncorhynchus tshawytscha*[1]	24	200	224	0.3	12,534	19,698	32,232	37.5	12,558	19,898	32,456	37.7
Largescale sucker	*Catostomus macrocheilus*	1	11	12	0.0	9,803	8,774	18,577	21.6	9,804	8,785	18,589	21.6
Northern pikeminnow	*Ptychocheilus oregonensis*	4	9	13	0.0	5,402	5,795	11,197	13.0	5,406	5,804	11,210	13.0
Redside shiner	*Richardsonius balteatus*	307	535	842	1.0	3,702	3,813	7,515	8.7	4,009	4,348	8,357	9.7
Longnose dace	*Rhinichthys cataractae*	235	165	400	0.5	5,276	2,501	7,777	9.0	5,511	2,666	8,177	9.5
Leopard dace	*Rhinichthys falcatus*	236	220	456	0.5	2,056	940	2,996	3.5	2,292	1,160	3,452	4.0
Sculpins (General)	Cottidae	264	401	665	0.8	423	740	1,163	1.4	687	1,141	1,828	2.1
Mountain whitefish	*Prosopium williamsoni*	1	50	51	0.1	32	1181	1,213	1.4	33	1,231	1,264	1.5
Sockeye salmon	*Oncorhynchus nerka*[1]	0	0	0	0.0	42	391	433	0.5	42	391	433	0.5
Rainbow trout	*Oncorhynchus mykiss*	4	12	16	0.0	21	111	132	0.2	25	123	148	0.2
Peamouth chub	*Mylocheilus caurinus*	1	0	1	0.0	70	1	71	0.1	71	1	72	0.1
Burbot	*Lota lota*	0	2	2	0.0	2	10	12	0.0	2	12	14	0.0
Total		1,077	1,605	2,682	3.1	39,363	43,955	83,318	96.9	40,440	45,560	86,000	100.0

[1] *"adult" = 1+ fish in this case*

Table 2. Results of factorial ANOVAs on Fork Length and Wet Weight of juvenile chinook captured by electrofishing in the Nechako River, 2010.

Ln (length)

	DF	Sum of Squares	Mean Square	F-Value	P-Value
Month	4	190.89	47.70	3,378.94	<.0001
Day or Night	1	0.70	0.70	72.67	<.0001
Month * D or N	4	1.06	0.27	27.50	<.0001
Residual	5,194	50.27	0.01		

Ln (weight)

	DF	Sum of Squares	Mean Square	F-Value	P-Value
Month	4	2,094.45	523.61	4,252.12	<.0001
Day or Night	1	7.17	7.17	58.25	<.0001
Month * D or N	4	7.43	1.86	15.09	<.0001
Residual	4,479	551.55			

Table 3. Summary of rotary screw trap (RST) catches of 0+ and 1+ chinook at Diamond Is, Nechako River, April 9 to July 15, 2010.

Trap number	Trap location	0+ chinook day	0+ chinook night	0+ chinook total	1+ chinook day	1+ chinook night	1+ chinook total
1	Left margin	245	3,934	4,179	4	455	459
2	Mid Channel	186	2,067	2,253	4	91	95
3	Right margin	1,032	1,462	2,494	3	13	16
	Total	1,463	7,463	8,926	11	559	570

Table 4. Factorial ANOVA on numbers of 0+ chinook captured by rotary screw traps standardized by volume sampled, Nechako, 2010.

	DF	Sum of Squares	Mean Square	F-Value	P-Value
Day/Night	1	150457563.00	150457563	143.18	<.0001
Trap location	2	16246901.40	8123450.69	7.73	0.0005
Day/Night * trap location	2	60796381.10	30398190.55	28.93	<.0001
Residual	564	592658948.00	1050813.74		

Table 5. Factorial ANOVA on numbers of chinook 1+ captured by rotary screw traps standardized by volume sampled, Nechako, 2010.

	DF	Sum of Squares	Mean Square	F-Value	P-Value
Day/Night	1	1085546.12	682723.2	96.03	<.0001
Trap location	2	1165057.67	582528.84	51.53	<.0001
Day/Night * trap location	2	1163011.86	581505.93	51.44	<.0001
Residual	564	6375504.34	11304.09		

Table 7. Fishes captured in the rotary screw traps in the upper Nechako River, 2010.

		Adult				Juvenile				Total			
Common Name	Scientific Name	Day	Night	Total	Percent	Day	Night	Total	Percent	Day	Night	Total	Percent
Chinook salmon	*Oncorhynchus tshawytscha*[1]	11	559	570	4.3	1,463	7,463	8,926	58.9	1,474	8,022	9,496	62.6
Largescale sucker	*Catostomus macrocheilus*	2	53	55	0.4	92	1,892	1,984	13.1	94	1,945	2,039	13.4
Redside shiner	*Richardsonius balteatus*	18	476	494	3.7	65	412	477	3.1	83	888	971	6.4
Leopard dace	*Rhinichthys falcatus*	15	286	301	2.3	19	352	371	2.4	34	638	672	4.4
Mountain whitefish	*Prosopium williamsoni*	0	1	1	0.0	34	621	655	4.3	34	622	656	4.3
Northern pikeminnow	*Ptychocheilus oregonensis*	2	52	54	0.4	29	502	531	3.5	31	554	585	3.9
Peamouth chub	*Mylocheilus caurinus*	0	35	35	0.3	22	242	264	1.7	22	277	299	2.0
Longnose dace	*Rhinichthys cataractae*	6	62	68	0.5	22	179	201	1.3	28	241	269	1.8
Sockeye salmon	*O. nerka*[1]	0	1	1	0.0	15	107	122	0.8	15	108	123	0.8
Rainbow trout	*O. mykiss*[1]	0	8	8	0.1	1	32	33	0.2	1	40	41	0.3
Sculpins (General)	Cottidae	2	2	4	0.0	0	4	4	0.0	2	6	8	0.1
Coho salmon	*O. kisutch*[1]	0	0	0	0.0	0	2	2	0.0	0	2	2	0.0
Total		56	1,535	1,591	10.5	1,762	11,808	13,570	89.5	1,818	13,343	15,161	100.0

[1] "adult" = 1+ fish in this case

Table 6. Mean electrofishing catch-per-unit-effort (CPUE, number/100 m^2) of juvenile chinook salmon, Nechako River, 2010. N = number sites electrofished (same for both ages).

