A FURTHER REPORT ON JUVENILE WHITE STURGEON HABITAT USE IN THE LOWER FRASER RIVER, 2008-09

Prepared for

Fraser River Sturgeon Conservation Society

Prepared by:

G. Glova[1], T. Nelson[2], K. English[1], and T. Mochizuki[1]

[1]LGL Limited
environmental research associates
9768 Second Street
Sidney, British Columbia V8L 3Y8

[2]Fraser River Sturgeon Conservation Society, Vancouver, BC

March 2009

LIMITED
environmental research associates

Table of Contents

List of Tables

List of Figures

List of Plates

Executive Summary

Studies were conducted in both 2007 and 2008 to gather baseline habitat use information on juveniles of endangered white sturgeon (*Acipenser transmontanus*) subpopulation in the lower Fraser River. In the first year, sampling occurred between the mouth of the Fraser River and Harrison River area during the September 2007-March 2008, period. In the second year, sampling was less extensive, both spatially and temporarily, and was carried out between Deas Island and Nicomen Island in the June-September period, 2008.

Tangle-netting was performed at 518 and 237 sites in the first and second study years, respectively. In the first year, sturgeon were captured at 129 of the sites (33%), a total of 304 individuals in all (0.59 fish/net set); in the second year, sturgeon were captured at 67 of the sites (39%), a total of 159 individuals in all (0.67 fish/net set). The results of the first year are reported in Glova et al. (2008). The present report is based on results obtained in the second year (2008), with some comparison of the findings in the first year.

In the second study year, the number of sturgeon caught/net set ranged from 1-13 fish, but most frequently consisted of a single fish. Most of the sturgeon captured were in September (73% of the total), with relatively few fish caught during the June-July sampling period (27%). The fish ranged in size from 140 to 1380 mm fork length (FL), with 42% being less than 300 mm FL. Very few fish were caught below 220 mm in length and of those that were aged, all were age-1^+ fish; no age-0 fish were determined from the sample that was aged.. The sturgeon caught were widely scattered from Deas Island to the Nicomen Island area, with the higher catches occurring in the Annacis and Hatzic areas, but also with quite reasonable catches near the Port Mann Bridge, Pitt River, Barnston Island, Stave River confluence, and Matsqui Island. Juvenile sturgeon were found in a wide range of water depths (3.3-18.6 m), but more commonly were in slow-flowing areas <15 m deep with fine substrates in side channels, side pools, backwaters and mainstem open channels. Three non-sturgeon native species (northern pikeminnow, peamouth chub, sculpin spp.) were abundant in the catch, but none of these had a statistically significant effect on the catch of juvenile white sturgeon, although the catch of sculpins was relatively strong.

In general, the findings of juvenile sturgeon distribution and habitat use in the lower Fraser River in the second study year corroborate reasonably well with those obtained in the first study year.

1. Introduction

From the ongoing white sturgeon (*Acipenser transmontanus*) monitoring and assessment program in the lower Fraser River by Fraser River Sturgeon Conservation Society (FRSCS) volunteers and others since 1999, there are indications that abundance and growth of the younger sector of this sub-population may be declining (Nelson et al. 2007, 2008). As this decline may be habitat-related, it is important that the habitats used by young sturgeon are adequately documented so that they can be conserved and protected, and improved where feasible. Continuing industrial and urban development in the lower Fraser is a major threat to the remaining habitat for juvenile sturgeon.

In 2007, a study was initiated to gather information on juvenile white sturgeon habitat use in the lower Fraser River. In the first year, sampling was conducted between September 2007 and March 2008, with the results reported in Glova et al. (2008).

Based on the successes achieved in the first year, the study was continued into 2008 with a slightly revised work plan. This report presents the results and findings of this second year of study, which was conducted in June, July, and September, 2008. Since no sampling was done during the spring-summer period in 2007, sampling in June and July in 2008 was intended to fill that gap, whereas sampling in September provided the data to compare variability in the results between years during that month.

The study area was less extensive in the second year of study – it extended from Deas Island to the Nicomen Island area, whereas in the first year it extended from the mouth of the Fraser River to the Harrison River area.

Hereafter, the first and second study years will be referred to as Year 1 and Year 2, respectively. As with Year 1, the results reported in Year 2 are largely descriptive, including basic habitat information, GIS-based mapping of the distribution of juvenile white sturgeon captured in the lower Fraser River, plots of effort and catch, and fish size-frequency distributions.

Mainly, the study objectives were to

- Conduct routine sampling in selected sites in June, July and September, 2008;
- Collect basic physical habitat data at all sites;
- Enter the data into an *Access* database (compatible with the MOE mapping group);
- Determine age of fish from pectoral fin ray samples from live and dead young sturgeon.
- Produce a descriptive report with GIS-based mapping products and data analysis and interpretations, and relevant comparisons with findings in the first year of study.
- Distribute reporting and mapping products to end-users including government/municipal resource managers, habitat specialists, and planners.

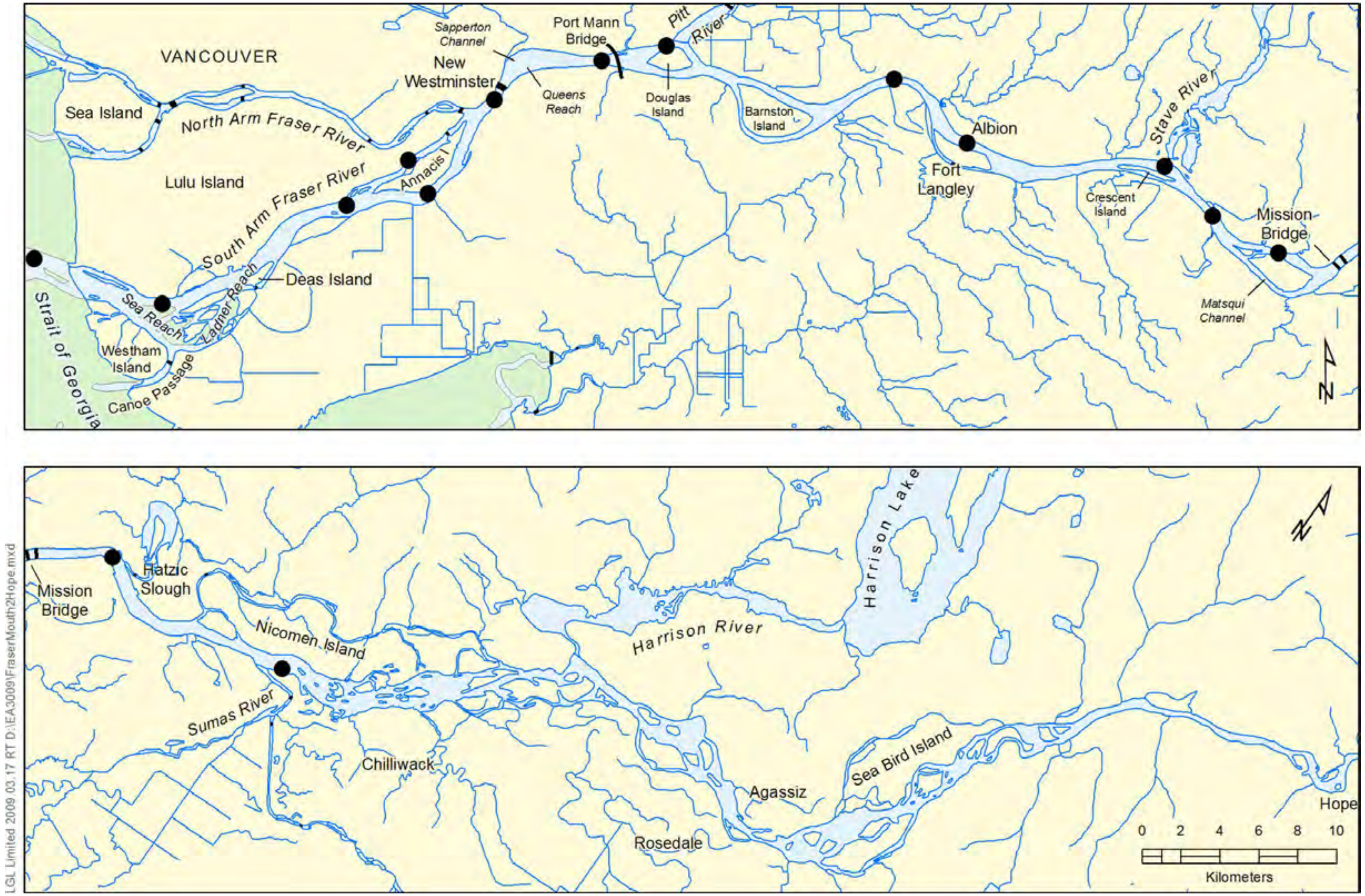

Figure 1: Map of Lower Fraser River. Circles indicate sites >15 m deep (from National Topographic Database 1:50000).

1.1 Sampling Rationale

The nets used were the same as those used in Year 1. They were made from soft, multi-strand, braided 2-inch mesh, with the dimensions of each net being 50 ft (15.2 m) long x 8 ft deep. This size was appropriate for sampling a variety of habitats and provided better site-specific information on catch of juvenile sturgeon in the lower Fraser River. In a few instances where longer nets were necessary, two nets were joined together.

The field crews, consisting entirely of First Nations personnel, were the same as used in Year 1: the lower crew sampled sites in the reach between Deas Island and Barnston Island; the upper crew sampled sites between Crescent Island and the Nicomen Island area. Both crews consisted of a field crew leader and a technician who were familiar with the river, navigational and boat safety issues, and fish netting procedures.

2. Methods

2.1 Field Sampling

Sampling of juvenile white sturgeon in Year 2 occurred during the periods 15-25 June, 13-31 July and 13-26 September, 2008. Since catch rates in Year 1 were frequently low with no sturgeon caught at many of the sites, sampling in Year 2 was largely restricted to sites at which reasonable catch rates occurred in the previous year. As with Year 1, in Year 2, the habitats sampled in each of the months included mainstem pools and open channels, side channels, backwaters, sloughs, and others to obtain information on the range of habitats occupied by juvenile white sturgeon.

The boats and sampling procedures used were the same as in Year 1. The lower crew used a fishing vessel with an aluminum hull (~8 m long) and inboard diesel engine, the upper crew used an aluminum boat (~5 m long) powered by a 50 hp motor. A total of 5-10 nets/d was set by the lower crew, and 5-6 nets/d by the upper crew; all nets were set in late afternoon on the bottom and retrieved the following morning. The location of each of the sets was recorded from a GPS unit onboard the boats. The fish caught were removed as the net was brought up, with any sturgeon present removed immediately and placed into a large, plastic container with fresh water. All other native fish were identified to species, counted and released, and mortalities recorded. Any non-native fish in the catch were identified to species, measured, and disposed of as per instructions on the MOE sampling permit. Fork length and girth were recorded for all sturgeon captured (including dead fish). All fish >200 mm FL were scanned for presence of a PIT tag, and any untagged, live fish was tagged with a PIT tag per standard tagging procedures (Nelson et al. 2007). For each sturgeon, the condition code (one of five categories: 1 = vigorous, no bleeding; 2 = vigorous, but bleeding; 3 = lethargic; 4 = lethargic and bleeding; 5 = dead) at time of release was recorded. Any dead juvenile sturgeon was frozen for examination of gut contents and age determination at a later date.

At the sites sampled, the habitat components measured included water depth (with depth sounder), and water temperature, dissolved oxygen, and conductivity at surface and bottom levels with a Hach meter. In the upper reach, bottom water samples for measurement were collected with a Van Doren type sampler as the bottom could not be reached with the Hach meter sensor cable. Bottom water velocity was measured with a Marsh-McBirney Flo-Mate meter with an 18.3-m cable during the September period only by both crews; surface water velocity was not measured as it bore no relevance to juvenile sturgeon bottom habitat. A sample of substrate was collected at most (94%) sites to determine substrate type. The habitat and fish data collected at each of the sites were recorded on a standardized data form (see Appendix). The completed original data forms were forwarded via courier or postal delivery to LGL Limited on a regular basis, with back-ups (photocopies) made before sending. For more details on sampling methodology see Glova et al. (2008).

