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Adult White Sturgeon Monitoring - Nechako River 2004.

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1 Introduction

The Nechako River population of white sturgeon (*Acipenser transmontanus*) is a red-listed species in British Columbia (BC Species and Ecosystem Explorer 2003) as well as a species recommended for listing as endangered by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC - November 2003). Genetic analysis indicates that the Nechako River population is distinct from that of the Fraser River suggesting that there is no or limited inter-breeding between the populations (Smith *et al*. 2002). In addition, research suggests that the Nechako population is experiencing recruitment failure with the population dominated by larger and older fish with few juveniles (Nechako White Sturgeon Recovery Initiative (NWSRI) 2004). At present the reasons for the recruitment failure is unknown. As the impact causing recruitment failure likely manifests within the first three months (Pers. Comm. Steve McAdam), the identification of habitats occupied by early life stages is critical. The location of spawning sites is an important first step in the identification of early juvenile habitat, but such sites were not confirmed for the Nechako River.

Information collected since 1995 has resulted in a better understanding of fish age structure and size at age as well as staging areas and rudimentary movement dynamics, through radio telemetry (Golder 2003, RL&L Ltd. 1996, 1997, 1998, 1999, 2000a, 2000b). One key component in understanding the life history of Nechako River sturgeon involves an understanding of spawning behaviour. Specifically, do Nechako sturgeon spawn, if so where, and is spawning effective? Analysis by McAdam and Lu (2002) showed a positive relationship between recruitment and August flow for the Nechako River upstream of the Nautley River, as well as the Nechako River at Vanderhoof, leading the authors to suggest that spawning occurs in the Vanderhoof area or further upstream. Higher spring use of the braided section of the Nechako River near Vanderhoof by radio tagged white sturgeon was documented by Golder (2003). Additionally, analysis of the numerous years of telemetry data (MWLAP 2003) identified sturgeon migrations from downstream habitats to locations upstream of Vanderhoof, and suggested further investigations were warranted. Results of such data analysis has been supported by visual observations of aggregations of between 3-60 sturgeon milling in the vicinity of Vanderhoof in two of the past three years.

Using the information on timing and location of these aggregations, this project was initiated in order to monitor Nechako River white sturgeon during the expected period of spawning activity (mid-May to mid-June) and to complete field surveys should a congregation of sturgeon be observed. The project was phased to provide opportunities for additional work based on findings as the study progressed. Tracking adult movements was designed to provide the opportunity to locate spawning aggregations. If spawning activity were suspected additional work would be conducted to collect data on spawning activity and spawning habitat followed by efforts to retrieve eggs and or larvae.

1.1 WHITE STURGEON SPAWNING - GENERAL

1.1.1 TIMING

White sturgeon spawning migrations have been associated with rising flows and water temperatures in the spring, typically from April to July (Miller and Beckman 1996; Paragamian and Kruse 2001; Paragamian *et al*. 2001; Parsley *et al.* 1993). Water temperature appears to be the key trigger for spawning with records of spawning occurring within the temperature range of 8.5-12°C in the Kootenai River and 10-18°C in the Columbia River. In both rivers the optimum spawning temperature was considered to be from 12-14°C (Paragamian and Kruse 2001; Paragamian *et al*. 2001; Parsley *et al.* 1993).

Recent studies in the lower Fraser River have suggested spawning may occur during the declining limb of the hydrograph and with water temperatures ranging from 11.3-18.4 °C (Perrin *et al.* 2000). A follow-up study conducted in 2003 resulted in sturgeon eggs being collected from water with an average temperature of 14.4 °C (Perrin *et al*. 2003). Spawning activity has been documented to take place over a period of several weeks to several months. Based on developmental age of eggs and larvae in the lower Fraser River in 1999, spawning was calculated to occur between July 4th and August 8 (Perrin *et al*. 2003). Work in the Columbia River based on the collection of newly spawned eggs indicated even more protracted spawning taking place from April through July (Parsley *et al.* 1993).

1.1.2 HABITAT

White sturgeon spawning is typically thought to occur in areas of higher velocity discharge that is dominated by cobble and boulder substrates (Scott and Crossman 1973; Parsley *et al*. 1993). However, in several recent studies, evidence of spawning at sites with lower velocity discharge (0.5-1.9 m/s) and finer substrates has been demonstrated (Paragamian and Kruse 2001 and Paragamian *et al*. 2001). This includes one study completed on the Fraser River where sturgeon appeared to prefer side-channel habitats with water velocities of 1.3-2.2 m/s and sand and gravel substrates (Perrin *et al*. 2003). Suitability of use conditions for spawning in the Columbia River suggests minimum spawning depths of 2 meters rising to an optimum value of 4 meters and greater. (Parsley and Beckman 1994). Data collected in the Fraser River downstream of Hope document spawning depths starting at 1 meter although eggs were most commonly found at water depths of between 3 and 4.5 meters (Perrin *et al.* 2003).

1.1.3 SPAWNING BEHAVIOUR

Paragamian and Kruse (2001a) suggest that male sturgeon typically migrate to spawning areas first and spend an average of 30 days in the vicinity, females then follow about a week later and only remain in the vicinity of the spawning area for an average of 10 days. Fraser River studies indicated shorter spawning periods based on retrieval of eggs. These data suggest that spawning events could have occurred between 1 and 8 days in individual spawning locals (Perrin 2003). White sturgeon are broadcast spawners, releasing eggs that sink to the bottom of the channel and adhere to the substrates. During the spawning period, adults will congregate together and have been known to surface, breach and roll (Perrin *et al*. 2003).

1.1.4 EGG PREDATION

Predation has been hypothesized as an important factor affecting recruitment of the Nechako white sturgeon (NWSRI 2004). However, this hypothesis still lacks empirical support, and only a single reference describing predation on sturgeon eggs was located, which identified northern pikeminnows (*Ptychocheilus oregonensis*), largescale suckers (*Catostomus macrocheilus*), and prickly sculpins (*Cottus asper*) as fish known to prey on white sturgeon eggs (Miller and Beckman 1996). In that study, of the 40 fish captured, 7 had consumed sturgeon eggs. Six of the guts examined had fewer than 10 sturgeon eggs, however, 1 largescale sucker was found to have eaten 70 sturgeon eggs.

1.1.5 NECHAKO POPULATION

Dixon (1986) completed a study on age, growth, and migration of white sturgeon in the Nechako River. The results of this study indicated that not only did sturgeon in the Omenica region of British Columbia grow at a slower rate than populations elsewhere but that they also moved considerable distances within limited sections of the river. Dixon (1986) also investigated the sturgeon fishery on the Nechako River and reported that year classes between 1945-1960 were under-represented in the fishery. Additionally, it was also determined that females within the population were being harvested prior to maturity and that continued overfishing of this population would most likely be detrimental.

From 1995 – 1999, RL&L Environmental Services Ltd. (RL&L) completed a white sturgeon study on the Fraser and Nechako rivers). The project included tagging and tracking of sturgeon and using egg mats to attempt the collection of sturgeon eggs. The five year monitoring program identified high use areas within the Nechako River that were most likely associated with feeding and overwintering activities and provided a population estimate of 547 fish (95% CI = 403 to 851) for the Nechako River (RL&L 2000b). Other results of the RL&L study were:

- Nechako River and Stuart River sturgeon interact based on mark-recapture and movement information. Genetic analysis indicated this complex was genetically distinct from Fraser sturgeon.
- Nechako population exhibited a different age structure than other Fraser populations, fish capture indicated a population of older fish predominantly between 31 and 50 years of age.
- Juveniles under 100 cm total length were infrequently encountered in the Nechako drainage, however when captured were within the same areas of the Nechako mainstem as adult fish.
- Extensive movements of Nechako River sturgeon for feeding, overwintering and possibly spawning purposes were generally more common than in other stocks.
- No sturgeon eggs or larvae were collected, and spawning activity was not observed during the course of the study.

Since 1999, tagging and monitoring of the Nechako River white sturgeon population has been undertaken by the L'heidli T'enneh and Golder Associates (Golder).

Approximately 20 tags were still active in the river in 2003 (Pers. Comm. Corry Williamson) providing the opportunity to continue to monitor movements of adult white sturgeon in 2004.

2 Methods

2.1 DETECTION AND MONITORING PROGRAM (PHASE A)

Monitoring of the Water Survey of Canada station at the Vanderhoof bridge (station 08JC001) was initiated upon award of the contract and continued until completion of the field program. The station provides real-time data on water temperature, primary water level and discharge.

Water samples were collected over the course of the study to document changes in turbidity, and were analysed with a LaMotte 2020 portable turbidity meter.

2.1.1 NOTIFICATION OF LOCAL RESIDENTS

A component of the monitoring program was to utilize the public as observers. Signs were posted at key locations, and provided contact information should a congregation of sturgeon be sighted. Additionally, a notice was placed in the local newspaper (Omineca Express). Some of the locations where signs were posted included:

- Vanderhoof bridge boat launch and walking trails;
- Fort Fraser, Braeside Road and Finmore boat launches;
- Vanderhoof airport; and
- Vanderhoof mall.

2.1.2 TELEMETRY

Two Lotek receivers (SRX_400-W7) were rented for the study, and were used for both the aerial surveys and as a base station (Vanderhoof bridge). Receivers were programmed to only scan for the frequencies used on the tagged sturgeon, thereby reducing scanning time and minimizing the possibility of missing signals.

2.1.2.1 Aerial Surveys

Telemetry overflights of the Nechako River between the Stuart and Nautley Rivers were conducted between the 28th of April and the 25th of May on a weekly basis in order to determine the presence or absence and movement patterns of tagged fish in the study area (Figure 1). The flights originated from the Vanderhoof airport and were flown over the Nechako River from Vanderhoof downstream to the Stuart River confluence, then from the Stuart River confluence upstream to the confluence of the Nautley River, and finally back downstream to Vanderhoof. This flight pattern resulted in two complete passes of the study area on each flight.