	Number of fish			0+ CPUE		1+ CPUE	
Date	**0+**	**1+**	**N**	**mean**	**SD**	**mean**	**SD**
Day							
Apr	139	20	108	1.0	2.0	0.2	0.5
May	7,071	3	137	26.4	46.2	0.0	0.1
Jun	4,964	1	137	27.5	66.6	0.0	0.0
Jul	307	0	136	1.3	5.1	0.0	0.0
Nov	53	0	107	0.4	1.1	0.0	0.0
Total	12,534	24					
Night							
Apr	386	139	109	2.9	4.7	1.1	1.8
May	11,413	46	137	62.1	70.3	0.3	0.8
Jun	5,029	3	137	29.8	38.2	0.0	0.1
Jul	2,665	12	136	14.7	20.2	0.1	0.3
Nov	205	0	106	1.4	2.8	0.0	0.0
Total	19,698	200					
Total	**32,232**	**224**					

Table 8. Summary of brood, outmigrants, outmigrants per spawner and spawner returns for years with spawner numbers greater than 2000, Nechako River.

Brood		Outmigrants		Outmigrants per	Returns	
Year	**Spawners**	**Year**	**Estimate**	**Spawner**	**Year**	**Spawner**
2000	2,562	2001	143,911	56	2005	2,347
2001	4,306	2002	874,676	203	2006	5,001
2002	2,536	2003	129,004	51	2007	1,194
2003	3,397	2004	372,958	110	2008	3,564

APPENDICES

Appendix 1. Daily catch of juvenile chinook salmon by rotary screw traps, and index of outmigrants at Diamond Island, Nechako River, 2010