2.2 Sturgeon Ageing

A small number of samples of a leading pectoral fin ray were collected from both live (14 fish) and dead (9 fish) young sturgeon for age determination. From live fish, a partial fin clip approximately 5 mm long was removed from the base of the fin with the use of nail clippers and small forceps (method used by the Oregon Department of Fish & Wildlife); from dead fish, an entire leading pectoral fin ray was removed. Individual samples from both live and dead fish were placed in small plastic vials with tops and couriered to the Pacific Biological Station in Nanaimo for age determination by an experienced fish-aging analyst.

The samples were prepared for reading by encasing the ray in Epothin brand epoxy to cut multiple cross sections of the ray using a Buehler Isomet low speed saw; for the dead fish samples, various cross sections were taken from the basal to distal end of the ray to ensure that the first year growth was included in the sections taken. The cross sections were aged using a Leica compound microscope at 40x magnification. The annual growth patterns were reasonably clear and confidence in the age analysis was rated as fairly good.

To provide a comparison of age from fin rays and otoliths, an attempt was made to extract otoliths from each of the dead fish; unfortunately, none was found in the fish sampled (FL range, 165-372 mm).

2.3 Sturgeon Diet

The stomach and intestinal tract from each of the dead sturgeon were examined in the laboratory for presence of food contents. In most of the fish the gut was empty and in the few that had minor amounts of material present in the gut, no identifiable food items were present.

2.4 Data Compilation and Analysis

Upon receiving the field data forms in the office, they were checked for completeness and in instances where information was missing, the field crew leader was contacted in an effort to complete the information record. The data were then entered into an *Access* database for use with other software packages. *Excel* charts were used to plot sturgeon catch in relation to various environmental variables. GIS-based mapping was used to plot the distribution of sturgeon caught in each of the three months sampled.

An examination of the fish catch data revealed it to be highly skewed, and exhibited the expected negative binomial error structure that is typical of catch and count data. To fit the continuous variables in this data set, non-parametric statistics were used throughout. Data from the total tangle-net sets made were used to calculate Spearman-rank correlations between sturgeon catch and five habitat variables: surface water temperature, water depth, sculpin catch, peamouth chub catch, and northern pikeminnow catch. Given that 5 comparisons were made, correlations were considered to be statistically significant only if the *P*-value was less than the Bonferroni adjusted alpha of 0.01 (i.e., 0.05/5).

At each of the tangle-netting sites, the substrate was classified as one of: boulder, cobble, gravel, sand, silt, mud, or combinations thereof. Only 3 substrate classes were recorded at more than 10 of the sites: sand (160), silt (34), and silt/sand (11) – these were used to test the statistical significance of substrate in relation to sturgeon catch.

3. Results

3.1 General

Tangle-netting was performed at 237 sites in various habitats of the lower Fraser River from Deas Island to the Nicomen Island area from June through September, 2008. The habitat types sampled (number of nets set in each habitat type is bracketed) included mainstem pool (3), slough (14), backwater (28), side pool (44), side channel (73) and mainstem open channel (75). Water depth at the sites sampled ranged from 2.1-18.6 m, with the average depth being 5.7 m.

Plots showing minimum and maximum and average values monthly for the various water quality parameters measured at the sites sampled are presented in the Appendix (Figure 1). For each of the parameters, plots of the surface and bottom values are similar. During the period of study, water temperature recorded ranged from 11.5 ºC in September to 17.5 ºC in July. On average, dissolved oxygen levels were approximately 9 mg/l. Conductivity ranged from 141 to 160 mS/cm. Salinity was not measured at any of the sites in Year 2 as the salinometer used in Year 1 was not available for our use. Salinity was measured at all sites sampled by the lower river crew in Year 1, and not likely to change appreciably between years. Bottom water velocity measured at the sites sampled in September averaged 0.08 m/s (range 0.05 to 0.11 m/s; Deas Island-Barnston Island area) and 0.25 m/s (range 0.02 to 0.49 m/s; Crescent Island-Nicomen Island area); the maximum 0.49 m/s recorded was in a mainstem open channel in the Nicomen Island area. Secchi depth during the June-July period ranged from 0.3-0.5 m, whereas in September it ranged from 0.6-3.1 m.

Sturgeon were captured at 67 (39%) of the sites, a total of 159 individuals in all (0.67 fish/set). Of the total caught for the June-September period, 1% was taken in mainstem pools and in sloughs, and 21%, 24%, 26%, and 27% in side pools, mainstem channels, side channels, and backwaters, respectively. For the June-July period which was characterized by high flows and dirty water, of the total 43 sturgeon caught, 2.3%, 18.6%, 25.5%, 25.7%, 27.9% were in sloughs, backwaters, mainstem channels, side channels, and sidepools, respectively. During September (flows moderate and clearer), of the total

116 sturgeon captured, 18.1%, 25.1%, 26.7%, and 30.1% were in sidepools, mainstem open channels, side channels, and backwaters, respectively.

Of the sturgeon for which condition was recorded and analyzed by size groups (Table 1), 82-91% were vigorous, with no bleeding, and 6-10% were lethargic; mortality ranged from 3-8% and was higher for fish of the smaller size group.

Table 1. Condition of juvenile white sturgeon sampled in the lower Fraser River, June-September 2008.

Conditon	<300 mm		≥ 300 mm	
Code [1]	No. of Fish	%	No. of Fish	%
1	71	82%	57	91%
2	0	0%	0	0%
3	9	10%	4	6%
4	0	0%	0	0%
5	7	8%	2	3%
Not coded	3		8	

[1] Condition code: 1 = vigorous, no bleeding; 2 = vigorous, but bleeding; 3 = lethargic; 4 = lethargic and bleeding; 5 = dead.

The distribution of sturgeon catches was strongly skewed (**Figure 2**), and exhibited the expected negative binomial error structure that is typical of catch and count data. For all three months combined, for more than 70% of the nets set, no sturgeon were caught; catches ranged from 1-13 fish, with a single fish being the most frequent result (15% of the time). A plot of the distribution of the catch among months (**Figure 3**) shows that zero catches occurred much more frequently in June and July (~80%) than in September (~55%), and that catches of more than 4 sturgeon occurred only in September. In all three months, a single fish was the most frequent (~15%) catch.

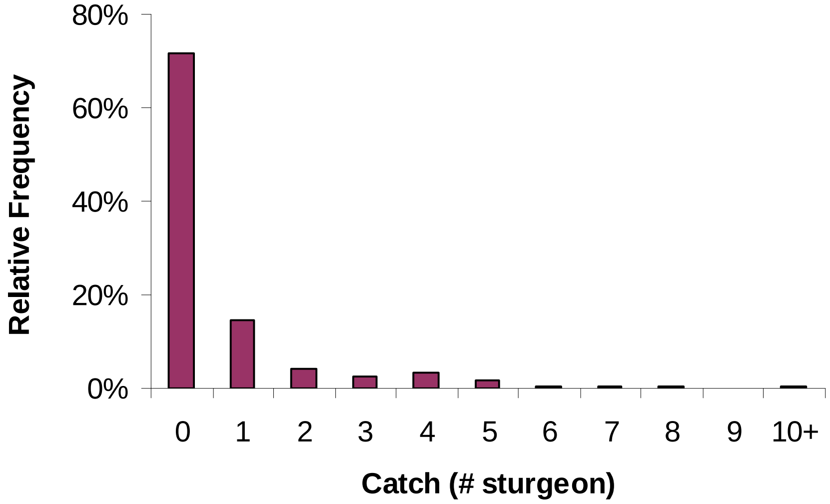

Figure 2: Relative frequency of juvenile white sturgeon caught, lower Fraser River, June-September 2008.

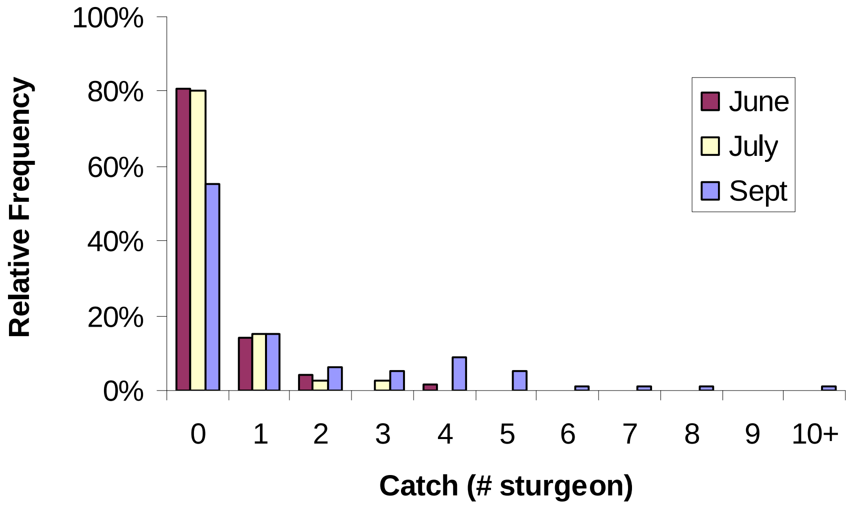

Figure 3: Relative frequency of juvenile white sturgeon caught by month, lower Fraser River, June-September 2008.

For comparison of the sturgeon catch between years, the distribution of the catch in September for Years 1 and 2 is shown in **Figure 4**; sturgeon were caught at 72 of the 184 sites (39.1%) sampled in Year 1, and at 36 of the 80 sites (45.0%) sampled in Year 2. The relative frequency of the numbers of sturgeon caught/set is very similar for both years: approximately 60% of the time, no fish were caught; the catch ranged from 1 to 13 fish, with a single fish being the most frequent (slightly >10%) catch. The September sturgeon catches did not differ significantly between years, regardless of whether ranked catch

(Chi sq = 1.2; df = 1; P =0.27) or ranked CPUE (Chi sq = 0.4; df = 1; P =0.53) data were analyzed.

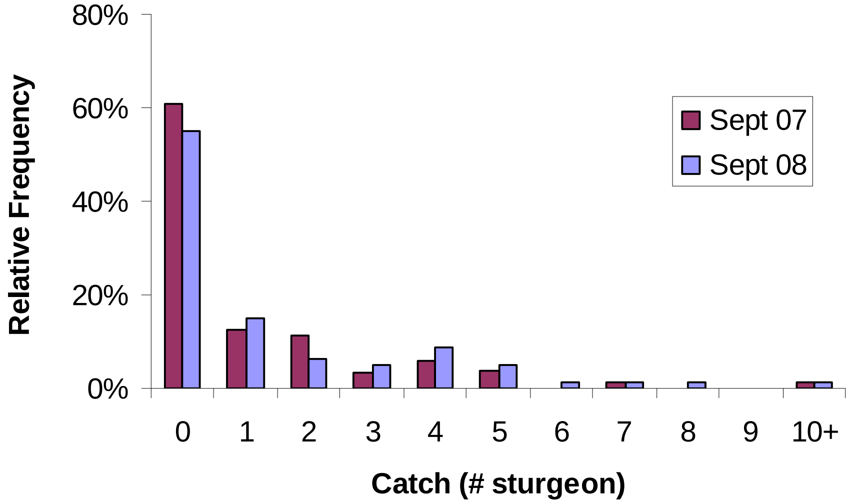

Figure 4: Comparison of relative frequencies of juvenile white sturgeon caught in the lower Fraser River in September, 2007 and 2008.

3.2 Distribution of Sturgeon

The distribution of sturgeon of all sizes caught in the lower Fraser River in Year 2 is shown on separate maps for each of the three months (**Figure 5**, **Figure 6** and **Figure 7**) to convey catch differences/similarities among months. Significantly (Chi sq = 18.2; df = 2; P < 0.0001) higher catch rates were observed in September than in June and July.

In June (**Figure 5**), for a total of 72 nets set, only 20 fish were caught in all (12.5% of the total catch), with fish captured at 18% of the sites sampled, mostly consisting of a single fish. The sites at which sturgeon were captured were widely scattered between Deas Island and the Hatzic Eddy, with other sites of capture being within the vicinity of Annacis, Barnston and Crescent islands and in the Matsqui Channel. During the June-sampling period, bottom water temperature ranged from 11.0 to 12.5 ºC.