Initially, both passes of the telemetry flights were flown at a height of between 600-800 feet (180 – 240 m) above the river to ensure no tags were missed. In later flights, the second pass was flown at a height of 400-600 feet (120 - 180 m) above the river to maximize visual observation opportunities. There is a trade off between the optimal altitude for telemetry and the optimal altitude for visually observing fish. The lower the flight, the narrower the cone of signal emmitance from the tag, and therefore the greater the risk of missing a signal. The higher the flight, the less likely it is that a sturgeon or congregation of sturgeon would be observed visually.

A fixed-wing plane wired for telemetry work was used to complete the aerial surveys. "H" antennae were mounted with vertical orientation set at an angle of 45° down, on both wings of the aircraft. One antenna was oriented forward while the other was oriented backwards using a co-phase wiring harness. Initially, to reduce the risk of missing a tag during scan time, two Lotek receivers (SRX_400-W7), one per antenna, were used during the overflights, one scanning manually and the other logging data. However, once the most effective elevation for telemetry and fish locations were established only one receiver was used during the flight to both manually scan for the tags and to log data. The six frequencies (149.700, 149.480, 149.320, 148.420, 148.320, 148.380) of the tagged fish were programmed into the receivers and were continually scanned during the flight at a rate of 10 seconds per frequency.

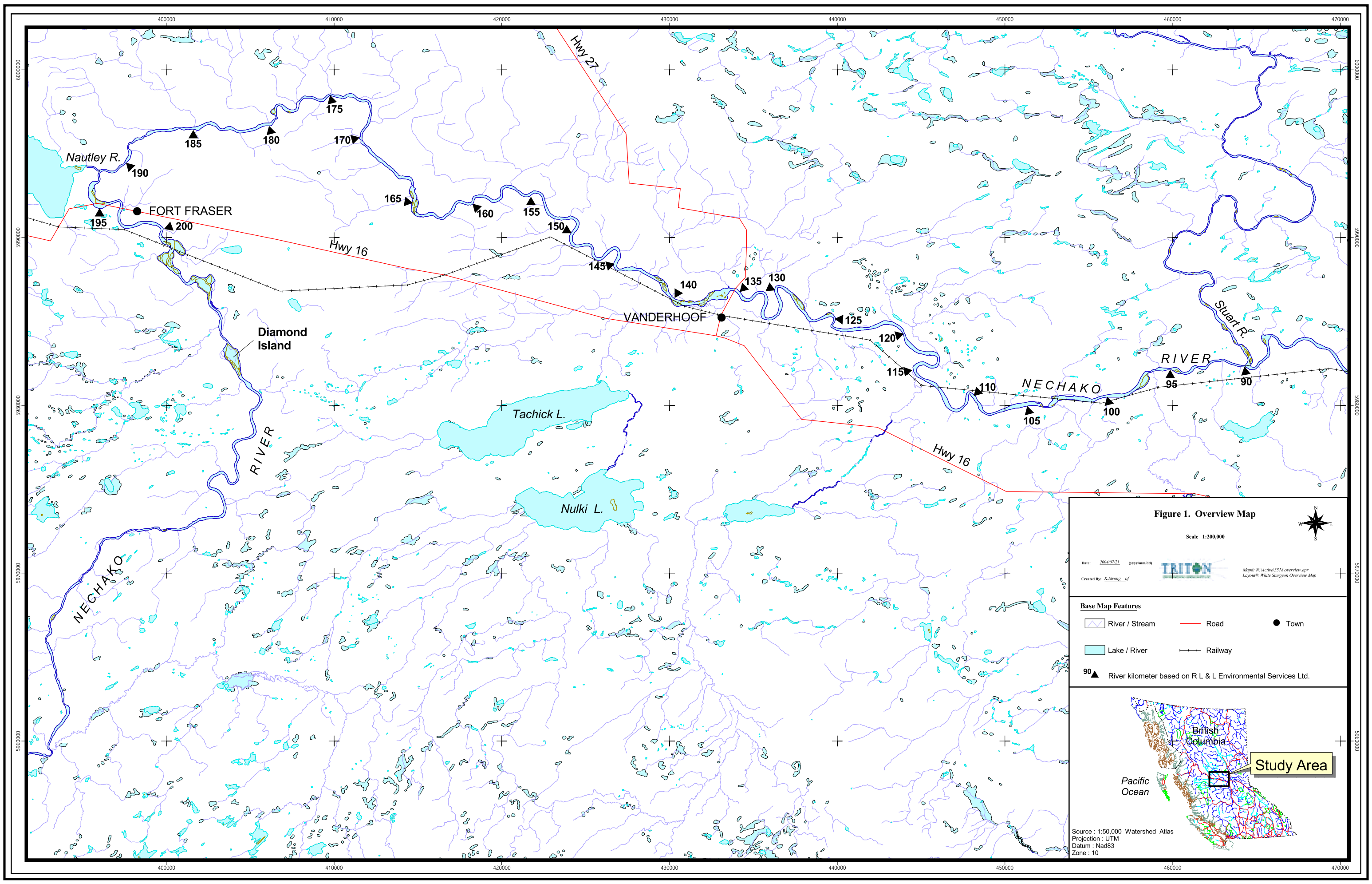


Figure 1. Overview Map
Scale 1:200,000
Nautley R.
FORT FRASER
Hwy 16
Hwy 27
Diamond
Island
VANDERHOOF
Tachick L.
Nulki L.
NECHAKO
RIVER
Stuart R.
195
200
190
185
180
175
170
165
160
155
150
145
140
135
130
125
120
115
110
105
100
95
90
Base Map Features
River / Stream
Road
Town
Lake / River
Railway
River kilometer based on R L & L Environmental Services Ltd.
British Columbia
Study Area
Pacific Ocean
Source : 1:50,000 Watershed Atlas
Projection : UTM
Datum : Nad83
Zone : 10

As each signal was received the frequency, code, river kilometre and time were recorded on data collection sheets. At the same time a UTM of where the signal was received was taken using a Garmin 12XL handheld GPS unit. Effort was not spent circling the plane to try and identify the exact location of each fish, as the goal of the telemetry data was to document general movement trends and timing.

In the event that a tag was located but a code was not received or if there was more than one signal received for a given frequency at one time, the receiver was paused on that frequency to enable codes to be generated for the signals being received. Additionally, during these events the aircraft circled the area in question until all codes were received.

On two occasions, not all codes could be established while in the plane, so after the flight was complete the section of river between Vanderhoof and km 114 was surveyed using a river boat. The tracking was completed and codes established using one receiver and either a four element or three element folding Yagi antenna.

2.1.2.2 Telemetry Base stations

Telemetry base-stations were used to monitor sturgeon movements at key areas identified from previous studies. These included base stations established by MWALP at the confluence of the Stuart and Nechako rivers and at KM 116 – a known overwintering area for sturgeon. Arrangements were made with Cory Williamson (MWALP, Prince George) to share data and downloading responsibilities.

In addition, a base station was established by Triton Environmental downstream of the Vanderhoof bridge, to detect fish passage close to the location where congregations of sturgeon have been anecdotally observed in recent years (Alcan Primary Metal 2004). Ms. Deirdre Goodwin, a homeowner just downstream of the Vanderhoof bridge, provided access to her property to establish the base-station.

2.2 SPAWNING ASSESSMENT (PHASE B)

Phase B of the project was initiated upon observation of a spawning congregation. Initiation of Phase B was undertaken following communication protocols established with the Alcan representative (Justus Benckhuysen). Mr. Benckhuysen was contacted immediately after the telemetry flight on the morning of May 18, 2004 and was informed that a congregation had been observed. A helicopter was then used to access the congregation site in order to document fish behaviour and to determine if spawning behaviour was evident.

Fish were paired and gamete release was observed, initiating further data collection focussed on the collection of eggs. Locations of spawners were geo-referenced for further detailed habitat assessments. The area of the congregation was accessed by boat on the evening of May 18th, and telemetry equipment was used to determine if any of the tagged individuals were part of the congregation.

2.3 DATA COLLECTION PROGRAM (PHASE C)

The data collection phase was initiated upon spawning behaviour being observed by fish within the congregation.

2.3.1 HABITAT ANALYSIS

Detailed analysis of the habitat conditions were completed in the vicinity of where spawning behaviour was observed. Data was collected both from habitat transects of the river as well as from spot locations associated with the egg and larval sampling. Collected information included water depth, water velocity, and substrate composition.

Water velocity was measured using a velocity sensor (Swoffer Instruments, Seattle, Washington) and depths were collected using a graduated rod. For habitat transects, velocities were collected at 40% of the depth for sites less than 1.0 m in depth and at both 20% and 80% of the depth for sites greater than 1.0 m in depth. Depths and velocities were collected at regular intervals (approximately 10 m) along the transect.

Substrates were described according to Kaufmann and Robison (2003) as either fines (< 2 mm), gravels (2-64 mm), cobbles (64-256 mm), boulders (256 – 4000 mm), or bedrock

(> 4000 mm). A variety of techniques were used in order to estimate substrate composition including visual observation in shallow water, a Petite Ponar grab, Aquaview underwater camera, and an underwater viewing tube in deeper water.

2.3.2 EGG COLLECTION

Techniques used to collect eggs included substrate (egg) mats, kick-netting, and substrate sampling. Substrate mats were deployed immediately downstream of where the sturgeon congregation was observed and in various habitats surrounding the location of the observed sturgeon congregation. Substrate mats were constructed from polyurethane industrial filter fabric (similar to latex coated animal hair) sandwiched between a metal frame with cross supports. Mats were anchored with a 2.5 kg lead weight and were marked by fluorescent buoys.

Kick-nets were used to sample the river margins downstream of known and suspected spawning locations. The D-ring kick net (31 cm wide, 24 cm height) was held on the bottom while upstream substrate was disturbed by kicking allowing fine material to enter the downstream net.