Date	Staff Guage (m)	Discharge (m^3/s)	RST Discharge sampled (m^3/s)			Percent of discharge sampled			Day/ Night	RST 1				RST 2				RST 3				Day Total		Combined (D+N) Total		Weighted Index Estimate	
										CH 0+		CH 1+		CH 0+		CH 1+		CH 0+		CH 1+							
			RST 1	RST 2	RST 3	RST 1	RST 2	RST 3		Count	Index	Count	Index	Count	Index	Count	Index	Count	Index	Count	Index	CH 0+	CH 1+	CH 1+	CH 0+	CH 1+	CH 0+
4/12/2010	0.155	32.65	0.95	0.98	0.75	3%	3%	2%	D	0	0	0	0	0	0	0	0	4	175	1	44	4	1	14	39	109.9	415
4/13/2010	0.155	32.65	0.95	0.98	0.75	3%	3%	2%	D	0	0	0	0	3	100	0	0	0	0	0	0	3	0	9	43	109.9	525
4/14/2010	0.156	32.69	0.90	0.90	1.01	3%	3%	3%	D	1	36	0	0	0	0	0	0	1	32	0	0	2	0	5	37	58.1	430
4/15/2010	0.156	32.72	0.96	0.85	0.79	3%	3%	2%	D	1	34	0	0	0	0	0	0	1	42	0	0	2	0	14	36	176.4	454
4/16/2010	0.160	32.99	0.96	0.85	0.79	3%	3%	2%	D	1	34	0	0	0	0	0	0	0	0	0	0	1	0	10	7	127.1	89
4/17/2010	0.163	33.17	0.96	0.85	0.79	3%	3%	2%	D	1	34	0	0	0	0	0	0	0	0	0	0	1	0	11	60	140.5	766
4/18/2010	0.178	34.21	0.98	0.90	1.30	3%	3%	4%	D	2	70	0	0	0	0	0	0	0	0	0	0	2	0	6	85	64.6	915
4/19/2010	0.190	35.11	1.02	0.92	0.60	3%	3%	2%	D	1	34	0	0	1	38	0	0	0	0	0	0	2	0	11	28	151.8	386
4/20/2010	0.218	37.16	0.95	0.88	1.04	3%	2%	3%	D	4	156	0	0	3	127	0	0	1	36	0	0	8	0	6	37	77.7	479
4/21/2010	0.255	40.16	0.95	0.88	0.80	2%	2%	2%	D	8	337	0	0	6	274	0	0	12	600	0	0	26	0	8	98	121.8	1492
4/22/2010	0.280	42.30	0.95	0.89	0.93	2%	2%	2%	D	22	975	0	0	1	48	0	0	10	453	0	0	33	0	13	59	197.9	898
4/23/2010	0.293	43.40	0.95	0.89	0.93	2%	2%	2%	D	6	273	0	0	5	244	0	0	1	46	0	0	12	0	27	170	421.8	2656
4/24/2010	0.295	43.63	0.95	0.88	1.07	2%	2%	2%	D	8	366	0	0	1	50	1	50	4	164	0	0	13	1	10	99	150.4	1489
4/25/2010	0.300	44.08	0.95	0.88	1.07	2%	2%	2%	D	6	277	0	0	2	100	0	0	0	0	1	41	8	1	14	66	212.7	1003
4/26/2010	0.304	44.45	1.10	1.09	0.91	2%	2%	2%	D	5	203	1	41	5	204	0	0	1	49	0	0	11	1	8	64	115.2	921
4/27/2010	0.323	46.18	1.10	1.09	0.91	2%	2%	2%	D	6	253	0	0	0	0	0	0	1	51	0	0	7	0	3	89	44.9	1331
4/28/2010	0.341	47.94	1.20	1.02	0.76	3%	2%	2%	D	4	160	0	0	1	47	0	0	2	125	0	0	7	0	1	58	16.0	930
4/29/2010	0.358	49.65	1.09	1.08	0.80	2%	2%	2%	D	6	273	0	0	4	183	0	0	5	310	0	0	15	0	3	42	50.1	701
4/30/2010	0.369	50.80	1.09	1.08	0.80	2%	2%	2%	D	4	186	0	0	1	47	0	0	8	508	0	0	13	0	15	64	256.2	1093
5/01/2010	0.379	51.91	1.22	1.09	0.78	2%	2%	1%	D	15	639	0	0	5	239	0	0	6	402	0	0	26	0	3	157	50.5	2645
5/02/2010	0.399	54.11	1.25	1.12	0.69	2%	2%	1%	D	6	259	0	0	3	145	0	0	9	707	0	0	18	0	5	157	88.3	2774
5/03/2010	0.398	53.94	1.25	1.12	0.69	2%	2%	1%	D	1	43	0	0	4	192	0	0	9	705	0	0	14	0	8	121	140.9	2131