In July (**Figure 6**), for a total of 85 nets set, only 23 sturgeon were caught (14.5% of the total catch), with fish caught at 19% of the sites (mostly a single fish). The distribution of the catch was similarly distributed to that observed in June, with sturgeon captured in the Annacis, Barnston, Matsqui and Hatzic areas, and a few scattered within the vicinity of Mission and Nicomen Island. During the July-sampling period, bottom water temperature ranged from 15.5 to 17.0 ºC.

In September (**Figure 7**), for a total of 80 nets set, 116 fish were caught (73% of the total catch), with fish caught at 45% of the sites sampled. Catches of five or more fish were taken in the areas around Annacis, Douglas and Barnston islands and the Hatzic Eddy, but most frequently in the Annacis and Hatzic Eddy areas – a maximum of 13 fish/set was recorded for the Hatzic area on 14 September. Catches of 1 to 4 sturgeon occurred within the vicinity of Port Mann Bridge, Stave, Matsqui, Mission, and Nicomen Island areas. Although the catch rates were higher in September, the overall distribution of the catch was not greatly different from that observed in June and July. During the September-sampling period, bottom water temperature ranged from 14.0 to 16.3 ºC.

For ease of comparison of the distribution of the sturgeon catch for all sizes between years, the September 2007 catch is shown in **Figure 8**. Although sampling effort in September in 2007 was not as extensive as in 2008 (see **Figure 7**), there is reasonable consistency in the distribution of the catch between years. In both years, the 'hot spots' were the Hatzic Eddy and Annacis Island areas, with several catches of five or more sturgeon taken from these sites. Smaller catches (1-4 fish) occurred within the vicinity of Deas Island, Port Mann Bridge, and Nicomen Island.

Juvenile sturgeon 300 mm long, or less, were captured at various sites between Annacis Island and Nicomen Island during June-September 2008 (**Figure 9**). 'Hot spots' at which five or more fish were captured/set included the Douglas Island, Barnston Island, and Hatzic Eddy areas. Frequent catches of 1-4 juvenile sturgeon occurred around Annacis Island, while other sites of 1-4 fish were widely scattered – Port Mann Bridge, Crescent Island, Mission, Matsqui Channel and Nicomen Island areas.

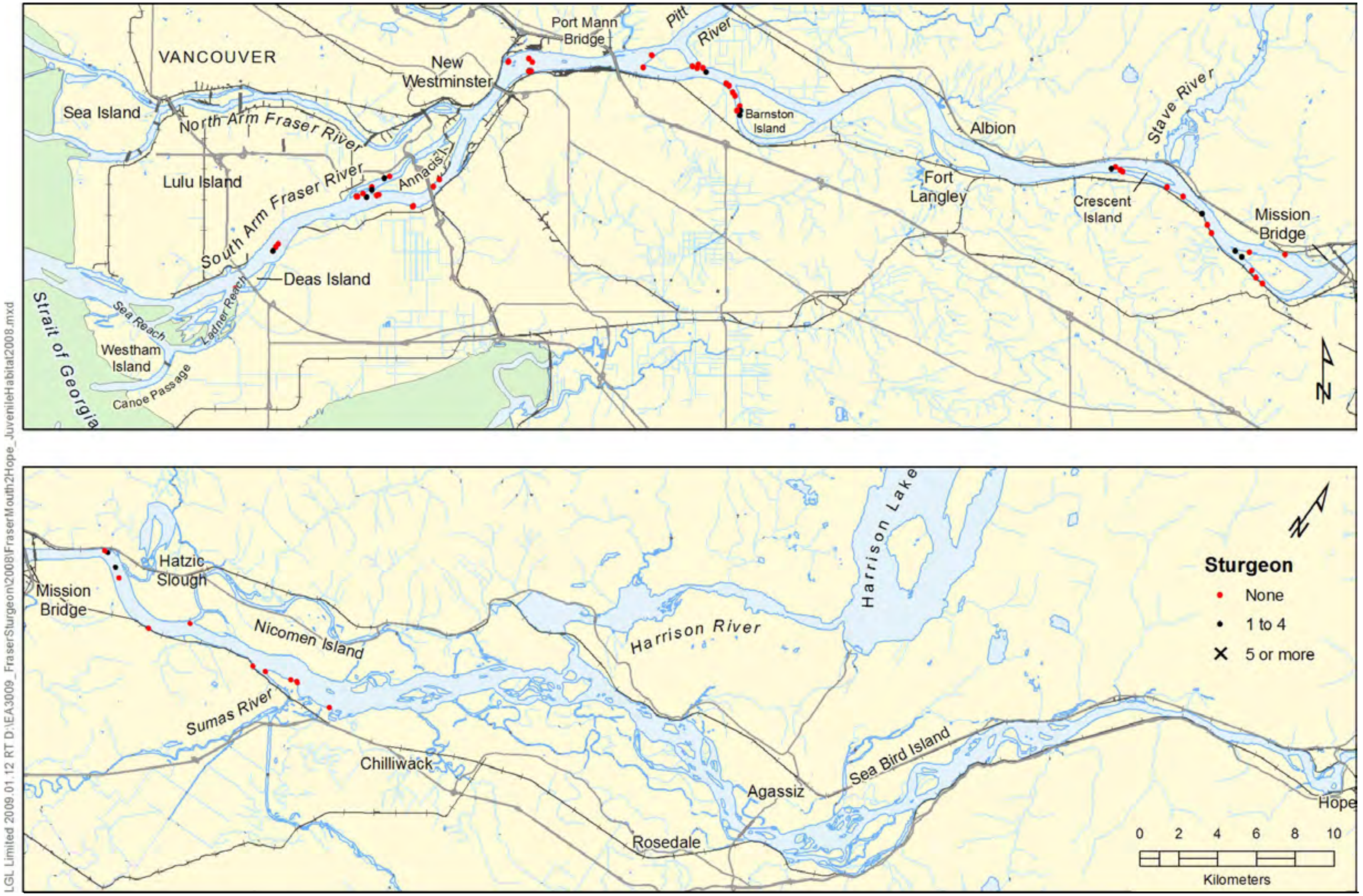

Figure 5: Sites sampled and juvenile white sturgeon caught, lower Fraser River, June 2008.

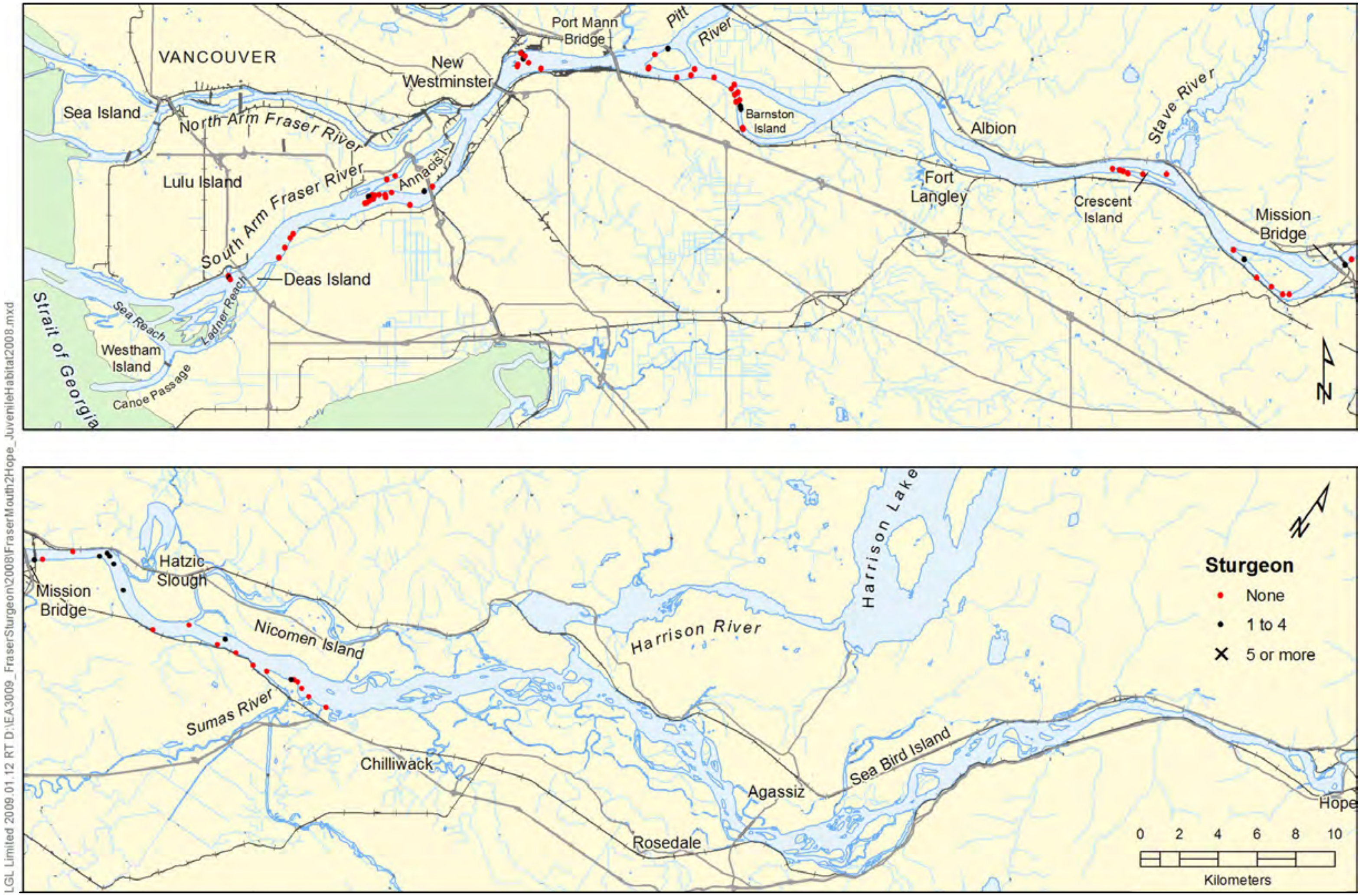

Figure 6: Sites sampled and juvenile white sturgeon caught, lower Fraser River, July 2008.