Substrate sampling was conducted using a Petite Ponar dredge to sample for eggs in areas too deep for kick netting. The spring-loaded dredge was deployed from the river boat, and would close upon contact with the substrate. The dredge was relatively ineffective as either substrate size was too large, substrates were too compact for the jaws to dig into, or water velocities were too fast resulting in the dredge reaching the substrate at a skewed angle. Use of the Petite Ponar was abandoned and substrates were sampled by scraping buckets across the top layer of substrates. Using this method, sampling depth was restricted to less than approximately 0.8 m, but a larger surface area could be sampled (0.5 m^2 versus 0.05 m^2). The collected substrate was sieved and washed though a 1 cm mesh frame and collected on to marquisette netting. The material that accumulated on the netting was then examined for eggs.

2.3.2.1 *Egg Identification and Viability Analysis*

Eggs collected during the field surveys were stored in river water and maintained at a constant temperature for later analysis for viability. After 72 hours, eggs were transported to Dr. Mark Shrimpton at the University of Northern British Columbia for confirmation of identification, and viability analysis. Observations were made of the eggs using a dissecting microscope, however, due to the cloudiness of the eggs, results were inconclusive. It was Dr. Shrimpton's opinion that the eggs were likely already dead and he made recommendations for fixing the eggs to prevent decomposition. Based on his recommendations, half the eggs (2) were fixed in Stockard's solution (a mixture of formaldehyde and acetic acid), which is used to clear cloudy eggs but destroys DNA, and other half (2) were stored in ethanol, which does not effect DNA allowing for the possibility of genetic tests to be run to confirm the identification. Photographs of the eggs were sent to personnel operating a white sturgeon hatchery for the Freshwater Fisheries Society of BC for another independent confirmation of the identification.

2.3.3 EGG-PREDATOR ANALYSIS

There were two primary sampling techniques used to assess predation on sturgeon eggs. In order to target juvenile and young adult predators, baited prawn traps and minnow traps were deployed in the vicinity of where the congregation was observed. Angling was used to target adults too large to enter a prawn trap. Gill nets were not used due to their indiscriminate sampling and the high probability of entangling sturgeon. In addition reconnaissance snorkelling was undertaken to look for aggregations of suspected predators.

In order to determine whether or not the fish captured were preying on sturgeon eggs, stomach samples were analysed. For all non-game fish and non-red or blue listed species this involved removing the stomach for analysis. For blue listed species such as bull trout, a stomach pump was used.

2.4 SAMPLING FOR LARVAE

Sampling for larvae was not part of the original scope of work, but rather was added to the scope upon the identification of the congregation and the capture of sturgeon eggs. Sampling was targeted at two larval stages: immediately post-hatch (yolk sack), and actively feeding larvae.

2.4.1 IMMEDIATELY POST-HATCH LARVAE

Passive sampling equipment consisted of two round fyke nets (0.55 m diameter, 3 m long, 6 mesh/cm) set along the river margins (depths < 1.1 m), targeting newly hatched larvae which may exhibit upward swimming behavior immediately after hatching (Brannon *et al.* 1986). Nets were set by using a sledgehammer to drive a piece of rebar into the substrate and then securing the bridle of the net to the rebar. Water velocity at the center of each net was measured with a velocity sensor (Swoffer Instruments) and was later used to estimate the volume of water sampled by each net.

Active sampling consisted of kick-netting (as previously described), which was targeted at larvae within the intersticial spaces of the channel substrates. Material collected in the fyke nets and by kick-netting were poured into white plastic basins for sorting.

2.4.2 ACTIVELY FEEDING LARVAE

Sampling for actively feeding larvae was generally completed from early afternoon until early evening (4:00 pm – 12:00 am) as the potential existed that larvae emerge or become more active under cover of darkness.

Passive sampling equipment consisted of two round fyke nets (0.55 m diameter, 3 m long, 6 mesh/cm), and two D-ring fyke nets used by Chris Perrin (Perrin *et al.* 2003) during the work he completed on the Fraser River (0.5 m^2 intake area, 3 m long). Nets were set on the bottom of the river. In shallower water (< 1.1 m) this was achieved by using a sledgehammer to drive a piece of rebar into the substrate and then securing the bridle of the net to the rebar. In deeper water the nets were weighted with 2.5 kg lead balls to keep the net on the bottom, and the bridle was attached to an anchor (cinder blocks or a piece of rail) to keep the nets from drifting downstream. The nets clogged in a relatively short time (approximately 0.25 hours) due to the algae and sloughing diatoms present in the river, and had to be checked frequently. Water velocity at the center of each net was measured with a velocity sensor (Swoffer Instruments) and was later used to estimate the volume of water sampled at each site. Material collected in the fyke nets was poured into white plastic basins for sorting.

Active sampling consisted of pole seining and beam trawls. A 3 m wide by 1 m tall pole seine (3.5 mesh/cm) was used to sample shallow margin habitat. Seines were generally completed in an upstream direction, with site length generally dependent on the amount of material collected by the seine or by the amount of a particular habitat available. At the end of the site the contents of the seine were carefully examined at waters edge.

Active sampling from the boat (beam trawl) was completed at several sites, including the deep run where numerous sturgeon were observed holding during the helicopter overflight. The use of the beam trawl was an exploratory technique used for the 2004 program, as due to the short preparation time for larval sampling (which was not a part of the original scope of work) the mesh on the trawl net was too coarse to catch larvae. The beam of the trawl was 3 m wide, with a tapered 6 m long net (3 mesh/cm cod, 2 mesh/cm main net). The net was effective at capturing larger fish, and may be useful for catching potential predators for stomach analysis (as long any congregating sturgeon have left the area). It is not recommended that the technique be used to sample for larvae as it resulted in a high rate of mortality for smaller fish which were often mutilated by cobble captured in the net.

2.4.3 TIMING DETERMINATION FOR ACTIVELY FEEDING LARVAE

For larval sampling, work was conducted in conjunction with the anticipated start of active feeding. Hatching occurs at 7-8 days at 14-16°C (approximately 120 ATUs; Conte *et al*. 1988). This would have been approximately May 27 (120.8 ATU) for eggs released by the observed congregation on May 18. The differentiation of the pyloric sphincter (the developmental stage where external feeding usually begins) begins approximately at 232 ATUs (370.8 hours at 15°; Conte *et al*. 1988), or at 8-9 days post hatch at 16-20°C (approximately 150 ATUs post hatch, or 270 ATU since egg deposition). With estimated daily mean temperatures of 14°C, this was predicted to occur on June 7.

Kick net sampling resulted in the recovery of a yolk sack larva estimated to be approximately four days post hatch on June 3 (as described in Conte *et al*. 1988; 72 ATUs). This indicates hatching at approximately 125 ATUs (May 27-28), which is supported by Conte *et al*. (1988). If active feeding begins 8-9 days post hatch, another 4-5 days at 18° (approximately 80 ATUs) would be required to active feeding which would confirm larval emergence to be June 7 with predicted daily mean temperatures of 13-14°C.

3 Results

3.1 DETECTION AND MONITORING

3.1.1 TEMPERATURE, FLOW AND TURBIDITY MONITORING

River discharge at the Vanderhoof bridge during the monitoring period ranged from 60 m^3/s on April 2, peaked at 134 m3/s on May 13 and 15 and generally declined through the end of May and June (Figure 2).

Mean daily water temperature at the Vanderhoof bridge during the monitoring period ranged from 3.9°C on April 1 to a high of 22°C on June 24. Daily mean water temperatures during the time of the sturgeon congregation ranged from approximately 13-15°C, the first time in the season that daily mean water temperatures were greater than 12°C (Figure 2). Detailed flow and temperature data can be found in Appendix 1.

Turbidity at the Vanderhoof bridge during the monitoring period was low and relatively stable, ranging from a high of 4.5 NTUs on May 4 to a low of 1.5 on May 15 (Table 1).

Table 1. Water turbidity (NTUs) at the Vanderhoof bridge.

Date	NTU
April 28, 2004	3.8
May 4, 2004	4.5
May 8, 2004	3.7
May 12, 2004	3.2
May 15, 2004	1.5
May 18, 2004 (morning)	1.6
May 18, 2004 (afternoon)	2.3
May 19, 2004	1.7
May 26, 2004	1.8

3.1.2 TELEMETRY

A total of 5 telemetry overflights were conducted between the 28th of April, 2004 and the 25th of May, 2004. On average, the number of active tags recorded during each flight was 8, with the highest number of tags (11) being recorded during the telemetry survey conducted on May 4th. All but one of the fish located during the tracking were recorded between km 108 (approximately Keillor Road) and the Vanderhoof Bridge (km 136), prior to the 18th of May. The exception to this (149.700-10), moved upstream of the bridge in the early spring, to km 154 of the Nechako River, where it remained until June 21st, when it moved to downstream of the Vanderhoof bridge.

When combined, the telemetry records from the overflights, boat surveys and base station monitoring show that approximately half of the tagged fish were continually moving within the river prior to the congregation event (see section 3.2 for a description of the congregation observed on May 18th), while the other half remained relatively stationary (Appendix 2). Additionally, the sturgeon that were observed to be moving prior to May 18th, generally moved back and forth within the area between km 116 and the Vanderhoof bridge (km 136).