5/04/2010	0.395	53.66	1.19	1.10	0.64	2%	2%	1%	D	10	451	0	0	2	98	0	0	4	337	0	0	16	0	14	198	257.1	3636
5/05/2010	0.395	53.66	1.19	1.10	0.64	2%	2%	1%	D	1	45	0	0	0	0	0	0	2	169	0	0	3	0	13	244	238.7	4480
5/06/2010	0.390	53.11	1.25	1.06	0.54	2%	2%	1%	D	4	170	0	0	3	150	2	100	3	295	0	0	10	2	16	189	298.0	3520
5/07/2010	0.391	53.22	1.25	1.06	0.54	2%	2%	1%	D	3	128	0	0	5	250	0	0	7	691	0	0	15	0	17	113	317.3	2109
5/08/2010	0.390	53.11	1.17	0.73	0.60	2%	1%	1%	D	2	91	2	91	6	435	0	0	7	615	0	0	15	2	23	92	487.8	1951
5/09/2010	0.389	53.00	1.17	0.73	0.60	2%	1%	1%	D	3	136	0	0	3	217	0	0	22	1929	0	0	28	0	17	271	359.8	5736
5/10/2010	0.388	52.89	1.16	0.99	0.69	2%	2%	1%	D	0	0	0	0	3	161	1	54	30	2304	0	0	33	1	32	213	596.8	3973
5/11/2010	0.385	52.56	1.16	0.99	0.69	2%	2%	1%	D	1	45	0	0	15	799	0	0	52	3969	0	0	68	0	17	235	315.1	4356
5/12/2010	0.385	52.56	1.19	1.07	0.72	2%	2%	1%	D	1	44	0	0	14	686	0	0	62	4499	0	0	77	0	10	210	176.2	3700
5/13/2010	0.385	52.56	1.19	1.07	0.72	2%	2%	1%	D	1	44	0	0	7	343	0	0	103	7474	0	0	111	0	9	161	158.6	2837
5/14/2010	0.381	52.13	1.05	0.96	0.83	2%	2%	2%	D	3	149	0	0	3	163	0	0	53	3319	0	0	59	0	10	212	183.7	3894
5/15/2010	0.377	51.64	1.05	0.96	0.83	2%	2%	2%	D	5	246	0	0	5	270	0	0	50	3102	0	0	60	0	11	243	200.2	4422
5/16/2010	0.379	51.86	1.05	0.93	0.89	2%	2%	2%	D	2	98	0	0	10	555	0	0	56	3245	0	0	68	0	8	264	143.9	4749
5/17/2010	0.380	52.02	1.05	0.93	0.89	2%	2%	2%	D	6	296	0	0	3	167	0	0	29	1686	0	0	38	0	15	151	270.7	2725
5/18/2010	0.386	52.65	1.26	1.14	0.64	2%	2%	1%	D	2	84	0	0	5	232	0	0	71	5838	0	0	78	0	15	176	260.2	3053
5/19/2010	0.396	53.81	1.26	1.14	0.64	2%	2%	1%	D	2	86	0	0	2	95	0	0	64	5378	0	0	68	0	16	165	283.7	2925
5/20/2010	0.400	54.22	1.14	1.13	0.83	2%	2%	2%	D	0	0	0	0	0	0	0	0	35	2300	0	0	35	0	3	123	52.6	2156
5/21/2010	0.400	54.22	1.14	1.13	0.83	2%	2%	2%	D	2	95	0	0	3	144	0	0	6	394	0	0	11	0	12	131	210.3	2296
5/22/2010	0.418	56.22	1.13	0.99	1.03	2%	2%	2%	D	7	350	0	0	2	114	0	0	22	1200	0	0	31	0	12	61	214.7	1091
5/23/2010	0.420	56.51	1.13	0.99	1.03	2%	2%	2%	D	0	0	0	0	5	286	0	0	17	932	0	0	22	0	12	61	215.8	1097
5/24/2010	0.435	58.29	1.16	0.99	0.85	2%	2%	1%	D	1	50	0	0	2	118	0	0	6	411	0	0	9	0	2	41	38.9	797
5/25/2010	0.435	58.29	1.16	0.99	0.85	2%	2%	1%	D	0	0	0	0	3	177	0	0	5	343	0	0	8	0	1	21	19.4	408
5/26/2010	0.430	57.69	1.27	1.04	1.04	2%	2%	2%	D	0	0	0	0	0	0	0	0	9	500	0	0	9	0	2	18	34.5	310
5/27/2010	0.430	57.69	1.27	1.04	1.04	2%	2%	2%	D	1	46	1	46	2	111	0	0	16	889	0	0	19	1	1	21	17.2	362
5/28/2010	0.426	57.22	1.22	1.10	0.89	2%	2%	2%	D	0	0	0	0	0	0	0	0	25	1599	0	0	25	0	2	41	35.7	731
5/29/2010	0.415	55.93	1.22	1.10	0.89	2%	2%	2%	D	3	138	0	0	0	0	0	0	6	375	0	0	9	0	0	14	0.0	244