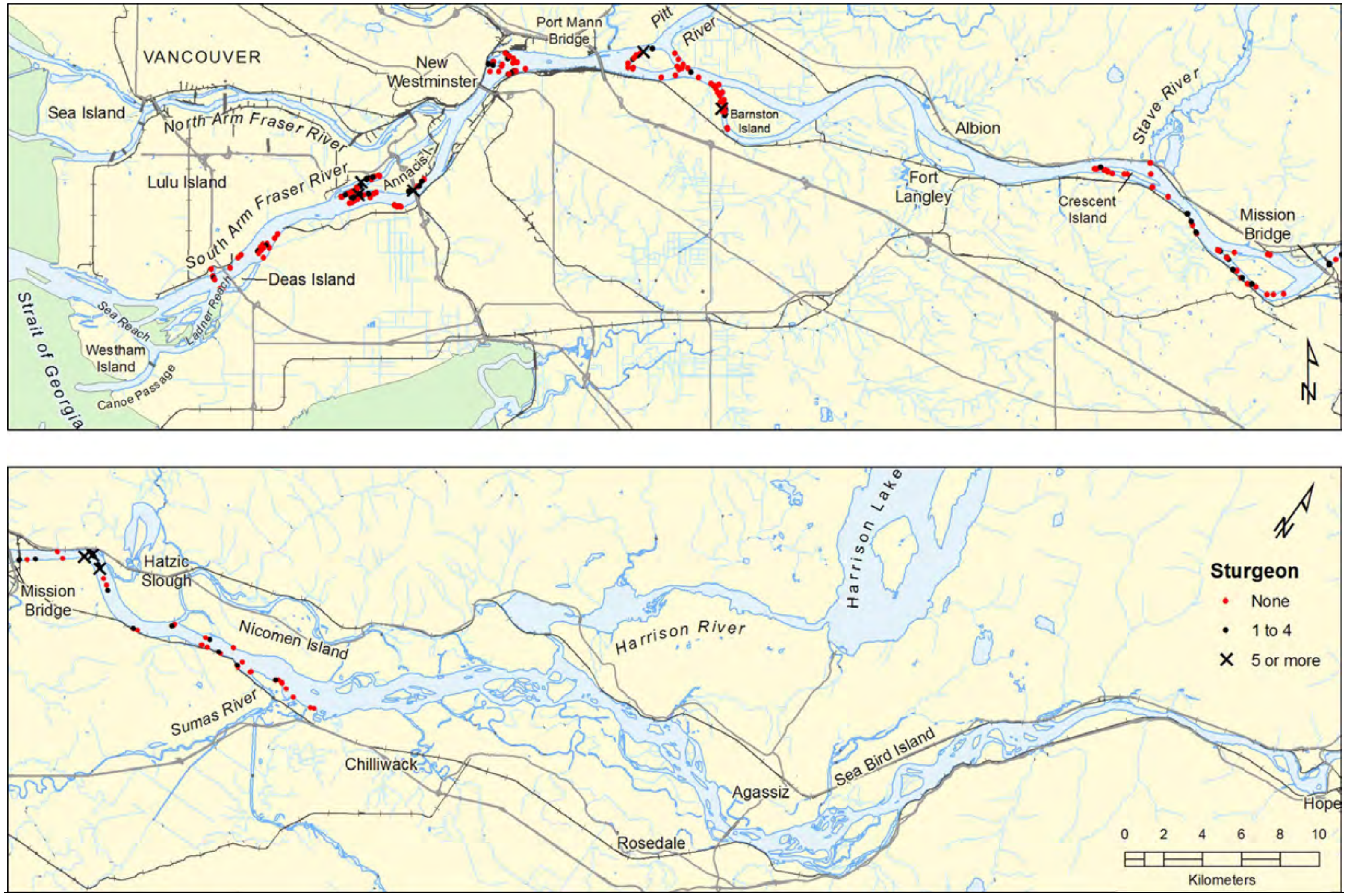

Figure 7: Sites sampled and juvenile white sturgeon caught, lower Fraser River, September 2008.

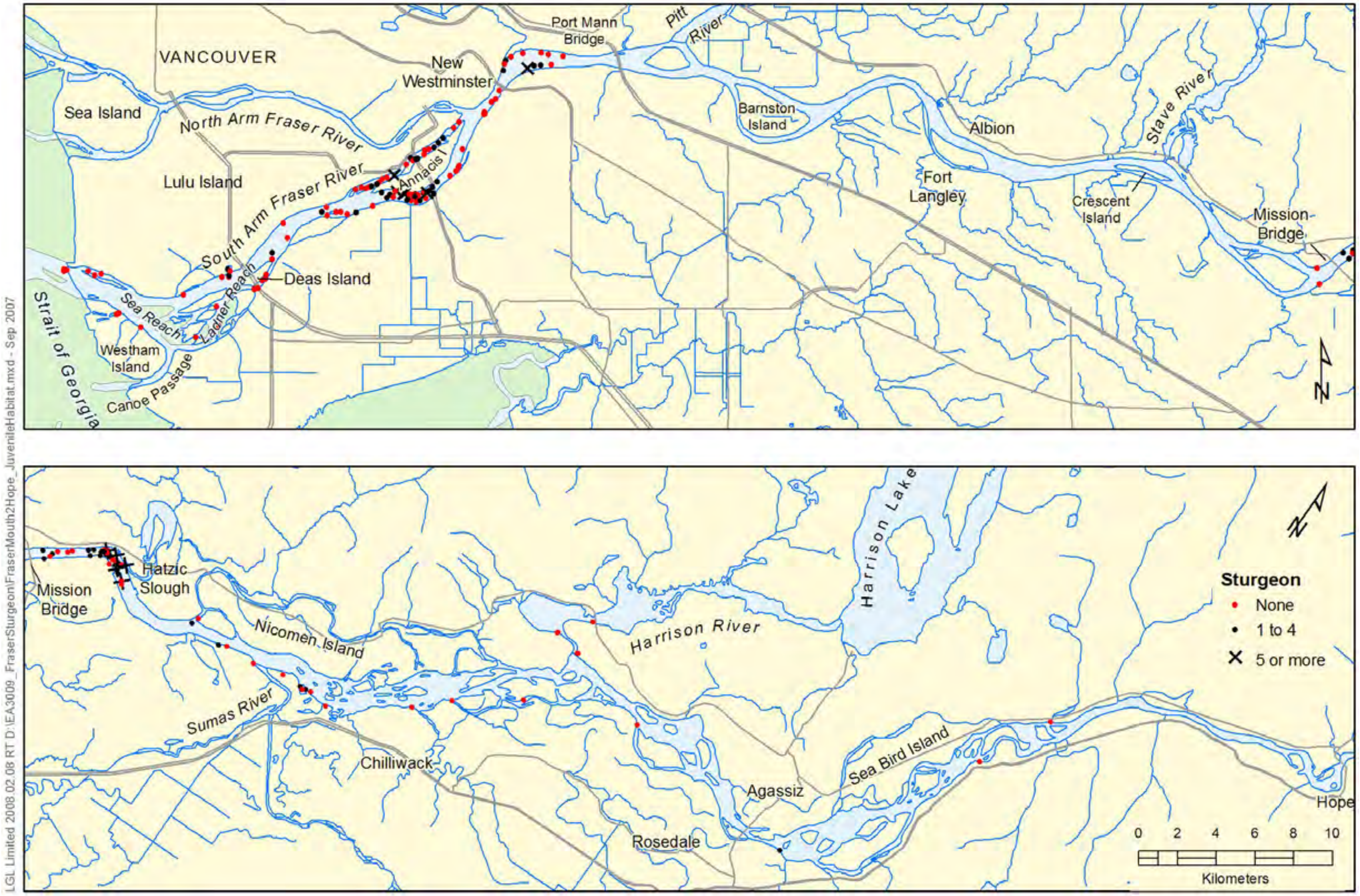

Figure 8: Sites sampled and juvenile white sturgeon caught, lower Fraser River, September 2007.

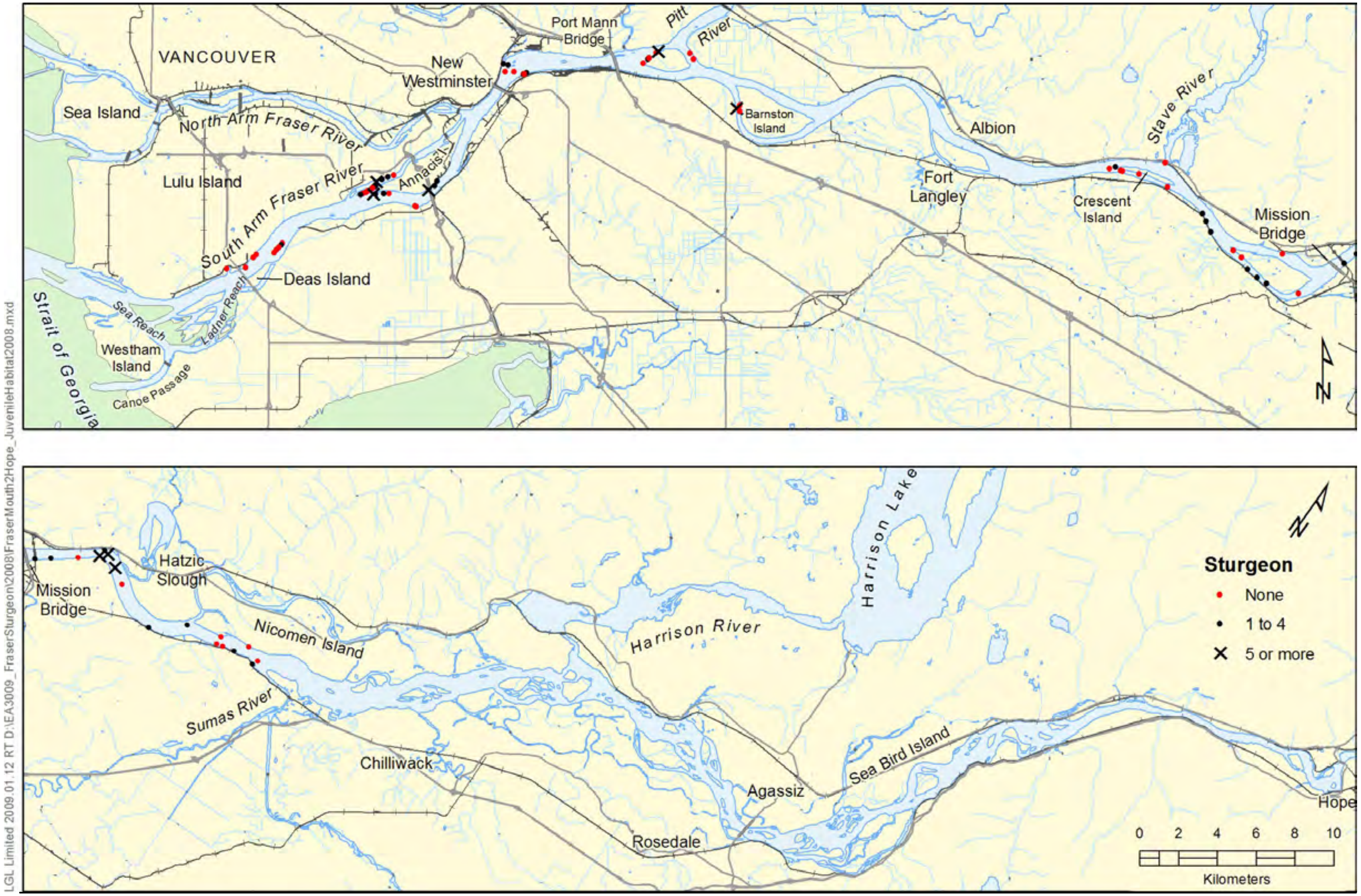

Figure 9: Sites sampled and juvenile white sturgeon caught ≤300 mm FL, lower Fraser River, June-September 2008.

A plot of the number of nets set and catch of juvenile white sturgeon for the overall study period in Year 2 (Figure 10) shows peak numbers were captured from approximately 83-86 rkm (Hatzic Eddy), with a second but smaller peak from approximately 21-23 rkm (Annacis Island). In spite of the approximately threefold greater sampling effort in the Annacis area, the peak catch did not exceed that obtained in the Hatzic area. At a few sites downstream of the Hatzic (72-81 rkm) and upstream of the Annacis (31-43 rkm), the numbers of sturgeon caught amounted to five or more fish. Most of the sampling effort in Year 2 was between 11 and 45 rkm and between 65 and 97 rkm.

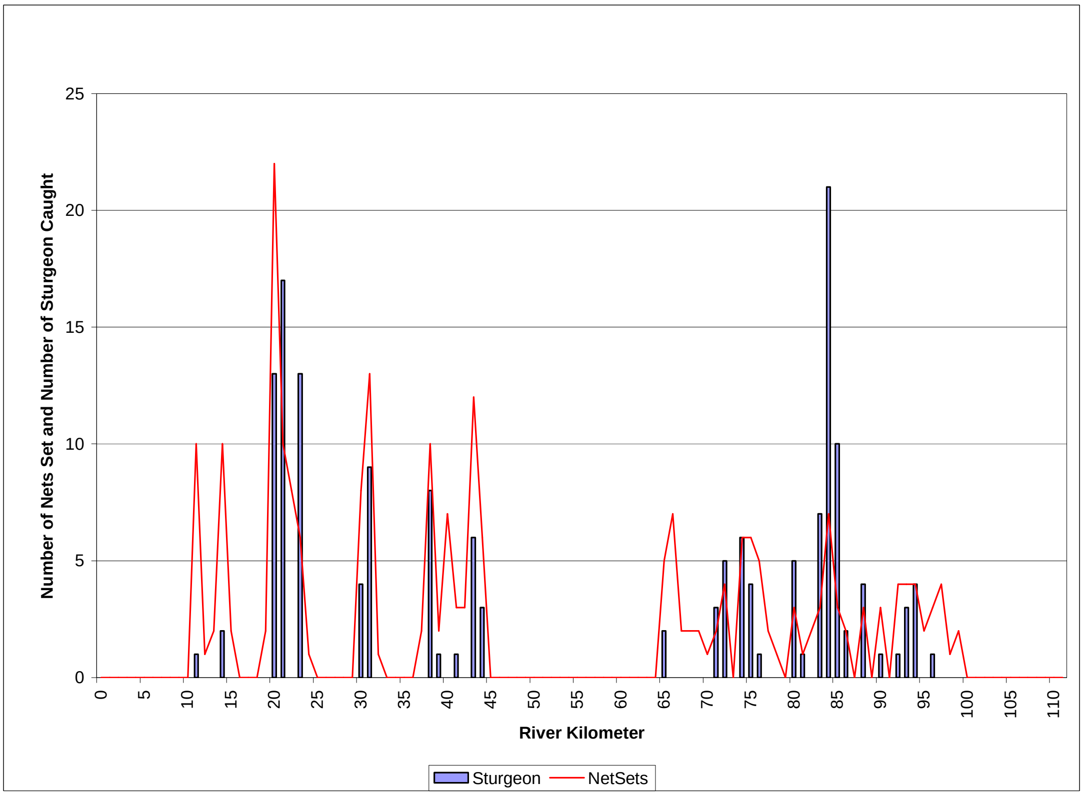

Figure 10: Plot of effort (number of nets set) and number of white sturgeon of all sizes caught in the lower Fraser River, June-September 2008.