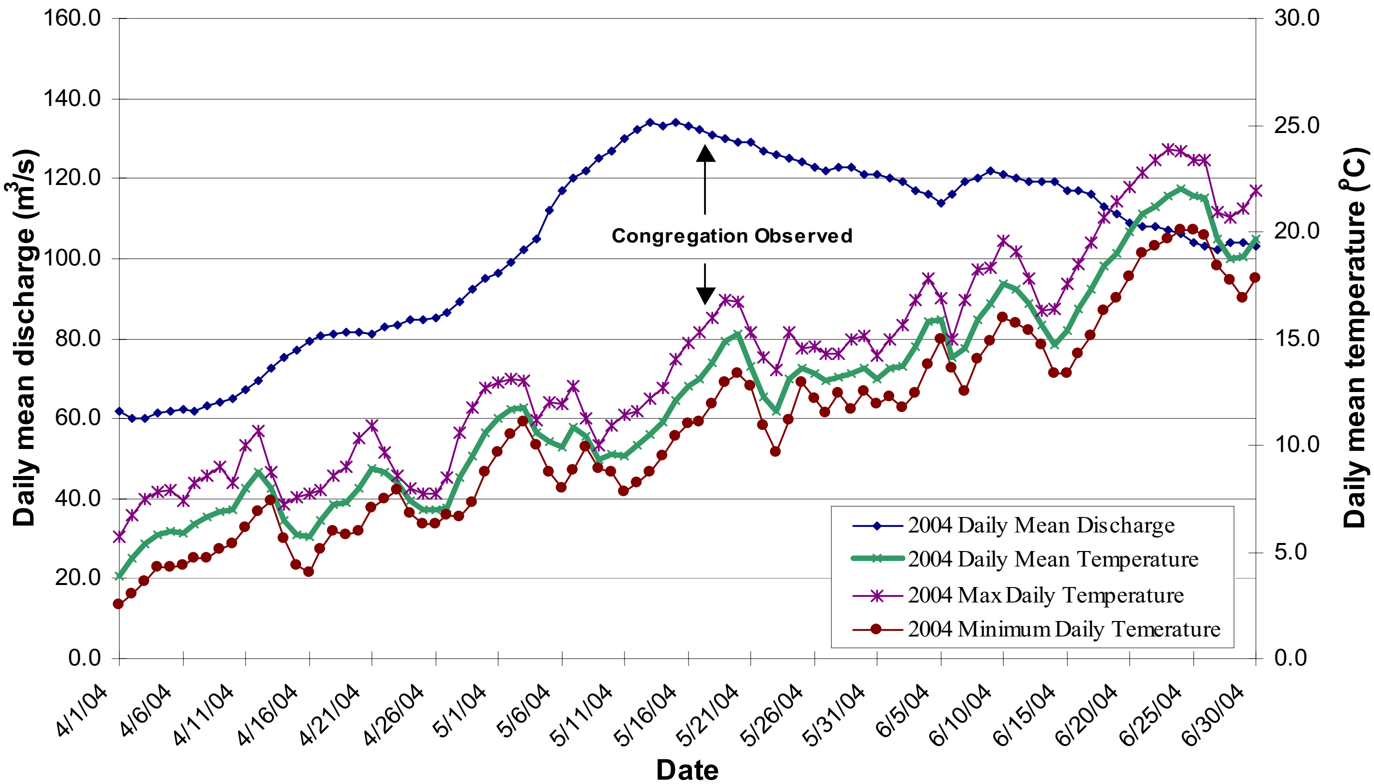


Figure 2. Daily mean discharge (primary X axis), and daily mean, minimum and maximum temperature (secondary X axis) at the Vanderhoof bridge (Water Survey of Canada station 08JC001) from April 1 to June 30, 2004.

During the congregation event on May 18th, 4 tagged males (149.700-1,2,3,9) were recorded to be within the congregation. An additional four fish (two females -149.700-5, 148.320-5; two males - 149.700-6, 15) were recorded by the base station at the Vanderhoof bridge, and although it cannot be confirmed that they were part of the congregation, it is likely that they were due to their close proximity (*i.e.* several hundred meters) to the congregation (Appendix 2).

Of the four radio tagged fish recorded to be in the congregation, three were known to be in late reproductive state, while the other was classified as maturing (MWLAP 2003). Within two days of the congregation event three of the four males recorded above the bridge moved downstream of the bridge to km 116 of the Nechako River.

3.1.2.1 Detailed events for each fish at the time of the observed congregation (May 18th)

Following are brief descriptions of the movements of tagged sturgeon known to be in the vicinity of Vanderhoof at the time of the congregation. Reproductive state of individual fish were taken from the MLWAP data summary (2003) which is based on information collected by Golder and RL&L during their studies on the Nechako River (*i.e.* reproductive state was not reassessed as part of the current study).

149.700- 1
This maturing male was not recorded in the study area until 1:01 am on the 18th of May, when it passed by the base station at km 116. It was also located later that night (22:30) above the Vanderhoof bridge (river km 138) within the vicinity of the observed congregation. On May 20th it moved downstream of the Vanderhoof bridge and was recorded by the km 116 base station at 19:07 that evening.

149.700-2
This late reproductive male was repeatedly found within the study area during overflights and was found to periodically move between km 120 and the Vanderhoof bridge (km 136) during the early spring. During the May 18th overflight, the fish was located at km 137 and was again recorded that evening at 20:40 around km 138 in the area of the observed congregation. The next morning he was recorded passing the Vanderhoof

bridge base station at 05:26 and the base station at km 116 four and half hours later (an average speed of approximately 4.5 km/hour). The final record of the fish was document during the flight on May 25th when it was located outside the study area at km 82 of the Nechako River (downstream of the Stuart River confluence).

149.700-3

149.900-3 is a large, late reproductive male who was found to move intermittently between km 116 and km 136 during the early spring. On May 18th at 01:57 he was recorded by the km 116 base station and was then recorded at 20:40 that evening in the area of the observed congregation. On the morning of the 19th, he moved downstream to the Vanderhoof bridge where he remained until 02:40 on the 20th of May.

149.700-5

Fish 149.700-5 is a late reproductive female that remained around km 132 on the Nechako River until the 17th of May when it moved 4 kilometers upstream into the area around the Vanderhoof bridge. On the 18th of May it moved back downstream to km 134 and was not located above the bridge during the time period at which the congregation was observed.

149.700-6

This early reproductive male underwent very few movements throughout the study period, remaining relatively stationary around km 132 until the 16th of May. On the 16th, he moved 4 kilometers upstream within range of the Vanderhoof base station, where he remained until the evening (23:25) of May 18th, after which he moved back downstream.

149.700-7

Fish 149.700-7 is a late reproductive female that remained within 2 kilometers of km 116 throughout the entire study period, until June 9th at 11:32 when she was recorded at the confluence of the Stuart and Nechako Rivers.

149.700-8

149.700-8, a late reproductive male, moved from km 116 to km 136 just before midnight on the 19th and was recorded by the Vanderhoof base station until the afternoon of the 22nd.

149.700-9

Fish 149.770-9 is a late reproductive male, who remained downstream of the Vanderhoof bridge around km 132 during the early spring until May 18th, when it was located at 21:14 in the vicinity of the observed congregation. After May 18th, the fish was recorded on several occasions moving between km 116 and 136 of the Nechako River.

149.700-10

Of all the fish tagged in the study area fish 700-10, a late reproductive male, was the only one to move above the Vanderhoof bridge in the early spring to km 154, where he remained until June 9th at 7:05 when he was recorded passing the Vanderhoof base station.

149.700-13

Another late reproductive male, code 13, remained relatively stationary at km 133 during the early spring and was first seen to move on the 15th of May, when it headed upstream to the Vanderhoof bridge area. On, the 18th of May, however, code 13, was located at km 108 and continued to move downstream, and was recorded outside the study area at km 85.5 (downstream of the Stuart River confluence) during the telemetry flight completed on the 25th of May.

149.700-15

During the early spring, 149.700-15, another late reproductive male, moved sporadically between km 123 and km 136 of the Nechako River. On the 18th of May he was located in the vicinity of the Vanderhoof Bridge, where he remained until May 20th, when he moved downstream to km 116.

148.320-5

Female 148.320-5, was located within the study area twice prior to May 15th, once on the 28th of April at km 116 and once on May 4th at km 127. Between May 15th-18th she was found to remain relatively stationary within the Vanderhoof bridge area, moving downstream to km 116 on the 17th of May. She was not located again after the 18th of May.

148.420-12

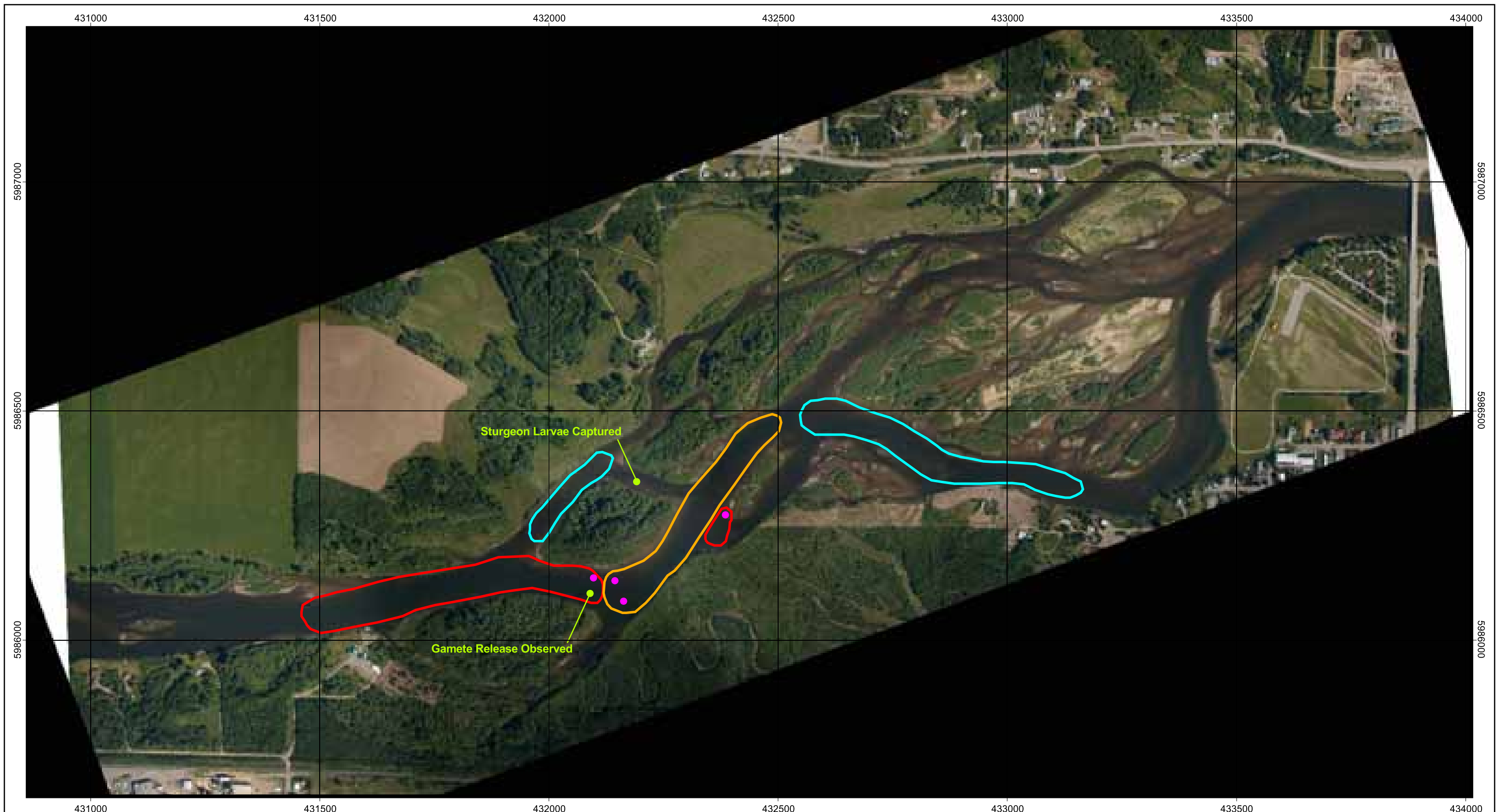
Fish 148.420-12, a late reproductive male, was only recorded within the study area on the initial flight, when he was located at km 116.2.