Date	Staff Guage (m)	Discharge (m^3/s)	RST Discharge sampled (m^3/s)			Percent of discharge sampled			Day/ Night	RST 1				RST 2				RST 3				Day Total		Combined (D+N) Total		Weighted Index Estimate	
										CH 0+		CH 1+		CH 0+		CH 1+		CH 0+		CH 1+							
			RST 1	RST 2	RST 3	RST 1	RST 2	RST 3		Count	Index	Count	Index	Count	Index	Count	Index	Count	Index	Count	Index	CH 0+	CH 1+	CH 1+	CH 0+	CH 1+	CH 0+
5/30/2010	0.411	55.47	1.15	1.08	0.82	2%	2%	1%	D	2	97	0	0	1	52	0	0	11	745	0	0	14	0	5	27	91.2	493
5/31/2010	0.403	54.56	1.15	1.08	0.82	2%	2%	2%	D	2	95	0	0	0	0	0	0	11	733	1	67	13	1	13	35	233.3	628
6/01/2010	0.399	54.11	1.02	0.92	0.85	2%	2%	2%	D	3	160	0	0	0	0	0	0	17	1088	0	0	20	0	5	69	97.3	1343
6/02/2010	0.400	54.16	1.02	0.92	0.85	2%	2%	2%	D	0	0	0	0	1	59	0	0	10	641	0	0	11	0	5	60	97.4	1169
6/03/2010	0.413	55.64	0.99	0.95	1.25	2%	2%	2%	D	4	224	0	0	0	0	0	0	19	847	0	0	23	0	6	98	104.8	1711
6/04/2010	0.420	56.51	0.99	0.95	1.25	2%	2%	2%	D	2	114	0	0	2	120	0	0	22	996	0	0	26	0	6	106	106.4	1880
6/05/2010	0.413	55.64	1.04	0.95	1.27	2%	2%	2%	D	1	54	0	0	2	117	0	0	8	350	0	0	11	0	1	87	17.1	1485
6/06/2010	0.405	54.78	1.04	0.95	1.27	2%	2%	2%	D	2	105	0	0	0	0	0	0	3	129	0	0	5	0	3	71	50.4	1193
6/07/2010	0.400	54.22	1.03	0.92	1.29	2%	2%	2%	D	0	0	0	0	0	0	0	0	11	462	0	0	11	0	2	101	33.4	1686
6/08/2010	0.400	54.22	1.03	0.92	1.29	2%	2%	2%	D	7	368	0	0	6	352	0	0	7	294	0	0	20	0	6	114	100.2	1903
6/09/2010	0.400	54.22	1.18	1.08	1.22	2%	2%	2%	D	4	184	0	0	1	50	0	0	15	667	0	0	20	0	6	141	93.4	2194
6/10/2010	0.398	53.99	1.18	1.08	1.22	2%	2%	2%	D	1	46	0	0	0	0	0	0	3	133	0	0	4	0	3	96	46.5	1488
6/11/2010	0.393	53.38	0.99	0.86	1.03	2%	2%	2%	D	3	161	0	0	2	124	0	0	5	260	0	0	10	0	3	89	55.7	1651
6/12/2010	0.380	51.97	0.99	0.86	1.03	2%	2%	2%	D	3	157	0	0	0	0	0	0	5	253	0	0	8	0	1	130	18.1	2348
6/13/2010	0.377	51.70	0.98	0.90	1.05	2%	2%	2%	D	4	210	0	0	2	115	0	0	3	147	0	0	9	0	1	166	17.6	2921
6/14/2010	0.374	51.33	0.98	0.90	1.05	2%	2%	2%	D	6	313	0	0	0	0	0	0	3	146	0	0	9	0	3	132	52.4	2306
6/15/2010	0.365	50.38	1.13	1.11	1.12	2%	2%	2%	D	6	268	0	0	0	0	0	0	3	135	0	0	9	0	2	96	30.0	1442
6/16/2010	0.358	49.70	1.11	1.03	1.12	2%	2%	2%	D	1	45	0	0	1	48	0	0	4	178	0	0	6	0	2	113	30.6	1727
6/17/2010	0.355	49.35	1.11	1.03	1.12	2%	2%	2%	D	2	89	0	0	3	144	0	0	4	177	0	0	9	0	0	73	0.0	1108
6/18/2010	0.352	49.04	1.20	1.01	1.05	2%	2%	2%	D	2	82	0	0	3	146	0	0	4	187	0	0	9	0	0	110	0.0	1656
6/19/2010	0.350	48.89	1.20	1.01	1.05	2%	2%	2%	D	5	204	0	0	4	194	0	0	1	47	0	0	10	0	0	52	0.0	780
6/20/2010	0.348	48.64	1.07	1.02	0.92	2%	2%	2%	D	3	137	0	0	0	0	0	0	5	266	0	0	8	0	0	211	0.0	3419
6/21/2010	0.340	47.89	1.07	1.02	0.92	2%	2%	2%	D	1	45	0	0	3	141	0	0	1	52	0	0	5	0	0	89	0.0	1420
6/22/2010	0.335	47.39	0.91	0.87	0.87	2%	2%	2%	D	1	52	0	0	2	108	0	0	3	164	0	0	6	0	0	157	0.0	2807
6/23/2010	0.330	46.91	0.91	0.87	0.87	2%	2%	2%	D	1	52	0	0	1	54	0	0	3	162	0	0	5	0	0	96	0.0	1699
6/24/2010	0.322	46.14	1.05	1.00	0.74	2%	2%	2%	D	2	88	0	0	0	0	0	0	3	186	0	0	5	0	0	110	0.0	1814
6/25/2010	0.322	46.14	1.05	1.00	0.74	2%	2%	2%	D	0	0	0	0	0	0	0	0	3	186	0	0	3	0	0	105	0.0	1731
6/26/2010	0.321	45.99	0.90	0.86	0.79	2%	2%	2%	D	1	51	0	0	0	0	0	0	0	0	0	0	1	0	2	62	36.0	1117
6/27/2010	0.316	45.52	0.90	0.86	0.79	2%	2%	2%	D	0	0	0	0	1	53	0	0	0	0	0	0	1	0	0	63	0.0	1123
6/28/2010	0.318	45.76	0.90	0.85	0.88	2%	2%	2%	D	0	0	0	0	0	0	0	0	2	104	0	0	2	0	1	39	17.4	679
6/29/2010	0.322	46.14	0.90	0.85	0.88	2%	2%	2%	D	2	103	0	0	0	0	0	0	0	0	0	0	2	0	0	89	0.0	1563
6/30/2010	0.321	45.99	0.82	0.88	0.86	2%	2%	2%	D	1	56	0	0	0	0	0	0	1	53	0	0	2	0	0	65	0.0	1169
7/01/2010	0.320	45.95	0.82	0.88	0.86	2%	2%	2%	D	0	0	0	0	0	0	0	0	2	107	0	0	2	0	0	32	0.0	575
7/02/2010	0.319	45.85	0.88	0.87	0.84	2%	2%	2%	D	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	40	0.0	707
7/03/2010	0.313	45.24	0.88	0.87	0.84	2%	2%	2%	D	3	154	0	0	0	0	0	0	0	0	0	0	3	0	0	60	0.0	1046
7/04/2010	0.310	45.00	1.04	0.99	0.84	2%	2%	2%	D	1	43	0	0	0	0	0	0	0	0	0	0	1	0	0	23	0.0	361
7/05/2010	0.310	45.00	1.04	0.99	0.84	2%	2%	2%	D	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	26	0.0	408
7/06/2010	0.303	44.31	0.88	0.87	0.80	2%	2%	2%	D	0	0	0	0	1	51	0	0	0	0	0	0	1	0	0	26	0.0	451
7/07/2010	0.301	44.13	0.83	0.87	0.80	2%	2%	2%	D	1	53	0	0	2	101	0	0	0	0	0	0	3	0	0	41	0.0	724
7/08/2010	0.299	43.99	0.83	0.87	0.80	2%	2%	2%	D	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	57	0.0	1004
7/09/2010	0.297	43.81	0.83	0.84	0.77	2%	2%	2%	D	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	78	0.0	1405
7/10/2010	0.298	43.86	0.83	0.84	0.77	2%	2%	2%	D	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	34	0.0	613
7/11/2010	0.298	43.86	0.80	0.82	0.93	2%	2%	2%	D	0	0	0	0	0	0	0	0	1	47	0	0	1	0	0	37	0.0	637
7/12/2010	0.298	43.86	0.80	0.82	0.93	2%	2%	2%	D	0	0	0	0	0	0	0	0	2	94	0	0	2	0	0	35	0.0	602
7/13/2010	0.330	46.86	0.85	0.82	0.94	2%	2%	2%	D	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	32	0.0	575
7/14/2010	0.381	52.07	0.85	0.82	0.94	2%	2%	2%	D	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	37	0.0	739
7/15/2010	0.497	66.20	1.01	0.98	0.42	2%	1%	1%	D	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	31	0.0	853
										245	11245	4	177	186	9636	4	203	1032	68234	3	152	1463	11	570	8926	9599	154434