The distribution of sturgeon <450 mm long caught during the June-September period in Year 2 (Figure 11) was very similar to that of sturgeon caught of all sizes (Figure 10), with peak numbers taken in the Hatzic and Annacis areas, and catches of five or more fish downstream of the Hatzic and upstream of the Annacis area. The numbers of sturgeon <450 mm long caught in the reach upstream of Annacis (31-43 rkm) and in the reach downstream of the Hatzic (72-81 rkm) (**Figure 11**) are similar to that shown for sturgeon of all sizes caught (**Figure 10**), indicating that most of the sturgeon in these areas were <450 mm long.

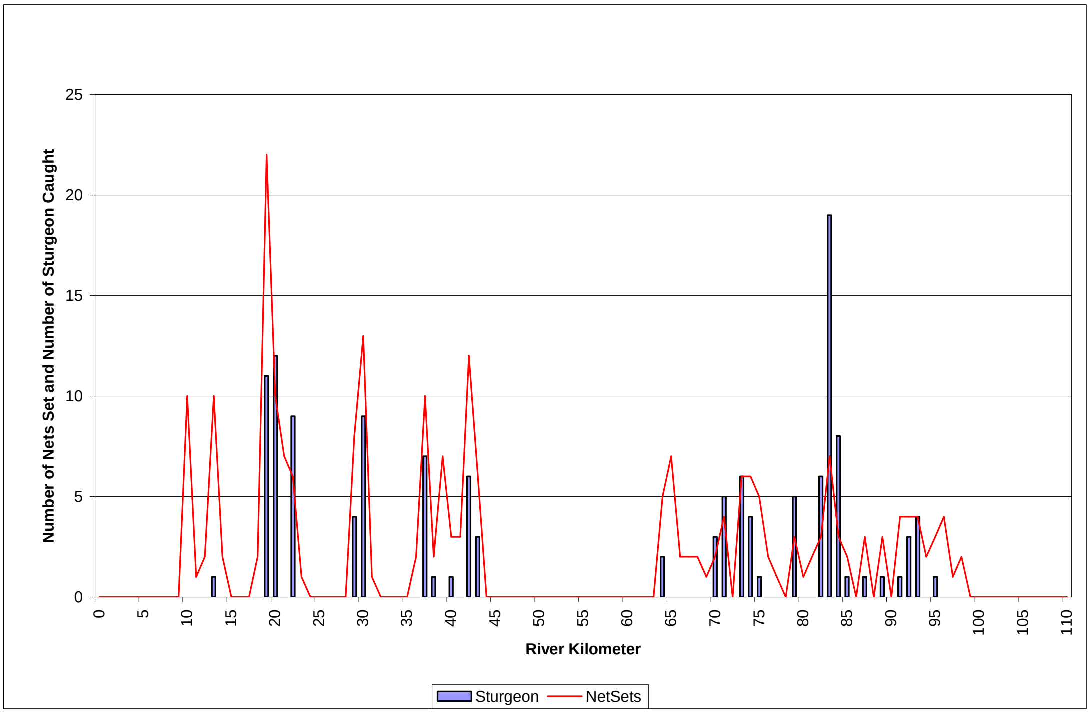

Figure 11: **Plot of effort (number of nets set) and number of white sturgeon <450 mm long caught in the lower Fraser River, June-September 2008.**

3.3 Size of Sturgeon

Sturgeon captured during the June-September period in 2008 ranged in size from 140 to 1380 mm fork length (average fork length, 337 mm). The smallest fish was caught at 29.5 rkm in the Queens Reach area (opposite Sapperton Channel) on 18 June, in main channel habitat with a soft, sandy bottom and water depth of 6 m. The bulk of the catch ranged in size from approximately 190-440 mm long (Figure 12). Very few (7 fish, 4.4% of the total) sturgeon were caught below 190 mm in length. Sturgeon less than 300 mm long made up 56.6 % of the total catch, whereas those between 300 and 450 mm in length comprised 28.3% of the total numbers caught.

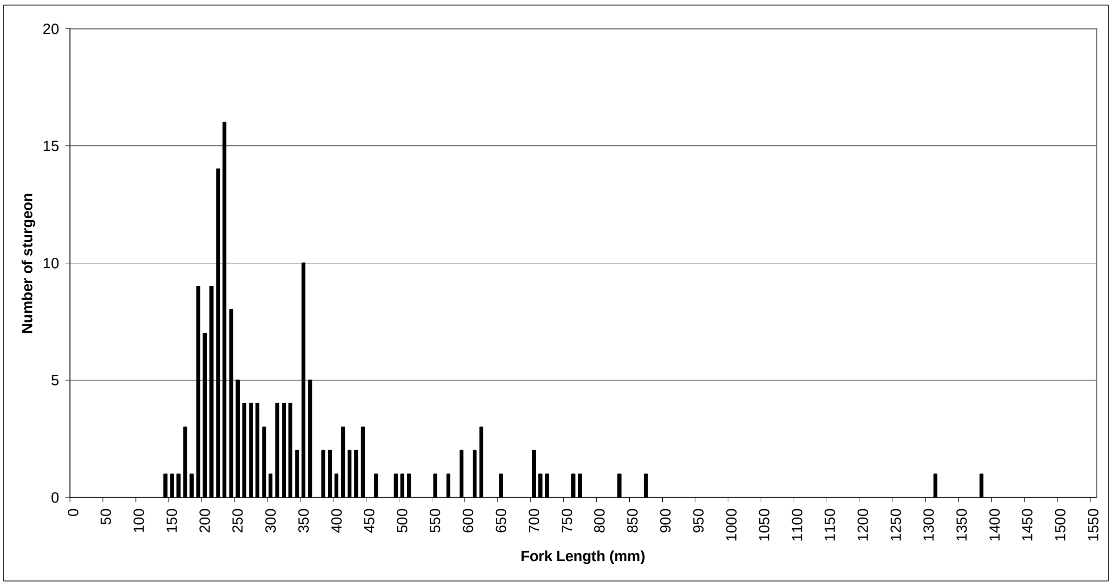

Figure 12: Size frequency of all white sturgeon caught in the lower Fraser River, June-September 2008.

A size-frequency plot of sturgeon <450 mm long caught during the June-September period (Figure 13) shows suggestive evidence of a bimodal distribution, with the main peak occurring at fish 230 mm long, and a secondary peak at fish about 350 mm long. A third peak may exist for fish somewhere between 410 and 430 mm long. An example of a small sturgeon and the habitat in which it was captured is shown in Plate 1.

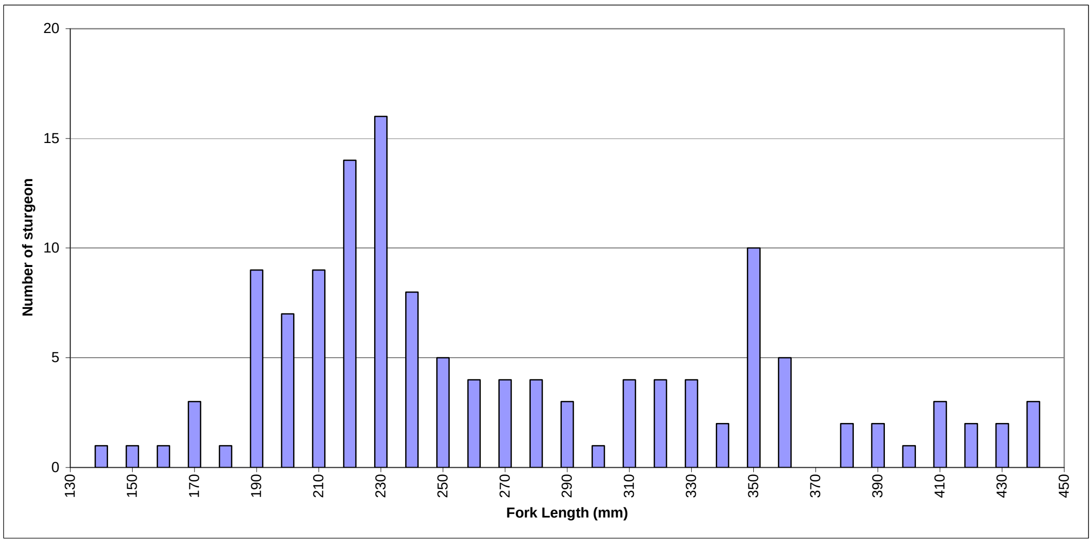

Figure 13: Size frequency of white sturgeon <450 mm long caught in the lower Fraser River, June-September 2008.

Plate 1: **Upper: juvenile white sturgeon ~180 mm fork length caught in the Hatzic Eddy area (September 2008); Lower: partial view of Hatzic Eddy area (flow from right to left) - a deep-water, main channel site used by white sturgeon of all sizes - lower Fraser River, September 2008.**

The size distribution of all sturgeon caught in the reach from Deas Island to Mission (Mission Bridge) was similar to that of the fish caught in the study reach upstream of Mission (not shown). For both reaches, most of the fish were <450 mm long (83.3% and 85.7% above and below Mission, respectively). Size frequency plots of sturgeon caught <450 mm long (in 10 mm size groups) for both above and below Mission (Figure 14) suggest the existence of three year classes for both reaches, although the pattern is more pronounced for the reach below Mission. There were considerably higher catches of sturgeon 210-240 mm long in the reach below Mission than above Mission.