3.2 SPAWNING ASSESSMENT

The congregation of sturgeon was observed during the telemetry flight on the morning of May 18. A total of 22 sturgeon were counted from the fixed wing plane. As outlined in the proposal methodology, the Triton crew contacted the Alcan representative (Justus Benckhuysen). The congregation was observed from the helicopter later in the afternoon, and documented using a video camera (Attachment 1). Several counts were completed from the helicopter with a maximum of 36 sturgeon observed. The congregation was located at the upstream end of the braided river section above the Vanderhoof bridge (Figure 3).

Spawning behaviour was observed from the helicopter, which included the pairing of sturgeon (Appendix 4, Plate 5), and the release of gametes by one pair (Attachment 1). Sturgeon were observed as singles, pairs, and occasionally in groups of three or four. Most pairs consisted of a smaller fish (presumed to be male) in close proximity to a larger fish (presumed to be female), with the head of the male typically two-thirds down the length of the female. Male fish would typically cross over from one side of the female to the other. Groups of sturgeon typically consisted of one larger fish (female) with two or three smaller fish vying for position beside the female. During the observed gamete release, the head of the male was slightly upstream of the female and it turned its ventral surface towards the female, rapidly undulating as it released milt.

The site of the congregation was accessed by boat on the evening of May 18 to further observe spawning behaviour. No breaching or rolling was observed. The only sturgeon observed passed across the top of the island where the crew was stationed. It was approximately 1.5 m in length and clearly broke the water surface as it moved from the left channel to the right channel.



LEGEND

- Numerous Fish, Multiple Pairings
- Occasional Single Fish
- Several Fish, Some Paired
- Sturgeon Egg Collection Site

NO.	DATE (yyyy/mm/dd)	REVISION	BY

NECHAKO RIVER STURGEON PROJECT 2004

Figure 3.
Sturgeon Congregation Location

Scale: 1:8,000 (100 0 100 200 300 400 Meters)

Basemap Source:	Map Datum:	Project No:	File No:	Date:
Air Photo Mosaic by Dave Gordon -June 16 2004	UTM Zone 10. NAD 83	3518	Map#: 3518\apr\Congregation Locations.apr Layout#: Figure 3.	2004/07/26

TRITON

Recreational boating activity was noted while trying to document spawning behaviour. There were six boats that passed through where the congregation was located during the three hours the crew was on the river.

Based on the observations through fixed wing aircraft, helicopter and observation by boat, spawning activity appeared to be of short duration (36 hours). Fish were first recorded approximately 02:00 on morning of the 15th of May and last seen around 05:30 on May 19th (Figure 6 and 7). Radio telemetry data from the station immediately downstream of the Vanderhoof Bridge recorded movements upstream and downstream on these dates indicating that these fish would have spent a maximum of 80 hours at the spawning site. However, many of the fish that arrived in the area on the 15th of May, left the area and headed downstream to km 116 on the morning of either the 17th or 18th and returned to km 136 in the evening of the same day. Due to such movements, only estimates can be generated for how long fish were in the spawning area prior to and after the spawning event.

3.3 DATA COLLECTION

The habitat data collection phase of the project started May 19, the day following the observation of the sturgeon congregation. Visual observation from a helicopter mid-morning indicated that only 7 smaller sturgeon remained in the spawning area.

3.3.1 SAMPLING FOR EGGS

3.3.1.1 Substrate (Egg) mats

A total of 14 egg mats were deployed at depths ranging from 0.7 to 3.0 m, and velocities ranging from 0.1 to 0.96 m/s (Appendix 3: Table 4). 8 mats were deployed on May 19th and sampled between 9:52 and 12:15 hours. One egg was captured at site SM9 (Figure 6) located approximately 50 meters downstream of known spawning activity. Five mats were left to sample for approximately 43 hours after the original retrieval. Mats were set for a combined total of 399 hours. Substrate mat locations are shown in Figure 6.

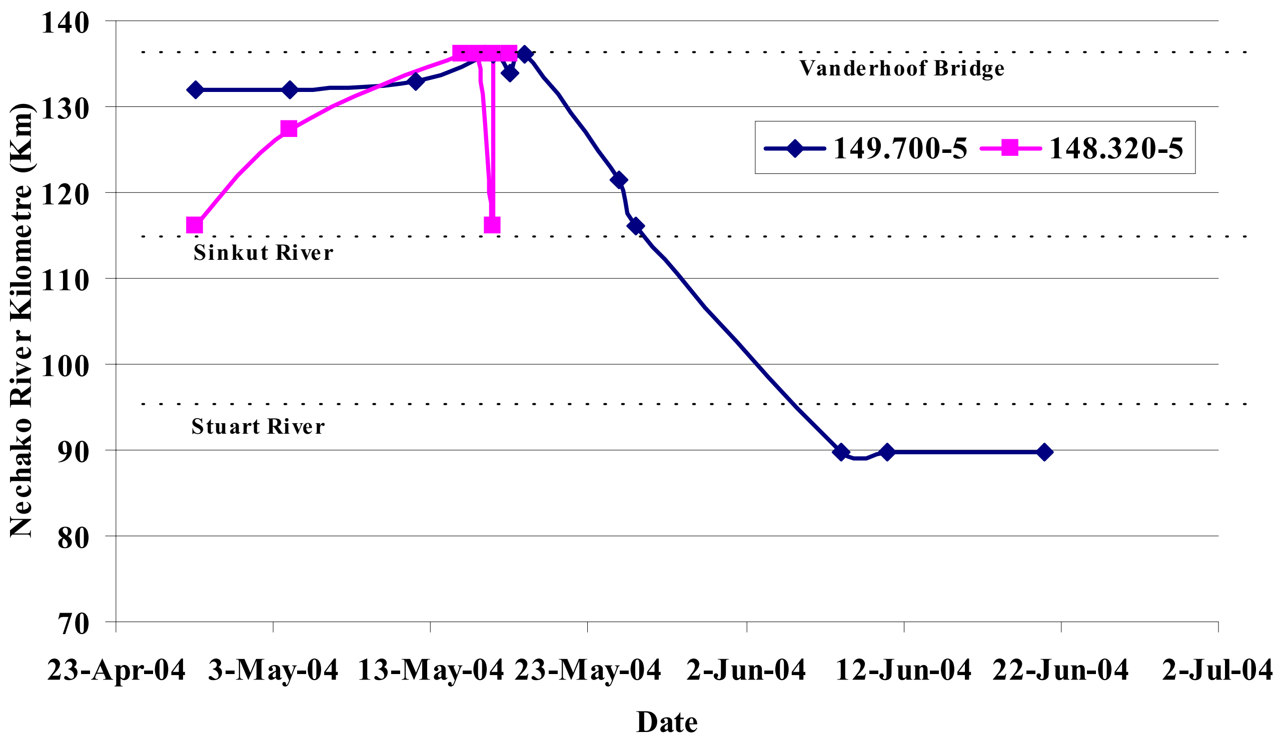


Figure 4. Detailed movements of tagged female sturgeon around the time of the congregation.