Appendix 1. Daily catch of juvenile chinook salmon by rotary screw traps, and index of outmigrants at Diamond Island, Nechako River, 2010 (cont'd)

Date	Staff Guage (m)	River Discharge (m^3/s)	RST Discharge sampled (m^3/s)			Percent of discharge sampled			Day/ Night	RST 1				RST 2				RST 3				Night Total	
										CH 0+		CH 1+		CH 0+		CH 1+		CH 0+		CH 1+			
			RST 1	RST 2	RST 3	RST 1	RST 2	RST 3		Count	Index	Count	Index	Count	Index	Count	Index	Count	Index	Count	Index	CH 0+	CH 1+
4/12/2010	0.155	32.65	0.95	0.98	0.75	3%	3%	2%	N	18	620	7	241	8	166	3	0	9	307	3	44	35	13
4/13/2010	0.155	32.65	0.95	0.98	0.75	3%	3%	2%	N	16	551	6	207	10	333	1	33	14	613	2	88	40	9
4/14/2010	0.156	32.69	0.90	0.90	1.01	3%	3%	3%	N	15	544	5	181	7	255	0	0	13	420	0	0	35	5
4/15/2010	0.156	32.72	0.96	0.85	0.79	3%	3%	2%	N	32	1087	12	408	0	0	1	39	2	83	1	42	34	14
4/16/2010	0.160	32.99	0.96	0.85	0.79	3%	3%	2%	N	4	137	9	308	0	0	1	39	2	84	0	0	6	10
4/17/2010	0.163	33.17	0.96	0.85	0.79	3%	3%	2%	N	52	1791	4	138	5	195	7	274	2	84	0	0	59	11
4/18/2010	0.178	34.21	0.98	0.90	1.30	3%	3%	4%	N	71	2484	5	175	12	456	1	38	0	0	0	0	83	6
4/19/2010	0.190	35.11	1.02	0.92	0.60	3%	3%	2%	N	21	719	7	240	0	0	4	152	5	294	0	0	26	11
4/20/2010	0.218	37.16	0.95	0.88	1.04	3%	2%	3%	N	26	1013	5	195	3	127	1	42	0	0	0	0	29	6
4/21/2010	0.255	40.16	0.95	0.88	0.80	2%	2%	2%	N	60	2525	7	295	5	228	1	46	7	350	0	0	72	8
4/22/2010	0.280	42.30	0.95	0.89	0.93	2%	2%	2%	N	12	532	12	532	11	523	1	48	3	136	0	0	26	13
4/23/2010	0.293	43.40	0.95	0.89	0.93	2%	2%	2%	N	102	4639	22	1001	28	1366	5	244	28	1300	0	0	158	27
4/24/2010	0.295	43.63	0.95	0.88	1.07	2%	2%	2%	N	70	3200	5	229	6	297	4	198	10	409	0	0	86	9
4/25/2010	0.300	44.08	0.95	0.88	1.07	2%	2%	2%	N	49	2264	11	508	7	350	0	0	2	83	2	83	58	13
4/26/2010	0.304	44.45	1.10	1.09	0.91	2%	2%	2%	N	49	1988	7	284	3	123	0	0	1	49	0	0	53	7
4/27/2010	0.323	46.18	1.10	1.09	0.91	2%	2%	2%	N	26	1096	3	126	56	2380	0	0	0	0	0	0	82	3
4/28/2010	0.341	47.94	1.20	1.02	0.76	3%	2%	2%	N	36	1436	1	40	10	468	0	0	5	314	0	0	51	1
4/29/2010	0.358	49.65	1.09	1.08	0.80	2%	2%	2%	N	11	501	2	91	12	550	1	46	4	248	0	0	27	3
4/30/2010	0.369	50.80	1.09	1.08	0.80	2%	2%	2%	N	26	1212	13	606	14	656	2	94	11	698	0	0	51	15
5/01/2010	0.379	51.91	1.22	1.09	0.78	2%	2%	1%	N	48	2044	1	43	59	2818	2	96	24	1606	0	0	131	3
5/02/2010	0.399	54.11	1.25	1.12	0.69	2%	2%	1%	N	67	2896	3	130	40	1929	2	96	32	2514	0	0	139	5
5/03/2010	0.398	53.94	1.25	1.12	0.69	2%	2%	1%	N	15	646	8	345	69	3317	0	0	23	1801	0	0	107	8
5/04/2010	0.395	53.66	1.19	1.10	0.64	2%	2%	1%	N	88	3969	8	361	23	1126	6	294	71	5983	0	0	182	14
5/05/2010	0.395	53.66	1.19	1.10	0.64	2%	2%	1%	N	166	7486	13	586	52	2547	0	0	23	1938	0	0	241	13
5/06/2010	0.390	53.11	1.25	1.06	0.54	2%	2%	1%	N	57	2424	13	553	66	3297	1	50	56	5514	0	0	179	14
5/07/2010	0.391	53.22	1.25	1.06	0.54	2%	2%	1%	N	75	3196	14	597	7	350	3	150	16	1579	0	0	98	17
5/08/2010	0.390	53.11	1.17	0.73	0.60	2%	1%	1%	N	34	1548	17	774	30	2173	4	290	13	1142	0	0	77	21
5/09/2010	0.389	53.00	1.17	0.73	0.60	2%	1%	1%	N	174	7907	14	636	46	3324	3	217	23	2017	0	0	243	17
5/10/2010	0.388	52.89	1.16	0.99	0.69	2%	2%	1%	N	115	5241	26	1185	18	965	5	268	47	3610	0	0	180	31
5/11/2010	0.385	52.56	1.16	0.99	0.69	2%	2%	1%	N	47	2129	16	725	88	4688	1	53	32	2442	0	0	167	17
5/12/2010	0.385	52.56	1.19	1.07	0.72	2%	2%	1%	N	38	1683	8	354	84	4118	2	98	11	798	0	0	133	10
5/13/2010	0.385	52.56	1.19	1.07	0.72	2%	2%	1%	N	32	1417	6	266	13	637	3	147	5	363	0	0	50	9
5/14/2010	0.381	52.13	1.05	0.96	0.83	2%	2%	2%	N	82	4077	8	398	35	1906	2	109	36	2255	0	0	153	10
5/15/2010	0.377	51.64	1.05	0.96	0.83	2%	2%	2%	N	85	4187	9	443	84	4532	2	108	14	869	0	0	183	11
5/16/2010	0.379	51.86	1.05	0.93	0.89	2%	2%	2%	N	96	4722	8	393	87	4832	0	0	13	753	0	0	196	8
5/17/2010	0.380	52.02	1.05	0.93	0.89	2%	2%	2%	N	48	2368	12	592	50	2786	2	111	15	872	1	58	113	15
5/18/2010	0.386	52.65	1.26	1.14	0.64	2%	2%	1%	N	39	1633	13	544	35	1621	2	93	24	1973	0	0	98	15
5/19/2010	0.396	53.81	1.26	1.14	0.64	2%	2%	1%	N	39	1669	12	513	29	1373	3	142	29	2437	1	84	97	16
5/20/2010	0.400	54.22	1.14	1.13	0.83	2%	2%	2%	N	24	1142	3	143	34	1634	0	0	30	1971	0	0	88	3
5/21/2010	0.400	54.22	1.14	1.13	0.83	2%	2%	2%	N	69	3282	9	428	37	1778	3	144	14	920	0	0	120	12
5/22/2010	0.418	56.22	1.13	0.99	1.03	2%	2%	2%	N	12	600	10	500	11	627	2	114	7	382	0	0	30	12
5/23/2010	0.420	56.51	1.13	0.99	1.03	2%	2%	2%	N	7	352	11	552	20	1145	0	0	12	658	1	55	39	12
5/24/2010	0.435	58.29	1.16	0.99	0.85	2%	2%	1%	N	15	753	2	100	11	650	0	0	6	411	0	0	32	2
5/25/2010	0.435	58.29	1.16	0.99	0.85	2%	2%	1%	N	6	301	1	50	3	177	0	0	4	274	0	0	13	1
5/26/2010	0.430	57.69	1.27	1.04	1.04	2%	2%	2%	N	2	91	2	91	4	221	0	0	3	167	0	0	9	2
5/27/2010	0.430	57.69	1.27	1.04	1.04	2%	2%	2%	N	0	0	0	0	1	55	0	0	1	56	0	0	2	0
5/28/2010	0.426	57.22	1.22	1.10	0.89	2%	2%	2%	N	2	94	2	94	6	313	0	0	8	512	0	0	16	2
5/29/2010	0.415	55.93	1.22	1.10	0.89	2%	2%	2%	N	4	183	0	0	1	51	0	0	0	0	0	0	5	0