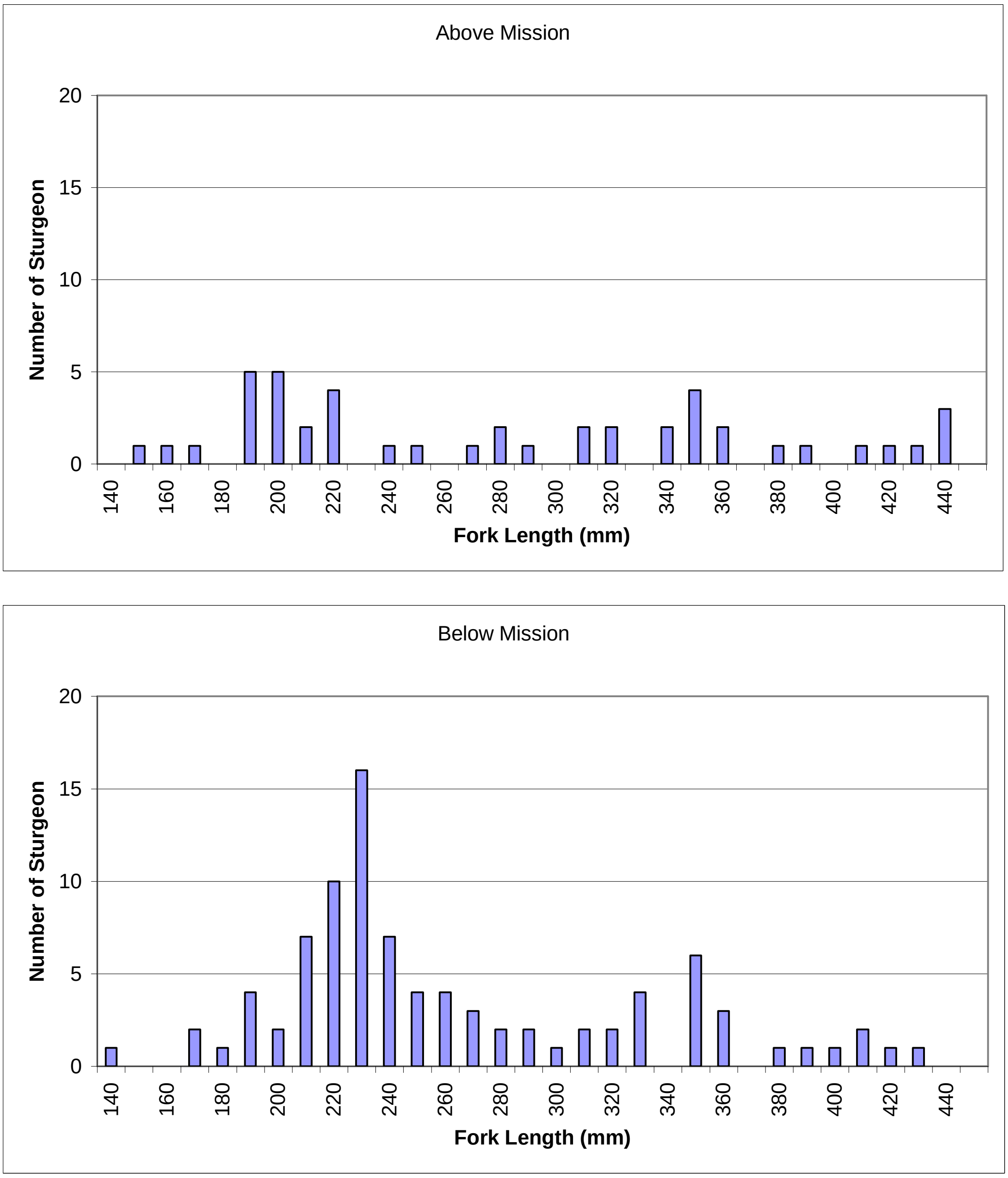

Figure 14: Size frequency of juvenile white sturgeon <450 mm long caught above and below Mission, lower Fraser River, June-September 2008.

3.4 Age of Young Sturgeon

The age of young sturgeon determined from first pectoral fin ray samples is shown in Table 2. Of the total 23 sturgeon that were aged, ranging in size from 165-372 mm fork length, all but two (8.7%) were age 1^+ ; one fish (200mm long) was concluded to be age 2^+ and one other (320 mm long) age 3^+. Although the age 2^+ fish was within the fork length range of age 1^+ fish, on the basis of the annuli present it was age 2^+. With the exception of this particular individual, among the sample of fish aged, fish ranging from 165-250 mm fork length were age 1^+. An outlier was a fish 372 mm long, which on the basis of the number of annuli present, was age 1^+.

There was no evidence of any age-0 fish among the sample of fish aged. Also, there was no difference in the age determinations of fish for given lengths between the live and dead fish samples; this is to be expected, since the number of annuli was found to be the same for sections taken anywhere from the basal to distal end of a ray.

Table 2 : Age of young white sturgeon determined from first pectoral fin ray samples, lower Fraser River, 2008.

Fork Length (mm)	No. Annuli*	Final Age
	Live Fish, *N* = 14	
183	1(1+)	1
190	1(1+)	1
198	1(2)	1
205	1(1+)	1
209	1(2)	1
212	1(2)	1
215	1(1+)	1
215	1(1+)	1
217	1(1+)	1
220	1(1+)	1
220	1(1+)	1
224	1(2)	1
250	1(1+)	1
320	3(3+)	3
	Dead Fish, *N* = 9	
165	1(2)	1
200	2(3) 1?	2
215	1(2)	1
215	1(2)	1
217	1(1+)	1
220	1(2)	1
230	1(1+)	1
232	1(2)	1
372	1(2)	1

* first number is age of fish on 1st January birthdate; number in brackets = number of annual zones and any visible plus growth

3.5 Other Fish Species

Non-sturgeon native fish caught during the field sampling program in Year 2 consisted of three fish species/categories (see table in Appendix): northern pikeminnow (*Ptychocheilus oregonensis*), sculpins (Cottidae), and peamouth chub (*Mylcheilus caurinus*), which comprised 65.2%, 10.7% and 6.1%, respectively, of the total 990 native fish (including sturgeon) captured. Of the total 831 non-sturgeon native fish caught, 20.9%, 30.6% and 48.5% were captured in June, July and September, respectively. The significance of the catch of each of these three fish species/categories in relation to the sturgeon catch is tested statistically in the following section. No non-native fish were caught at the sites sampled in Year 2.

3.6 Significance of Environmental Variables

Data from the 237 tangle-net sets in Year 2 were used to calculate the Spearman-rank correlations between sturgeon catch and five habitat variables: surface water temperature, water depth, sculpin catch, peamouth chub catch, and northern pikeminnow catch (Table 3). The relationship between surface water temperature and sturgeon catch was non-significant due to the low numbers caught in July (Figure 15), whereas that between water depth and sturgeon catch was statistically significant after the Bonferroni adjustment (Table 3), with the highest catch (13 fish) occurring in the deepest (18.6 m) water sampled (Figure 15). None of the relationships between the catch of non-sturgeon native species and that of sturgeon were statistically significant, although that of sculpins was close to being significant (Table 3; Figure 16). Similar results were observed regardless of whether ranked catch data or ranked CPUE data were analyzed (Table 3).

Similar results were obtained when sturgeon catch numbers were treated as 'present' (Catch $\geq$1) or 'absent' (Catch = 0). Logistic regression models were constructed to describe the probability of sturgeon presence as a function of the five habitat variables. Water depth showed a statistically significant (Table 4) relationship with the presence/absence of sturgeon. The relationship with sculpin catch was relatively strong, but was not statistically significant after the Bonferroni adjustment (Table 4).

Table 3 . Spearman rank correlation coefficients (r_s), and *P*-values, for relationships between Sturgeon Catch (either as raw catch values, or as CPUE) and 5 habitat variables in 237 tangle-net sets performed during June-September, 2008. Statistically significant *P*-values are shown in bold. Also shown are the minimum and maximum observed values for each of the 5 variables.

			Catch		CPUE (fish/hr)	
Variable	Min	Max	r_s	*P*	r_s	*P*
Surface Temperature (°C)	11.5	17.5	-0.001	0.99	0.008	0.90
Depth (m)	2.1	18.6	0.218	**0.0007**	0.215	**0.0011**
Sculpin Catch	0	12	-0.115	0.08	-0.123	0.06
Peamouth Chub Catch	0	9	0.095	0.15	0.105	0.11
Pikeminnow Catch	0	23	-0.034	0.61	-0.058	0.39

Table 4. Parameter estimates, model tests (chi sq) and *P*-values for logistic regressions describing the probability of sturgeon presence as a function of 5 habitat variables in 237 tangle-net sets performed during June-September, 2008. *P*-values in bold were statistically significant after the Bonferroni adjustment.

Variable	intercept	slope	Chi sq.	*P*
Surface Temperature (°C)	-1.76	0.05	0.5	0.49
Water Depth (m)	-2.85	0.33	17.4	**<.0001**
Sculpin Catch	-0.84	-0.29	4.2	0.04
Peamouth Chub Catch	-0.98	0.14	1.1	0.30
Pikeminnow Catch	-0.79	-0.05	1.9	0.16

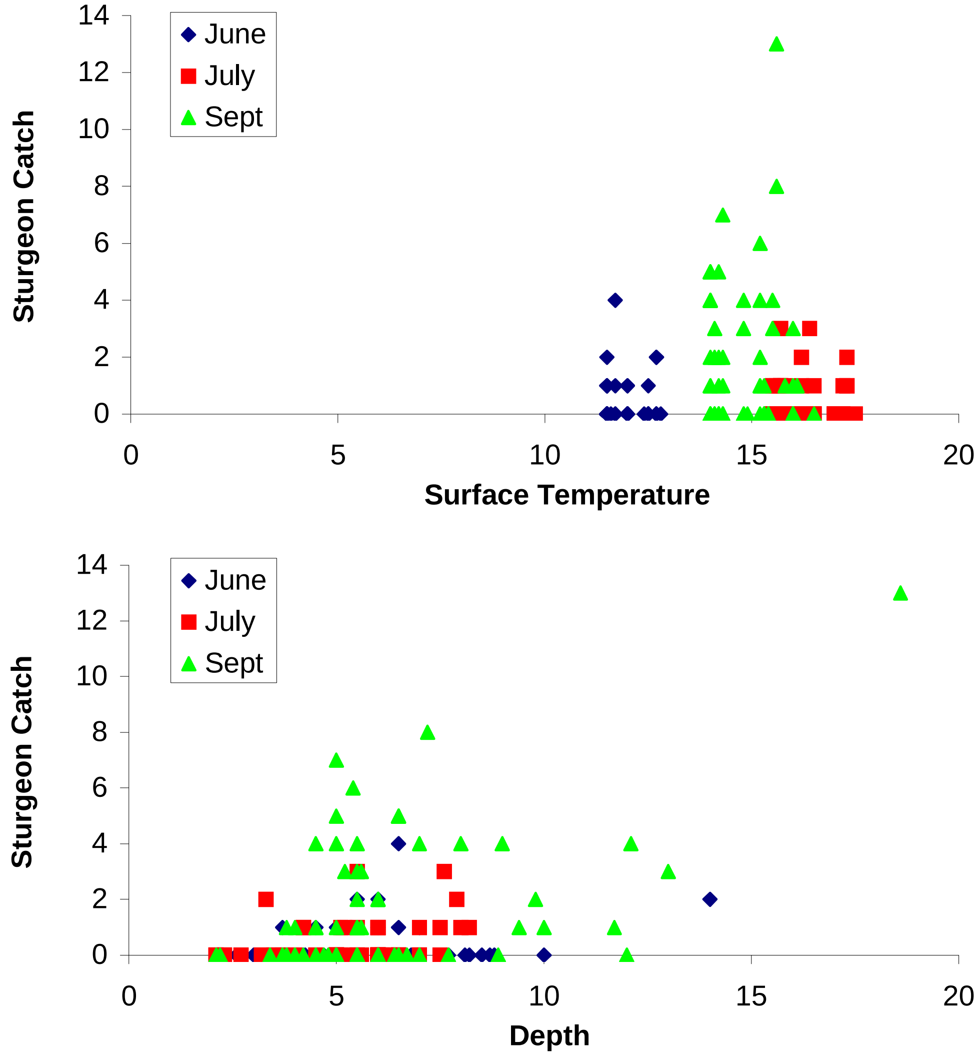

Figure 15: **Scatter-plots of sturgeon catch as a function of surface water temperature (°C) and water depth (m), lower Fraser River, June-September 2008.**