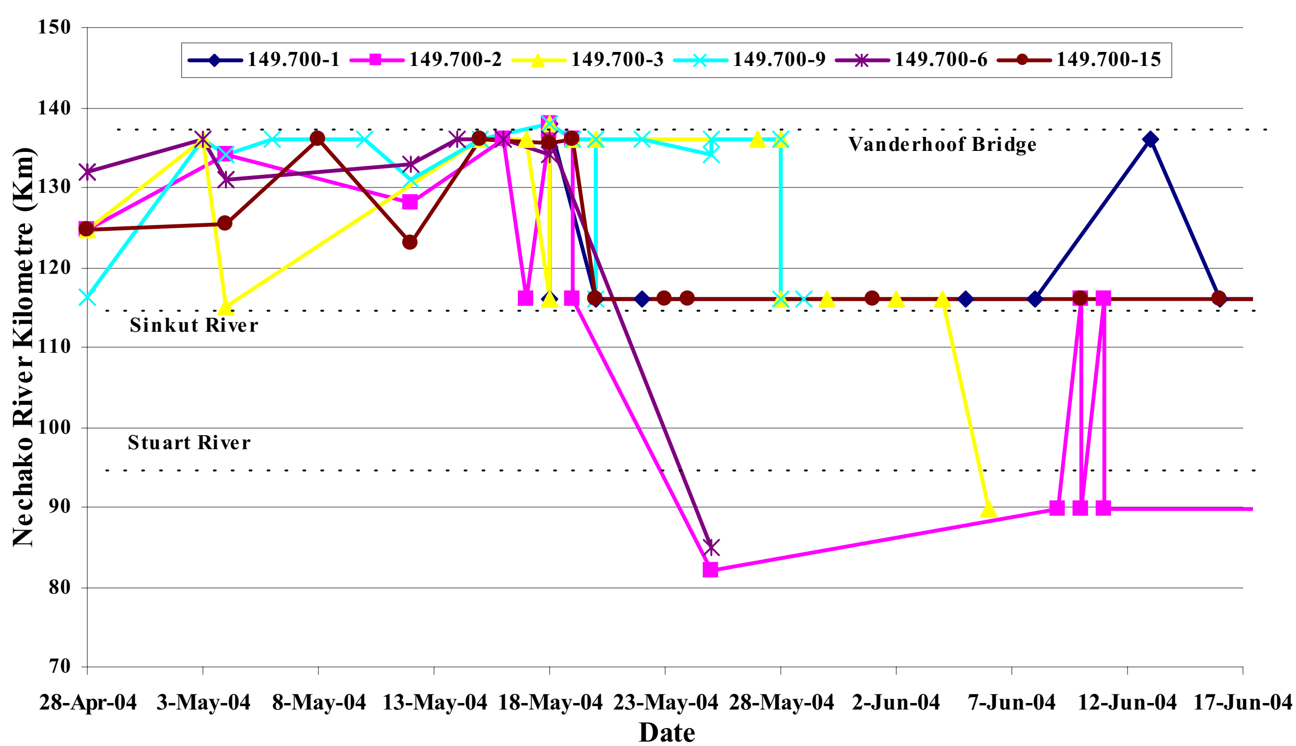


Figure 5. Detailed movements of tagged male sturgeon around the time of the congregation.

3.3.1.2 <u>*Kick-netting*</u>

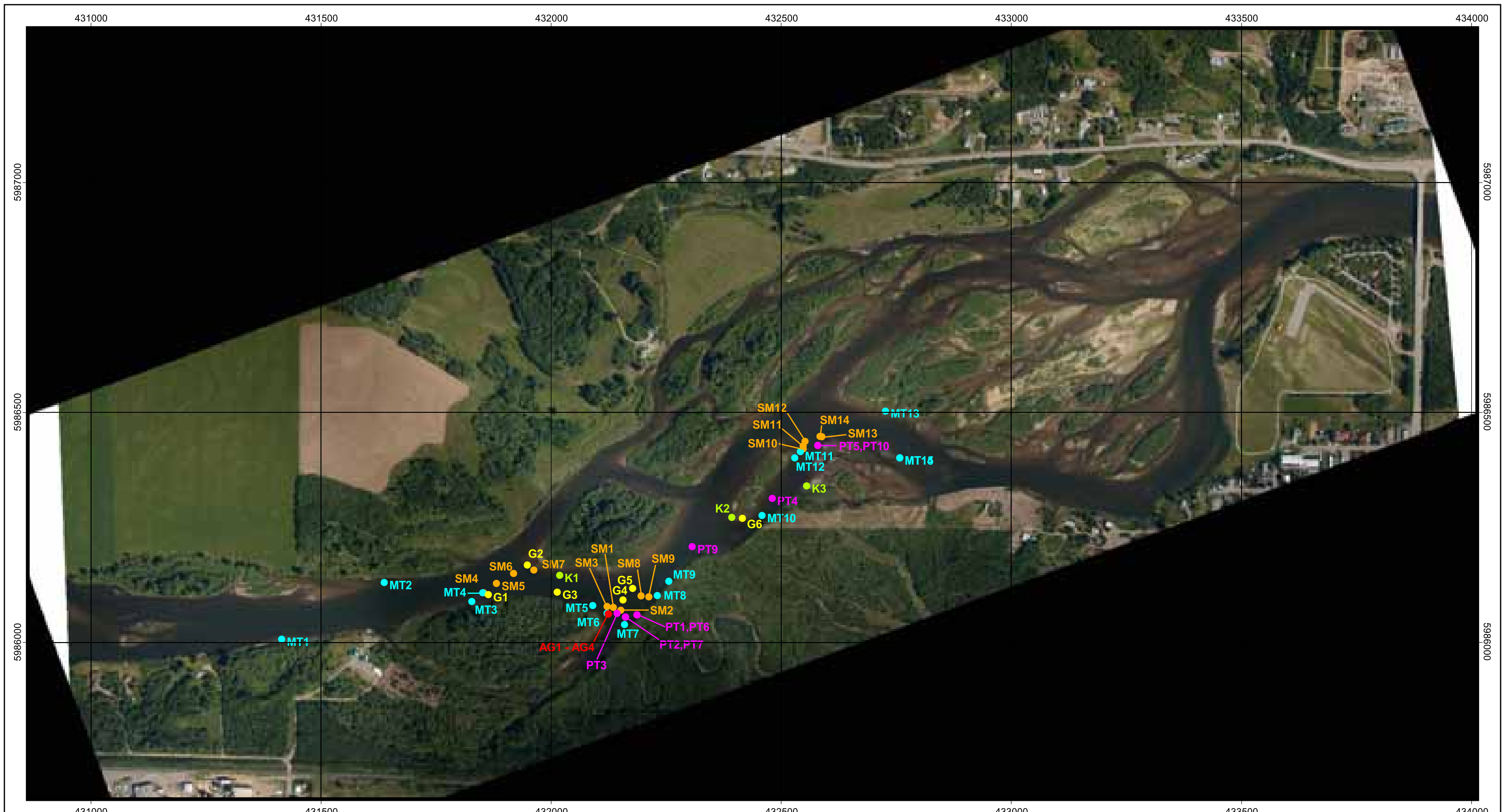
Kick netting was undertaken for a total of 13 hours between May 20 and May 22 (Appendix 3: Table 5; Figure 6), which resulted in the sampling of approximately 1,300 m^2. Three sturgeon eggs were collected by kick-netting. Two eggs were captured from an area immediately downstream of the observed spawning area (site K1) while one egg was captured at the head of an island located approximately 300 meters downstream of the known spawning area (site K2) but in a location within 50 meters of a suspected spawning location. Substrates at kick netting locations were generally comprised of a mix of large and small gravels.

3.3.1.3 <u>*Substrate Sampling*</u>

A total of 6 substrate grabs (12 m^2) were collected and carefully examined on May 20. Although numerous sucker eggs were collected by substrate sampling, no sturgeon eggs were colleted using this method. Kick-netting proved to be a far more efficient method of sampling compared with substrate grabs.

3.3.1.4 <u>*Egg Identification and Viability*</u>

Individuals contacted to confirm the identification of the four collected eggs (Dr. Shrimpton, UNBC; Ron Ek, Tim Yesaki, and Laird Siemens; Freshwater Fisheries Society of BC) all agreed that based on visual observations the eggs were white sturgeon eggs. Discussions with Dr. Shrimpton regarding DNA analysis of the eggs were initiated, however, due to the expense associated with running the test, it was decided to wait until the results of the larval sampling before proceeding (since the capture of a white sturgeon larvae would further support the egg identification). Once the eggs had been fixed, viability analysis was no longer possible, however, the capture and subsequent rearing of a sturgeon larva confirms that a proportion of the eggs are viable. Likewise, based on the results of the larval sampling and the positive identification of the eggs based on visual observations, it was decided that further DNA analysis was not necessary.



LEGEND

- Angling (AG)
- Kick Netting (K)
- Minnow Trap (MT)
- Prawn Trap (PT)
- Substrate Grab (G)
- Substrate Mat (SM)

NO.	DATE (yyyy/mm/dd)	REVISION	BY

NECHAKO RIVER STURGEON PROJECT 2004

Figure 6.
Egg Sampling Sites

N W E S

100 0 100 200 300 400 Meters

Scale: *1:8,000*

Basemap Source:	Map Datum:	Project No:	File No:	Date:
Air Photo Mosaic by Dave Gordon -June 16 2004	UTM Zone 10. NAD 83	3518	Map#: 3518\apr\Egg Sampling Sites.apr Layout#: Figure 4.	2004/07/20