Date	Staff Guage (m)	River Discharge (m^3/s)	RST Discharge sampled (m^3/s)			Percent of discharge sampled			Day/ Night	RST 1				RST 2				RST 3				Night Total	
										CH 0+		CH 1+		CH 0+		CH 1+		CH 0+		CH 1+			
			RST 1	RST 2	RST 3	RST 1	RST 2	RST 3		Count	Index	Count	Index	Count	Index	Count	Index	Count	Index	Count	Index	CH 0+	CH 1+
5/30/2010	0.411	55.47	1.15	1.08	0.82	2%	2%	1%	N	8	387	4	194	4	206	1	52	1	68	0	0	13	5
5/31/2010	0.403	54.56	1.15	1.08	0.82	2%	2%	2%	N	14	667	11	524	5	254	1	51	3	200	0	0	22	12
6/01/2010	0.399	54.11	1.02	0.92	0.85	2%	2%	2%	N	37	1970	5	266	9	530	0	0	3	192	0	0	49	5
6/02/2010	0.400	54.16	1.02	0.92	0.85	2%	2%	2%	N	20	1066	1	53	20	1179	3	177	9	577	1	64	49	5
6/03/2010	0.413	55.64	0.99	0.95	1.25	2%	2%	2%	N	40	2242	6	336	17	1000	0	0	18	802	0	0	75	6
6/04/2010	0.420	56.51	0.99	0.95	1.25	2%	2%	2%	N	41	2334	6	342	32	1913	0	0	7	317	0	0	80	6
6/05/2010	0.413	55.64	1.04	0.95	1.27	2%	2%	2%	N	32	1713	1	54	29	1701	0	0	15	656	0	0	76	1
6/06/2010	0.405	54.78	1.04	0.95	1.27	2%	2%	2%	N	35	1844	3	158	28	1617	0	0	3	129	0	0	66	3
6/07/2010	0.400	54.22	1.03	0.92	1.29	2%	2%	2%	N	54	2840	2	105	25	1466	0	0	11	462	0	0	90	2
6/08/2010	0.400	54.22	1.03	0.92	1.29	2%	2%	2%	N	56	2945	4	210	15	879	1	59	23	965	1	42	94	6
6/09/2010	0.400	54.22	1.18	1.08	1.22	2%	2%	2%	N	49	2249	5	230	30	1501	1	50	42	1868	0	0	121	6
6/10/2010	0.398	53.99	1.18	1.08	1.22	2%	2%	2%	N	48	2194	3	137	23	1146	0	0	21	930	0	0	92	3
6/11/2010	0.393	53.38	0.99	0.86	1.03	2%	2%	2%	N	54	2904	0	0	14	869	3	186	11	573	0	0	79	3
6/12/2010	0.380	51.97	0.99	0.86	1.03	2%	2%	2%	N	61	3194	1	52	30	1813	0	0	31	1571	0	0	122	1
6/13/2010	0.377	51.70	0.98	0.90	1.05	2%	2%	2%	N	50	2628	1	53	34	1950	0	0	73	3585	0	0	157	1
6/14/2010	0.374	51.33	0.98	0.90	1.05	2%	2%	2%	N	55	2870	3	157	19	1082	0	0	49	2389	0	0	123	3
6/15/2010	0.365	50.38	1.13	1.11	1.12	2%	2%	2%	N	28	1250	2	89	34	1543		0	25	1128	0	0	87	2
6/16/2010	0.358	49.70	1.11	1.03	1.12	2%	2%	2%	N	48	2154	2	90	22	1064	0	0	37	1646	0	0	107	2
6/17/2010	0.355	49.35	1.11	1.03	1.12	2%	2%	2%	N	42	1872	0	0	15	720	0	0	7	309	0	0	64	0
6/18/2010	0.352	49.04	1.20	1.01	1.05	2%	2%	2%	N	54	2209	0	0	15	728	0	0	32	1496	0	0	101	0
6/19/2010	0.350	48.89	1.20	1.01	1.05	2%	2%	2%	N	10	408	0	0	12	581	0	0	20	932	0	0	42	0
6/20/2010	0.348	48.64	1.07	1.02	0.92	2%	2%	2%	N	96	4379	0	0	52	2482	0	0	55	2921	0	0	203	0
6/21/2010	0.340	47.89	1.07	1.02	0.92	2%	2%	2%	N	37	1662	0	0	29	1363	0	0	18	941	0	0	84	0
6/22/2010	0.335	47.39	0.91	0.87	0.87	2%	2%	2%	N	98	5120	0	0	38	2059	0	0	15	818	0	0	151	0
6/23/2010	0.330	46.91	0.91	0.87	0.87	2%	2%	2%	N	32	1655	0	0	32	1716	0	0	27	1457	0	0	91	0
6/24/2010	0.322	46.14	1.05	1.00	0.74	2%	2%	2%	N	52	2275	0	0	16	737	0	0	37	2299	0	0	105	0
6/25/2010	0.322	46.14	1.05	1.00	0.74	2%	2%	2%	N	56	2450	0	0	21	968	0	0	25	1553	0	0	102	0
6/26/2010	0.321	45.99	0.90	0.86	0.79	2%	2%	2%	N	37	1888	2	102	16	856	0	0	8	464	0	0	61	2
6/27/2010	0.316	45.52	0.90	0.86	0.79	2%	2%	2%	N	40	2020	0	0	10	529	0	0	12	689	0	0	62	0
6/28/2010	0.318	45.76	0.90	0.85	0.88	2%	2%	2%	N	26	1329	1	51	2	107	0	0	9	469	0	0	37	1
6/29/2010	0.322	46.14	0.90	0.85	0.88	2%	2%	2%	N	53	2731	0	0	20	1080	0	0	14	736	0	0	87	0
6/30/2010	0.321	45.99	0.82	0.88	0.86	2%	2%	2%	N	38	2135	0	0	14	734	0	0	11	587	0	0	63	0
7/01/2010	0.320	45.95	0.82	0.88	0.86	2%	2%	2%	N	18	1010	0	0	9	471	0	0	3	160	0	0	30	0
7/02/2010	0.319	45.85	0.88	0.87	0.84	2%	2%	2%	N	24	1245	0	0	7	371	0	0	9	488	0	0	40	0
7/03/2010	0.313	45.24	0.88	0.87	0.84	2%	2%	2%	N	42	2150	0	0	10	522	0	0	5	268	0	0	57	0
7/04/2010	0.310	45.00	1.04	0.99	0.84	2%	2%	2%	N	12	519	0	0	5	227	0	0	5	269	0	0	22	0
7/05/2010	0.310	45.00	1.04	0.99	0.84	2%	2%	2%	N	21	909	0	0	2	91	0	0	3	161	0	0	26	0
7/06/2010	0.303	44.31	0.88	0.87	0.80	2%	2%	2%	N	15	752	0	0	4	204	0	0	6	332	0	0	25	0
7/07/2010	0.301	44.13	0.83	0.87	0.80	2%	2%	2%	N	27	1435	0	0	10	506	0	0	1	55	0	0	38	0
7/08/2010	0.299	43.99	0.83	0.87	0.80	2%	2%	2%	N	33	1748	0	0	17	858	0	0	7	387	0	0	57	0
7/09/2010	0.297	43.81	0.83	0.84	0.77	2%	2%	2%	N	51	2700	0	0	18	943	0	0	9	513	0	0	78	0
7/10/2010	0.298	43.86	0.83	0.84	0.77	2%	2%	2%	N	17	901	0	0	10	524	0	0	7	400	0	0	34	0
7/11/2010	0.298	43.86	0.80	0.82	0.93	2%	2%	2%	N	17	931	0	0	13	699	0	0	6	283	0	0	36	0
7/12/2010	0.298	43.86	0.80	0.82	0.93	2%	2%	2%	N	19	1040	0	0	10	538	0	0	4	188	0	0	33	0
7/13/2010	0.330	46.86	0.85	0.82	0.94	2%	2%	2%	N	19	1050	0	0	8	458	0	0	5	249	0	0	32	0
7/14/2010	0.381	52.07	0.85	0.82	0.94	2%	2%	2%	N	18	1105	0	0	12	763	0	0	7	388	0	0	37	0
7/15/2010	0.497	66.20	1.01	0.98	0.42	2%	1%	1%	N	18	1180	0	0	10	677	0	0	3	475	0	0	31	0
										3934	184640	455	20402	2067	107689	91	4446	1462	89635	13	559	7463	559