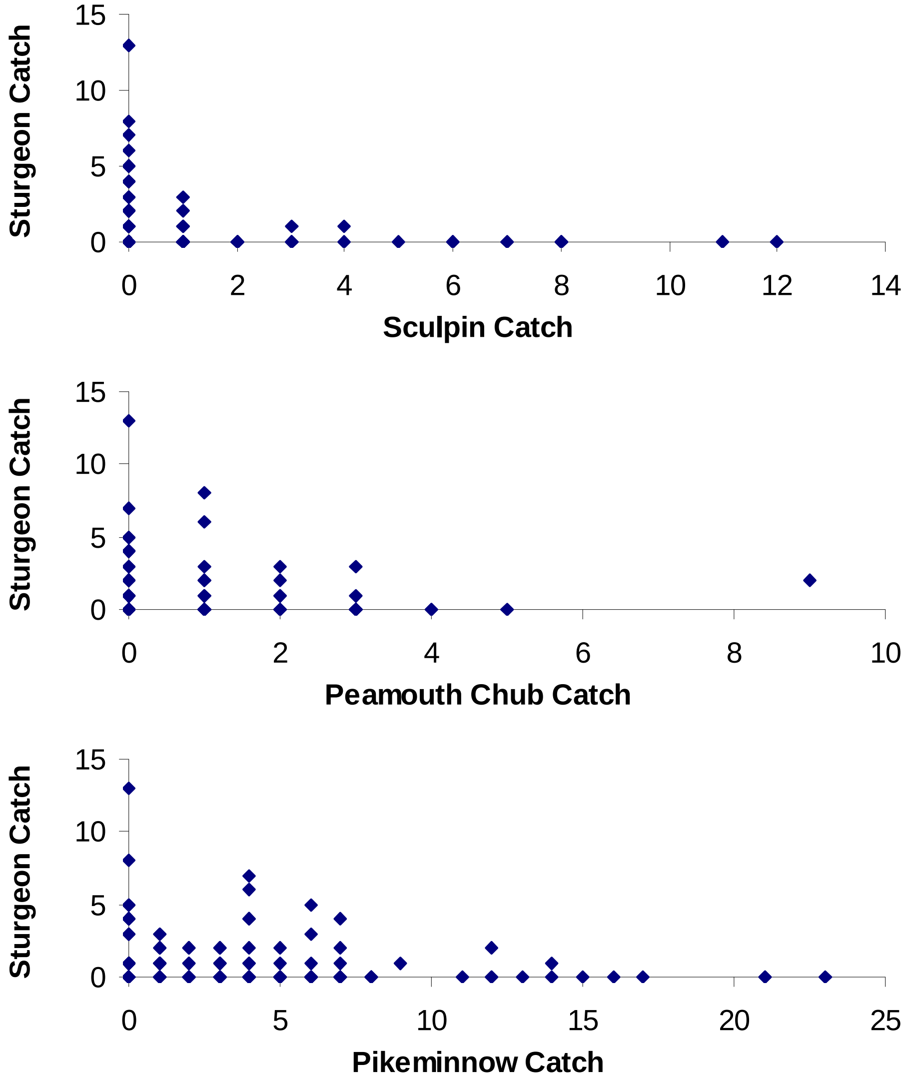

Figure 16: Scatter-plots of sturgeon catch as a function of catch of the three most common bycatch species: sculpins, peamouth chub, and northern pikeminnow, lower Fraser River, June-September 2008.

Plots of the relative frequency of sturgeon catch in relation to substrate types are shown in Figure 17. There was no significant effect of substrate, either on ranked sturgeon catch (Chi sq = 0.9; df = 2; P = 0.63), or on ranked sturgeon CPUE (Chi sq = 1.8; df = 2; P = 0.4), although fish were more frequently caught on a mix of silt and sand. Very rarely, a sturgeon was caught on a mix of sand/gravel substrate.

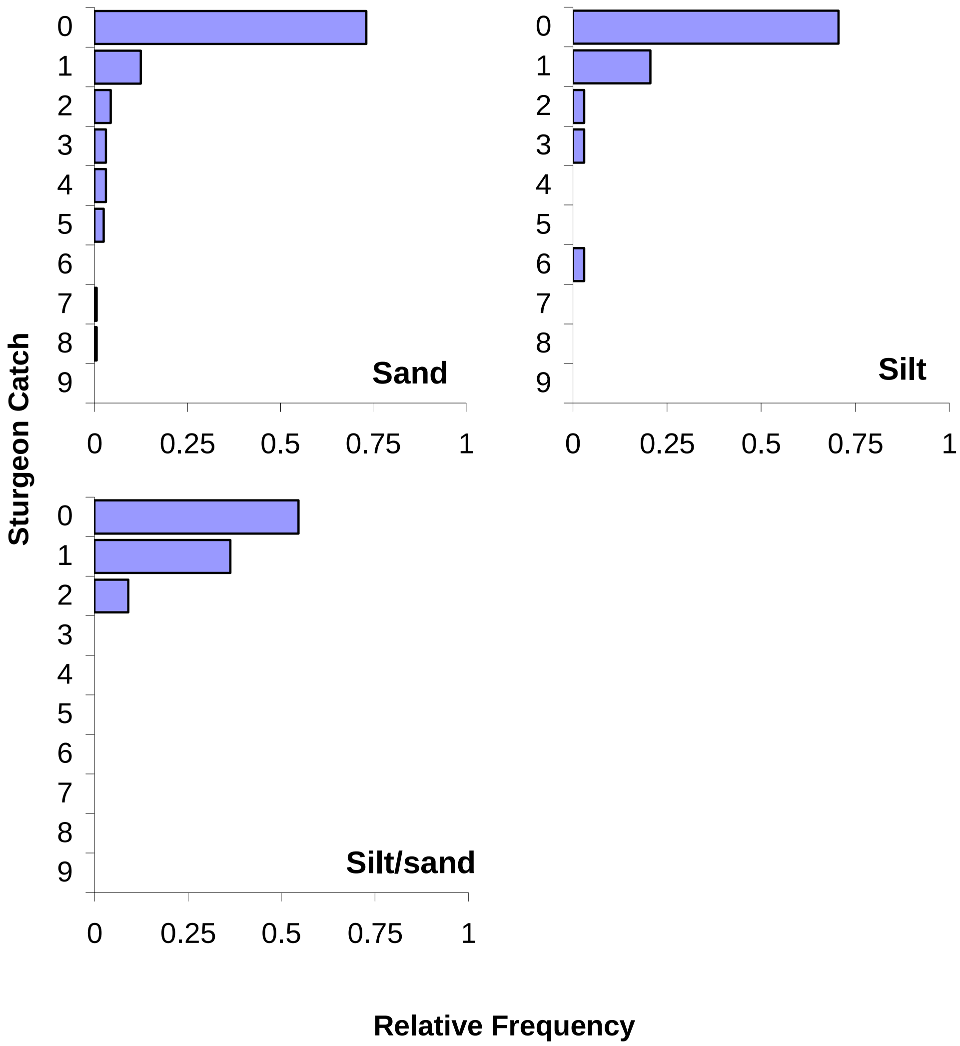

Figure 17: Relative frequency of juvenile sturgeon catch by substrate type, for substrates with n >10, lower Fraser River, September2007-March 2008.

4. Discussion

Two years of sampling of the juvenile sector of the subpopulation of white sturgeon in the lower Fraser River (from the mouth to Harrison River confluence) has provided fairly consistent results of the distribution and habitats used by sturgeon. From the main findings for which there is reasonable consistency between the two study years, it can be summarized that juvenile sturgeon:

- are widely scattered from Deas Island to the Sumas River area, with preferred sites being the Annacis and Hatzic areas, and to some extent the Port Mann Bridge, Barnston, Stave, and Matsqui areas; and

- they occur in a wide range (~1-26 m) of water depths, but more commonly are found in areas 3-15 m deep, with slow to moderate water velocities (range 0.1-0.5 m/s near the bottom), and fine substrates (silt, and a mix of silt and sand) in side channels, side pools, backwaters, and mainstem channels.

Similar physical habitat characteristics of sites occupied by juvenile sturgeon have been reported by others from studies conducted in the lower Fraser River (e.g., Lane and Rosenau 1993) and lower Columbia River (Parsley et al. 1993). Similarly, within the upper Columbia River (on the Canadian side), juvenile sturgeon have been found to occur mainly in the deeper and slower-flowing areas such as the lower reaches and confluences of tributaries, large backwaters, side channels and sloughs (Failing and Gregory 2003; Bennett et al. 2005) and deep, slow-flowing mainstem areas (RL & L 2000; Golder 2003; Neufeld and Spence 2004). In several of the lower Columbia River reservoirs, although sturgeon were caught at all depths (by gill netting), a greater proportion of the catch occurred at depths from 10-30 m (North et al. 1993). These authors noted that catches of white sturgeon in reservoirs were generally greater in the tailraces (a preference possibly related to feeding) and declined with distance downstream.

The exceedingly low catches of juvenile sturgeon (0.28 fish/set) in June and July in 2008 were unexpected. Water temperatures then (11-17 °C) were within the range (9-19 °C) for which higher catches were recorded during September-November 2007 (Glova et al. 2008). Although sturgeon catches drop off markedly as temperatures declined during winter (December-March, 0.1 sturgeon/set; Glova et al. 2008) - a response well documented for sturgeon in lower Columbia reservoirs (Brad Cady, WDFW, pers. comm.), during summer, however, higher catches can be expected. The most likely explanation for the paucity of sturgeon caught in June and July was the influence of prevailing high flows due to freshets and heap tides with strong outgoing currents; such conditions undoubtedly affected tangle netting efficiency and may have affected sturgeon distribution/behaviour.

The response of juvenile sturgeon to flood conditions is virtually unknown, but, presumably they seek out areas with appropriate cover (e.g., marginal areas of channels, backwaters, side channels, debris clusters), or hold within the interstices of the bed in the area in which they were present preceding a flood. Of the sturgeon caught in the reach below Mission in June and July, approximately 50% were in side channels; of those caught in the reach above Mission, 96% were in backwaters and sidepools. Interestingly, the catch of non-sturgeon native species (northern pikeminnow, peamouth chub, and sculpins) was not drastically lower in June and July, which accounted for 20.9% and 30.6%, respectively, of the total 831 individuals captured during June-September, 2008. Although these fish were fairly abundant, none of the relationships between the catch of these species and that of sturgeon was significant.

The results of age determination from pectoral fin ray samples indicate that in all likelihood no age-0 (young-of-year; y-o-y) sturgeon were captured during this two year study. Sturgeon ranging from 165-250 mm fork length were determined to be age 1^+ by an experienced fish aging analyst; fish aging by one experienced reader has been found to be more precise and accurate than by combined efforts of several readers (Flain and Glova 1988; Bilton et al. 1983). An exception to our above age determinations was a fish 372 mm long, which, on the basis of the number of annuli present, was age 1^+. The smallest sturgeon captured during this study was 140 mm fork length, and although not aged, almost certainly was age 1^+. Some outside supportive evidence for our findings comes from a sturgeon 180 mm long captured toward mid July 2007 in one of the fish wheels operated at the Mission railway bridge by LGL Limited. Since spawning of white sturgeon may occur in May and June (Scott and Crossman 1973; Triton 2004), and most likely in June or July following peak freshet (RL&L 2000), at the time of capture this fish almost certainly was age 1^+

In contrast to our findings that sturgeon 140-250 mm in length in the lower Fraser River are age 1^+ fish, Washington researchers (McCabe and Tracy 1994; Ruth Farr, unpubl. data, pers. comm.) maintain that sturgeon up to 180 mm in length in the lower Columbia River system by end of September are age 0^+ fish. These differences suggest that growth of young sturgeon in the Fraser River is not as rapid, though it is difficult to appreciate why they should be so much slower considering that the thermal and food regimes of these two adjacent systems are probably not that different.

As it is now confirmed that no y-o-y sturgeon were sampled in this two year study, for management, protection and conservation purposes of this endangered subpopulation of white sturgeon in the Fraser River, it is important that the distribution and habitat requirements of y-o-y fish be given high priority in future study.

5. Conclusion

Two years of fairly extensive sampling has provided reasonably consistent evidence that the juveniles of this subpopulation of white sturgeon in the lower Fraser River are widely scattered from Deas Island to the Sumas River area, with preferred sites being the Annacis and Hatzic areas, as well as the Port Mann Bridge, Barnston, Stave, and Matsqui areas. They occupy a wide range of water depths (1-26 m), but more frequently are found in areas 3-15 m deep, with slow to moderate water velocities (0.1-0.5 m/s), and fine substrates (silt, and a mix of silt and sand) in side channels, side pools, backwaters, and mainstem channels.

Because of exceedingly low catch rates during winter when water temperatures were below 7 °C, information specifically on where juvenile sturgeon spend the winter was not documented. Sampling during May (before the onset of high flows in June/July) may fill this gap in juvenile sturgeon life history.