TRITON

3.3.2 HABITAT DOCUMENTATION

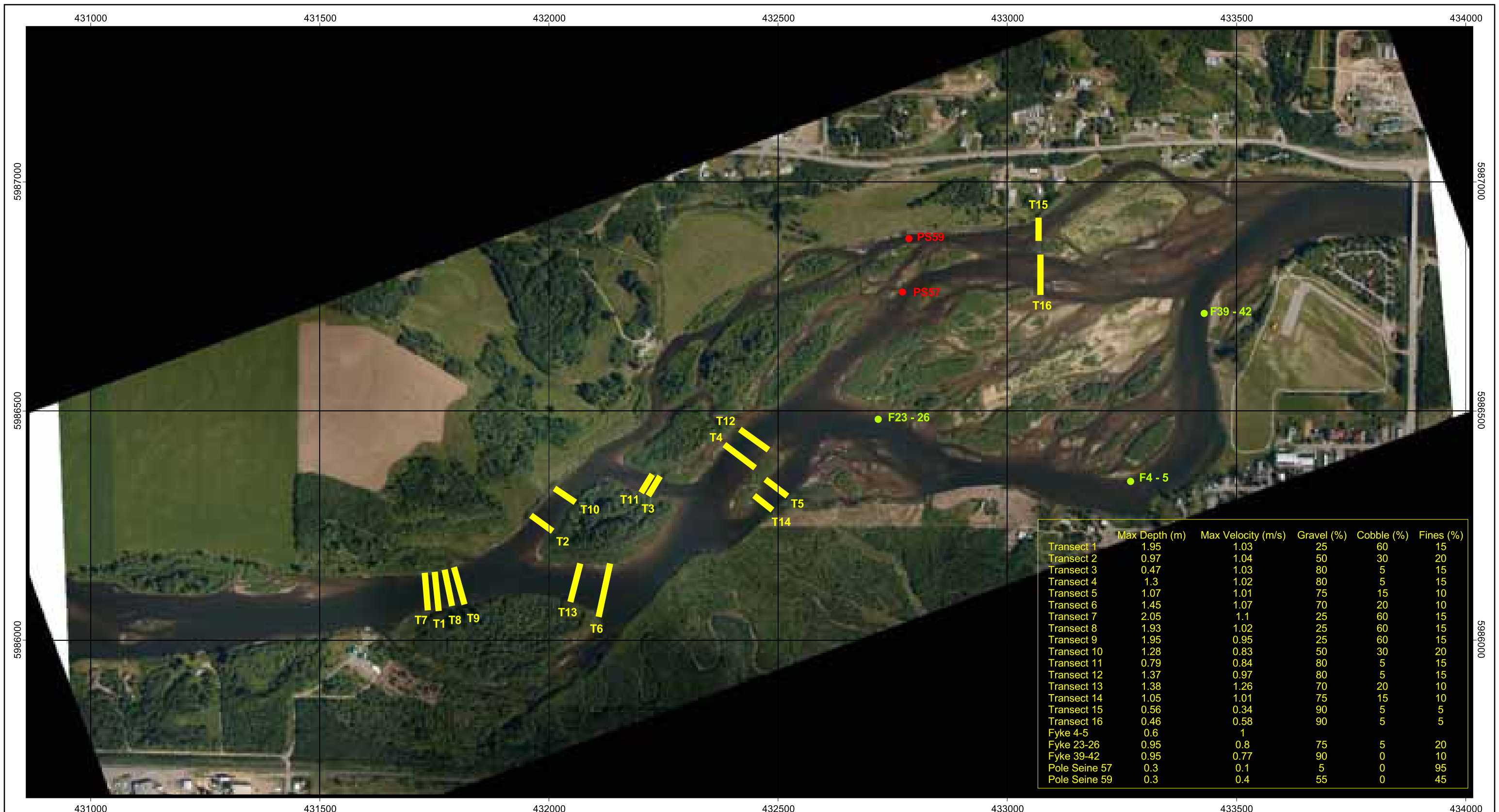
A total of 16 transects were completed in order to gather habitat data for the spawning area. The transects were located in the main channels where spawning activity was observed, as well as in channels upstream and downstream of that area. In addition, data on depth, velocity and substrate composition were also collected at the majority of the egg and larvae sample sites. Figure 7 shows the location of each of the transects as well as a subset of the sample sites where velocity and substrate data were collected. Detailed channel profiles and water velocities for transects 7-16 (detailed transects) can be found in Appendix 3: Figure 26.

Water Velocity

Water velocities were collected from each of the 16 transects (3 – 12 stations each) as well as from 65 pole seining sites, 51 fyke net sites, 2 net towing sites, and 12 egg mat sites. The majority of the velocities recorded at the sample sites (*i.e.* non-transect sites) were less than 1.0 m/s (average = 0.46 m/s; minimum = 0.0 m/s, maximum = 1.16 m/s). Similarly, the majority of the velocities collected along the transects were also less than 1.0 m/s, although 10 of the 16 transects completed had at least one velocity measurement greater than 1.0 m/s. However, each of those measurements was located at the deepest part of the transect and most were associated with the surface measurement (*i.e.* 80% of depth). The highest water velocity recorded along any of the transects was 1.26 m/s, which was recorded in Transect 13 (the transect nearest to where the release of gametes was observed).

Substrate

The results of the substrate analysis (Figure 7) showed that the study area is primarily dominated by a mix of gravel and fine substrates. Cobble substrates were only prevalent at the four upstream habitat transects (transects 1, 7-9), which corresponds to the area where the greatest density of white sturgeon were observed (Figure 3). With the exception of the four cobble dominated transects, gravel was the dominant substrate at transects located where sturgeon were observed to be congregating. Fine substrates were abundant at sites located closer to and downstream of the Vanderhoof bridge but were also prevalent within back channel habitats throughout the study area.



	Max Depth (m)	Max Velocity (m/s)	Gravel (%)	Cobble (%)	Fines (%)
Transect 1	1.95	1.03	25	60	15
Transect 2	0.97	1.04	50	30	20
Transect 3	0.47	1.03	80	5	15
Transect 4	1.3	1.02	80	5	15
Transect 5	1.07	1.01	75	15	10
Transect 6	1.45	1.07	70	20	10
Transect 7	2.05	1.1	25	60	15
Transect 8	1.93	1.02	25	60	15
Transect 9	1.95	0.95	25	60	15
Transect 10	1.28	0.83	50	30	20
Transect 11	0.79	0.84	80	5	15
Transect 12	1.37	0.97	80	5	15
Transect 13	1.38	1.26	70	20	10
Transect 14	1.05	1.01	75	15	10
Transect 15	0.56	0.34	90	5	5
Transect 16	0.46	0.58	90	5	5
Fyke 4-5	0.6	1			
Fyke 23-26	0.95	0.8	75	5	20
Fyke 39-42	0.95	0.77	90	0	10
Pole Seine 57	0.3	0.1	5	0	95
Pole Seine 59	0.3	0.4	55	0	45

LEGEND

Habitat Transects (T) · Pole Seine (PS) · Fyke Net (F)

NO.	DATE (yyyy/mm/dd)	REVISION	BY

NECHAKO RIVER STURGEON PROJECT 2004

Figure 7.
Habitat Transects

100 0 100 200 300 400 Meters
Scale: 1:8,000

Basemap Source: Air Photo Mosaic by Dave Gordon -June 16 2004
Map Datum: UTM Zone 10. NAD 83
Project No: 3518
File No: Map#: 3518\apr\Habitat Transects.apr Layout#: Figure 5.
Date: 2004/07/26

TRITON

3.3.3 PREDATOR ANALYSIS

A total of 15 minnow traps were set between May 21 and May 22 for a total effort of 214 hours (Table 7). Minnow trapping resulted in the capture of 3 redside shiner (RSS) adults (54 to 86 mm), one sculpin adult (82 mm) and 12 northern pikeminnow (NPM) juveniles (62-91 mm). Only trap bait was recovered from the 5 NPM stomachs analyzed (Table 10).

12 prawn traps were set for a total of 332.3 hours between May 19 and May 20 resulting in the capture of only 1 RSS (Table 8).

2.2 hours of angling effort resulted in the capture of 1 bull trout, 4 NPM sub adult (205 – 272 mm) and 1 rainbow trout (216 mm; Table 9). Three of the NPM had empty stomachs while the fourth had a partially digested RSS. The rainbow trout stomach yielded only invertebrates (Table 10).

3.3.3.1 Visual observations of potential predators

Three hours of snorkeling through the area of sturgeon activity failed to observe any aggregation of predator species. However an aggregation of adult suckers was noted approximately 100 meters upstream of the area of surgeon activity.

3.3.4 SAMPLING FOR LARVAE

12 kick netting locations were sampled between May 27th and May 30th over an area of 1,710 m² (Table 11). Total sampling time was 17.1 hours. The one sturgeon larva was captured at site K12. Detailed habitat data was collected at the site where the single sturgeon larva was captured. Depth along the kick-netting transect ranged from 0.53 – 0.55 m, with near-bottom velocities ranging from 0.87 – 1.22 m/s. Substrates consisted of 5% cobble, 20% small gravel (< 2 cm), and 75% gravel (2 – 6.5 cm) with a measured D_{95} of 8 cm.