Appendix 2. Mean monthly catch-per-unit-effort (CPUE, fish caught per 100 m^2) of juvenile chinook salmon by 10 km intervals of the upper Nechako River, 2010.

Date	Day/Night	Distance from Kenny Dam	Midpoint (km)	0+ CPUE		1+ CPUE	
				mean	SD	mean	SD
April	Day	9.0-19.9	15	2.5	5.5	0.2	0.4
		20.0-29.9	25	1.1	1.2	0.2	0.4
		30.0-39.9	35	1.6	1.9	0.1	0.2
		50.0-59.9	55	0.6	0.9	0.2	0.5
		70.0-79.9	75	0.4	0.8	0.1	0.3
		80.0-89.9	85	0.4	0.6	0.3	0.7
April	Night	9.0-19.9	15	5.1	7.8	2.0	2.1
		20.0-29.9	25	4.9	5.6	1.4	2.5
		30.0-39.9	35	2.4	2.4	0.9	1.2
		50.0-59.9	55	1.7	1.8	0.7	0.9
		70.0-79.9	75	0.0	0.0	0.7	0.8
		80.0-89.9	85	0.3	0.8	0.5	0.7
May	Day	9.0-19.9	15	22.0	37.2	0.1	0.2
		20.0-29.9	25	45.5	64.2	0.0	0.0
		30.0-39.9	35	16.5	33.9	0.1	0.2
		50.0-59.9	55	22.9	43.1	0.0	0.0
		70.0-79.9	75	23.6	37.2	0.0	0.0
		80.0-89.9	85	7.7	12.8	0.0	0.0
May	Night	9.0-19.9	15	24.3	29.5	0.2	0.9
		20.0-29.9	25	102.3	85.0	0.1	0.4
		30.0-39.9	35	72.1	69.5	0.4	1.1
		50.0-59.9	55	48.9	65.5	0.5	1.1
		70.0-79.9	75	63.4	39.6	0.4	0.9
		80.0-89.9	85	45.4	75.0	0.3	0.7
June	Day	9.0-19.9	15	20.5	54.8	0.0	0.1
		20.0-29.9	25	44.6	111.7	0.0	0.0
		30.0-39.9	35	8.5	22.1	0.0	0.0
		50.0-59.9	55	0.9	1.6	0.0	0.0
		70.0-79.9	75	1.9	2.6	0.0	0.0
		80.0-89.9	85	0.0	0.0	0.0	0.0
June	Night	9.0-19.9	15	35.2	35.3	0.0	0.0
		20.0-29.9	25	43.6	53.8	0.0	0.0
		30.0-39.9	35	29.0	24.2	0.0	0.0
		50.0-59.9	55	24.0	31.2	0.0	0.2
		70.0-79.9	75	12.9	14.6	0.1	0.3
		80.0-89.9	85	10.1	11.6	0.0	0.0
July	Day	9.0-19.9	15	4.8	9.8	0.0	0.0
		20.0-29.9	25	0.7	1.6	0.0	0.0
		30.0-39.9	35	0.3	0.9	0.0	0.0
		50.0-59.9	55	0.0	0.2	0.0	0.0
		70.0-79.9	75	0.0	0.0	0.0	0.0
		80.0-89.9	85	0.1	0.5	0.0	0.0
July	Night	9.0-19.9	15	30.9	31.6	0.0	0.1
		20.0-29.9	25	17.0	15.6	0.1	0.4
		30.0-39.9	35	7.4	6.6	0.1	0.3
		50.0-59.9	55	7.7	7.5	0.0	0.0
		70.0-79.9	75	4.5	4.7	0.1	0.4
		80.0-89.9	85	3.5	3.7	0.0	0.2

Date	Day/Night	Distance from Kenny Dam	Midpoint (km)	0+ CPUE		1+ CPUE	
				mean	SD	mean	SD
November	Day	9.0-19.9	15	1.1	1.1	0.0	0.0
		20.0-29.9	25	0.6	1.6	0.0	0.0
		30.0-39.9	35	0.3	0.6	0.0	0.0
		50.0-59.9	55	0.1	0.3	0.0	0.0
		70.0-79.9	75	0.2	0.4	0.0	0.0
		80.0-89.9	85	0.1	0.3	0.0	0.0
November	Night	9.0-19.9	15	1.8	1.1	0.0	0.0
		20.0-29.9	25	1.2	2.4	0.0	0.0
		30.0-39.9	35	2.5	5.6	0.0	0.0
		50.0-59.9	55	1.2	1.1	0.0	0.0
		70.0-79.9	75	1.8	2.3	0.0	0.0
		80.0-89.9	85	0.6	0.6	0.0	0.0