6. Recommendations

The emphasis in Year 2 was to fill in gaps in sampling in Year 1 and provide some comparison of the variability of the findings between years. These gaps (i.e., sampling earlier in the season – June/July – and age determination of small sturgeon) have been filled and some appreciation of inter-annual variability of the results is now available. Reasonable consistency was obtained in the findings on distribution and habitat use of juvenile white sturgeon in the lower Fraser River between the two study years.

Still remaining, however, is the almost complete gap in knowledge of the distribution and habitat use of young-of-year (y-o-y) sturgeon in the lower Fraser River. From the results of age determinations in Year 2, it is evident that no y-o-y sturgeon were sampled during the two years of study. To fill the gap in knowledge of the distribution and habitat requirements of y-o-y sturgeon, it is recommended that the following sampling efforts should be considered in Year 3:

- Conduct tangle netting with smaller mesh nets (1”) in various sites between Deas Island and the Harrison River during September-November in 2009, as it is possible that y-o-y sturgeon were present in the study area but missed capture by the 2” mesh nets used in the first two study years.
- Conduct sampling in May 2009 with 2” mesh nets to provide information on juvenile sturgeon post-winter habitat use; sampling in June 2008 was unsuccessful due to high flows and dirty water (frequent freshets).
- Conduct sampling with both 1” and 2” mesh nets in May-September in the central Fraser Valley (upstream of the Harrison River) with a focus on gravel habitats.
- Pilot alternative sampling methods (traps, trawls) and techniques in an attempt to locate and collect age-0 white sturgeon and document their preferred rearing habitats.

7. Acknowledgments

We gratefully acknowledge and appreciate the funding received for this study from the following sources:

BC Ministry of Environment
Fisheries and Oceans Canada, Species at Risk Program – Aboriginal Involvement
Fisheries and Oceans Canada, Habitat Stewardship Program
Fraser River Sturgeon Conservation Society
Vancouver Foundation, Environment Advisory Committee

Many people contributed to this study to whom we express our sincere thanks: Erin Stoddard of MOE for his continued support and interest; Rick Hansen for his unfailing interest, support, and enthusiasm in all phases of the work; Robin Tamasi for GIS mapping; David Robichaud for statistical analyses; Darlene Gillespie, Pacific Biological Station, Nanaimo, for sturgeon age determinations; Ralph Roberts for his role as Field Crew Coordinator and Field Team Leader of the lower river crew; Rennie Matson for technical assistance and use of his fishing boat for sampling in the lower river; Troy Ganzeveld for his duties as Field Team Leader of the upper river crew and use of his boat; Kelsey Ned for technical assistance with the upper river crew; and Jim Rissling for assistance with PIT tagging equipment and PIT tag data management.

8. References

Bennett, W.R., G. Edmundson, E.D. Lane, and J. Morgan. 2005. Juvenile white sturgeon (*Acipenser transmontanus*) habitat and distribution in the Lower Fraser River, downstream of Hope, BC, *Canada. Journal of Applied Ichthyology 21*: 375-380.

Bilton, H.T., M. Flain, D.H. Lucas, P. Kearton, and R. Gard. 1983. Tests on the accuracy of ageing New Zealand quinnat salmon (*Oncorhynchus tshawytcha*) from their scales. Canandian Technical Report of Fisheries and Aquatic Sciences 1199. 16 p.

Flain, M. and G.J. Glova. 1988. A test of the reliability of otolith and scale readings of chinook salmon (*Oncorhynchus tshawytcha*). New Zealand Journal of Marine and Freshwater Research 22: 497-500.

Glova, G., T. Nelson, K. English, and T. Mochizuki. 2008. A preliminary report of juvenile white sturgeon habitat use in the lower Fraser River, 2007-2008. Prepared for the Fraser River Sturgeon Conservation Society, Vancouver, BC.

Golder Associates Ltd. 2003. Upper Columbia River juvenile white sturgeon monitoring, Phase 1 investigations, fall 2002. Report prepared for BC Hydro, Castlegar, BC.

Lane, E.D. and M.L. Rosenau. 1993. The conservation of sturgeon stocks in the lower Fraser River watershed. A baseline investigation of habitat, distribution, age and population of juvenile white sturgeon (*Acipenser transmontanus*) in the lower Fraser River, downstream of Hope. BC Habitat Conservation Fund Project – Final Report.

McCabe, G.T., Jr., and C.A. Tracy. 1994. Spawning and early life history of white sturgeon, *Acipenser transmontanus*, in the lower Columbia River. *Fishery Bulletin 92 (4)*: 760-772.

Nelson, T. C., W.J. Gazey, and K. K. English. 2007. Status of white sturgeon in the lower Fraser River: Report on the findings of the Lower Fraser River White Sturgeon Monitoring and Assessment Program 2006. Report prepared for the Fraser River Sturgeon Conservation Society, Vancouver, BC.

Nelson, T. C., W.J. Gazey, and K. K. English. 2008. Status of white sturgeon in the lower Fraser River: Report on the findings of the Lower Fraser River White Sturgeon Monitoring and Assessment Program 2007. Report prepared for the Fraser River Sturgeon Conservation Society, Vancouver, BC.

Neufeld, M.D., and C.R. Spence. 2004. Kootenay Fisheries Investigations Sturgeon and Burbot Progress, 2002-03. Ministry of Water, Land and Air Protection, Nelson, BC.

North, J.A., R.C. Beamesderfer, and T.A. Rien. 1993. Distribution and movements of white sturgeon in three lower Columbia reservoirs. *Northwest Science 62 (2)*: 105-111.

Parsley, M.J., L.G. Beckman, and G.T. McCabe, Jr. 1993. Habitat use by spawning and rearing white sturgeon in the Columbia River downstream of McNary Dam. *Transactions of the American Fisheries Society 122*: 217-227.

RL&L. Environmental Services Ltd. 2000. Fraser River white sturgeon monitoring program – comprehensive report (1995- 1999). Final report prepared for BC Fisheries. R.L. & L. Report No. 815F: 92 p + appendices.

Scott, W.B., and E.J. Crossman. 1973. Freshwater Fishes of Canada. *Bulletin 184*. Fisheries Research Board of Canada, Ottawa. 966 pp.

Triton Environmental Consultants Limited. 2004. Adult white sturgeon monitoring – Nechako River 2004. Report prepared for Alcan Primary Metal, Kitimat, BC.

Appendix

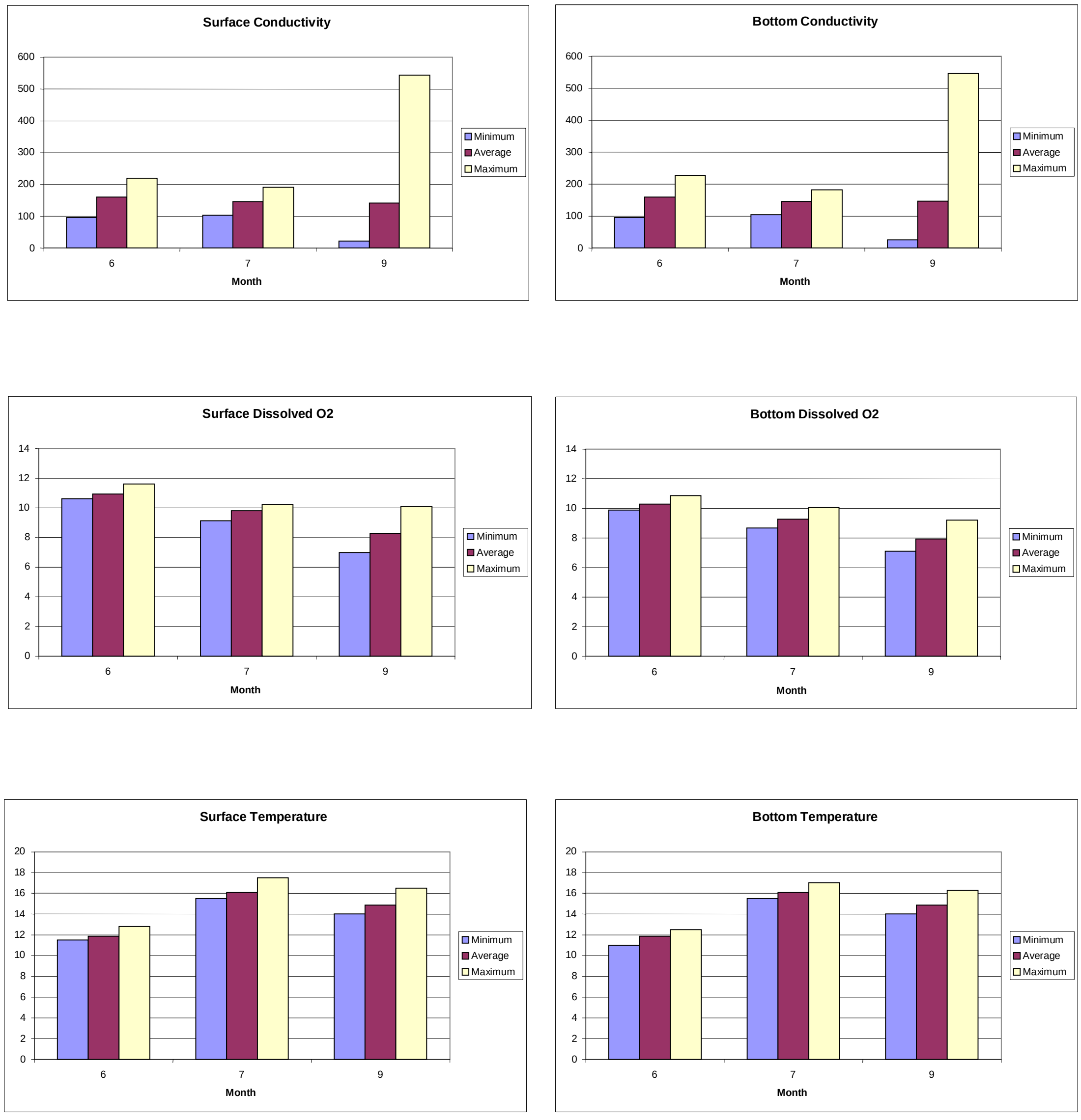

Figure 1: Plots of water quality parameters measured at sites sampled in the lower Fraser River, June-September 2008.

Table 1: Catch of non-sturgeon native fish species in lower Fraser River, June-September 2008.

Species	Number of fish
Pike minnow	645
Sculpin	106
Peamouth chub	80
	831

Field Data Form

FRASER RIVER STURGEON CONSERVATION SOCIETY
JUVENILE WHITE STURGEON HABITAT SURVEY

FAX to Tony Mochizuki: 250-655-4761 (phone: 250-656-0127)
Page:______ of ________

Name of Person that Recorded Data: ____________________________ Weather: ________________________________

Date (dd/mmm/yy)__________________ Location:____________ River km:____________ Tidal level: low med high

UTM:__________ ____________ Latitude:____________ Longitude:____________ Tide direction: incoming outgoing flood ebb

Time net in:__________________ Time net out:____________ Soak time:____________ Photo taken:____________________

Habitat Information General description: ____

Habitat type (circle one): mainstem mainstem pool sidepool backwater side channel slough other (specify) ____________ LWD ☐ SWD ☐

Surface temp (C):________ Bottom temp (C):________ Depth (m):____________ Surface velocity (m/s):____________ Bottom velocity (m/s):________

Substrate (circle): mud silt sand gravel cobbles boulders bedrock other (specify) _______________ Bottom condition: soft / hard

Surface dissolved O_2 (mg/l):____________ Surface salinity (‰):____________ Surface conductivity (mS/cm):____________ Turbidity:____________

Bottom dissolved O_2 (mg/l):____________ Bottom salinity (‰):____________ Bottom conductivity (mS/cm):____________ TDS (mg/l):____________

White Sturgeon					Native Fish			Non-native Fish[1]			Comment ☑
No.	Fork Length (mm)	Girth (mm)	Condition at Release[2]	Stomach Sampled ☑	Species	Fork Length (mm)	Condition at Release[2]	Species	Fork Length (mm)	Condition at Release[2]	

Comments:

[1] Largemouth bass, smallmouth bass, black crappie, brown catfish, carp, American shad
[2] 1=vigorous, no bleeding; 2=vigorous, bleeding; 3=lethargic, no bleeding; 4=lethargic, bleeding; 5=dead