Fyke net sampling: post-hatch larvae

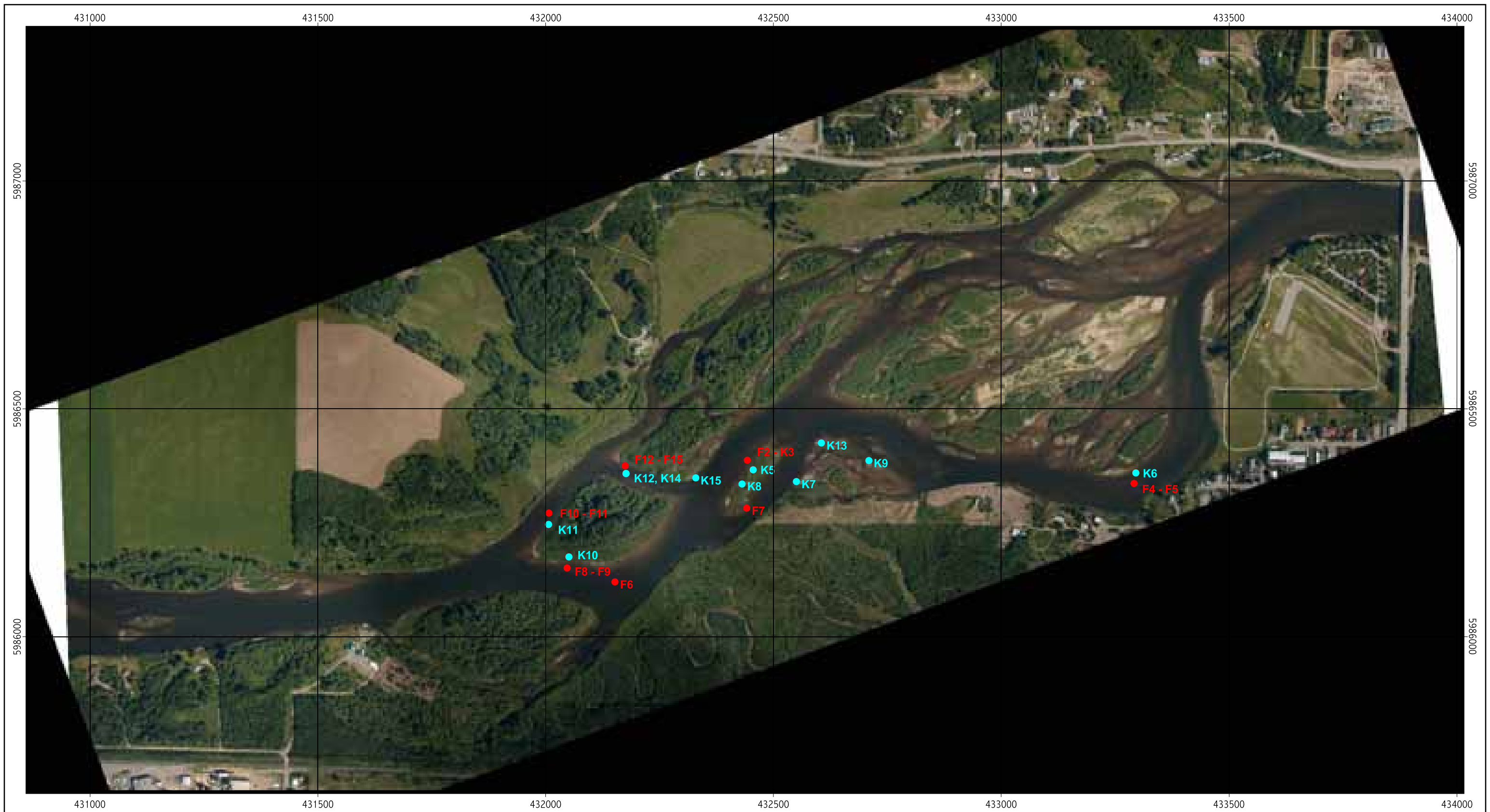
15 fyke net sets were deployed for pre-feeding larva between May 27th and May 30th (Figure 8). Total sampling time was 1,237 minutes and 62,660 m³ of water was sieved. Average depth was 0.72 m (range 0.45-0.85) and average velocity was 0.87 m/sec (range 0.46-1.16; Table 12). No larval sturgeon were captured.

Fyke net sampling: actively feeding larvae

In addition, fyke net sampling was also conducted for actively feeding larva emerging out of the substrate. 36 fyke net sets were deployed between June 6 and June 8, 2004 (Figure 9). Sampling effort was 3,094 minutes and 93,445 m³ of water was sieved. Average depth was 0.95 m (range 0.35 – 3.5 m). Average velocity was 0.67 m/sec. (range 0.28 – 1.04 m/sec.; Table 13). Figure 9 shows locations of fyke net sampling for actively feeding larva. Substrate was dominated by gravels throughout the net locations. 461 larval suckers were captured as well as 2 chinook young of the year. No larval sturgeon were captured.

Pole seining – actively feeding larvae

Pole seining was undertaken between June 7th and June 9th (Table 14). 65 pole seine sets were undertaken during this period. Maximum depths at pole seine sites ranged from 0.1 to 0.7 meters while maximum velocity ranged from 0 - 0.5 m/sec. Total area sampled was 3,588 m². Substrate varied between gravel dominated or fines dominated due to localized velocities at the sample sites. A total of 1,192 fish were captured by pole seining with chinook being the dominant species caught (30%). Other species captured included juvenile suckers (16%), larval suckers (1%), northern pikeminnow (22%), redside shiner (15%), mountain whitefish (9%), longnose dace (1%) and leopard dace (6%). No larval sturgeon were captured.



LEGEND

- Fyke Net (F)
- Kick Netting (K)

NO.	DATE (yyyy/mm/dd)	REVISION	BY

NECHAKO RIVER STURGEON PROJECT 2004

Figure 8.
Larval (Post Hatch) Sites

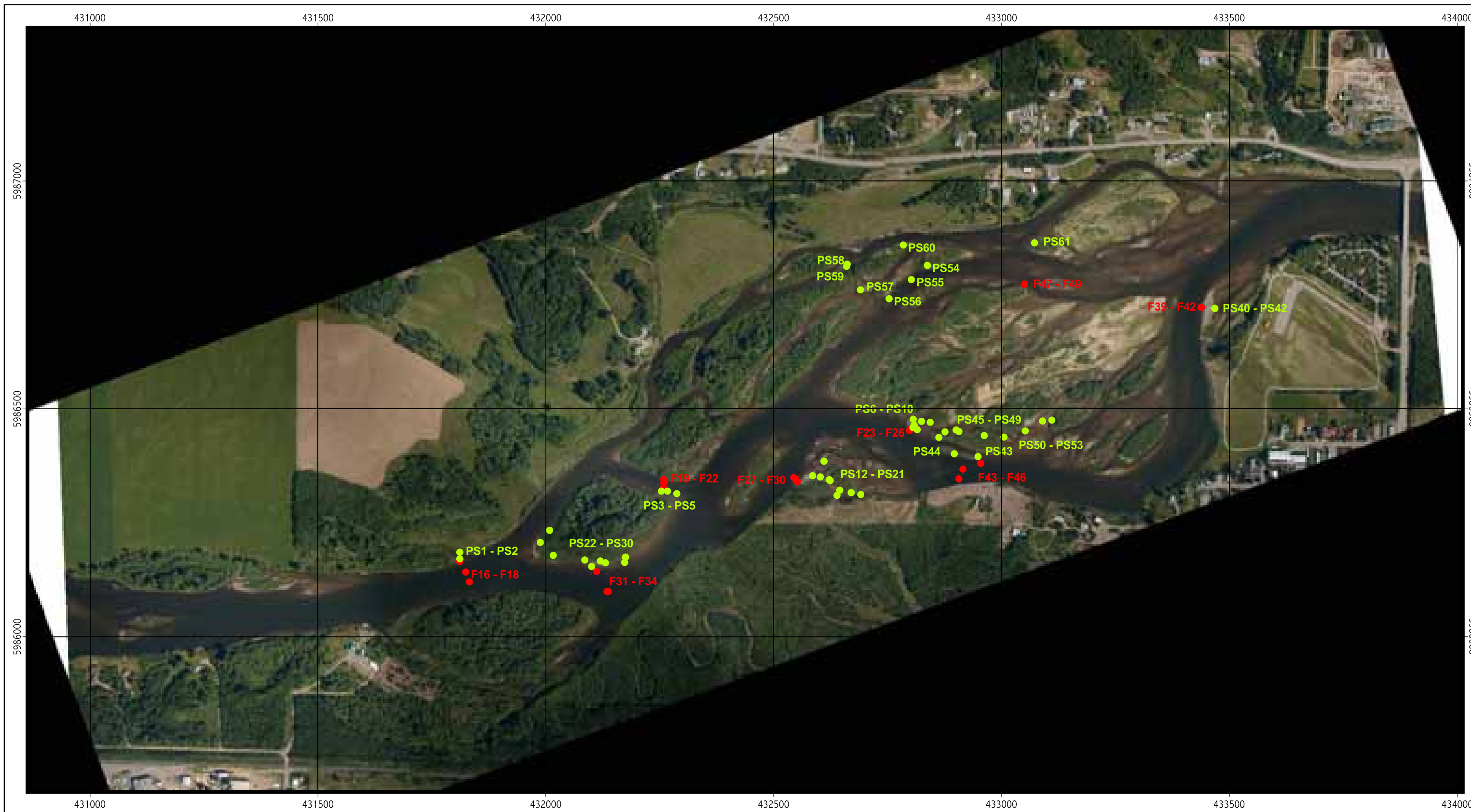
N W E S

100 0 100 200 300 400 Meters

Scale: *1:8,000*

Basemap Source:	Map Datum:	Project No:	File No:	Date:
Air Photo Mosaic by Dave Gordon -June 16 2004	UTM Zone 10. NAD 83	3518	Map#: 3518\apr\fig4.apr Layout#: fig 4	2004/07/20

TRITON



LEGEND

- Fyke Net (F)
- Pole Seine (PS)

NO.	DATE (yyyy/mm/dd)	REVISION	BY

NECHAKO RIVER STURGEON PROJECT 2004

Figure 9.
Larval (Actively Feeding) Sites

N W E S

100 0 100 200 300 400 Meters

Scale: *1:8,000*

Basemap Source:	Map Datum:	Project No:	File No:	Date:
Air Photo Mosaic by Dave Gordon -June 16 2004	UTM Zone 10. NAD 83	3518	Map#: 3518\apr\fig5.apr Layout#: fig 5	2004/07/20

TRITON

4 DISCUSSION

The 2004 Nechako white sturgeon sampling program proved valuable in extending our knowledge of behaviour of Nechako white sturgeon. The existing information on sturgeon aggregation in the Vanderhoof area allowed for an opportunistic program to be developed focusing on spawning activity.

The monitoring of pre-spawning white sturgeon using radio telemetry confirmed continued use of previously identified areas (*e.g.* RL&L 2000a, Golder 2003) downstream of Vanderhoof. Prior to the actual documented spawning event sturgeon movements were detected from the staging areas, possibly reflecting the approaching river conditions requisite for spawning. Work on sturgeon in the Kootenai River recorded increase of short-range daily movements prior to the onset of actual spawning (Paragamian and Kruse 2001).

Although difficult to conclusively determine, the duration of the actual spawning activity appeared to be short (approximately 36 hours) and less than some values reported in the literature. General spawning periods reported included spawning over several weeks in the Fraser River (Perrin *et al.* 2003) to several months in the Columbia River (Parsley *et al.* 1993). However spawning periods in larger systems may reflect spatial/temporal differences in spawning cues for multiple spawning populations. Data from individual spawning sites in the Fraser River provide estimates of spawning periods varying from 1 to 9 days (Perrin *et al.* 2003). Kootenai River female sturgeon demonstrated a residency of between 1-28 days (average 10.5) in the documented spawning reach (Paragamian and Kruse 2001).

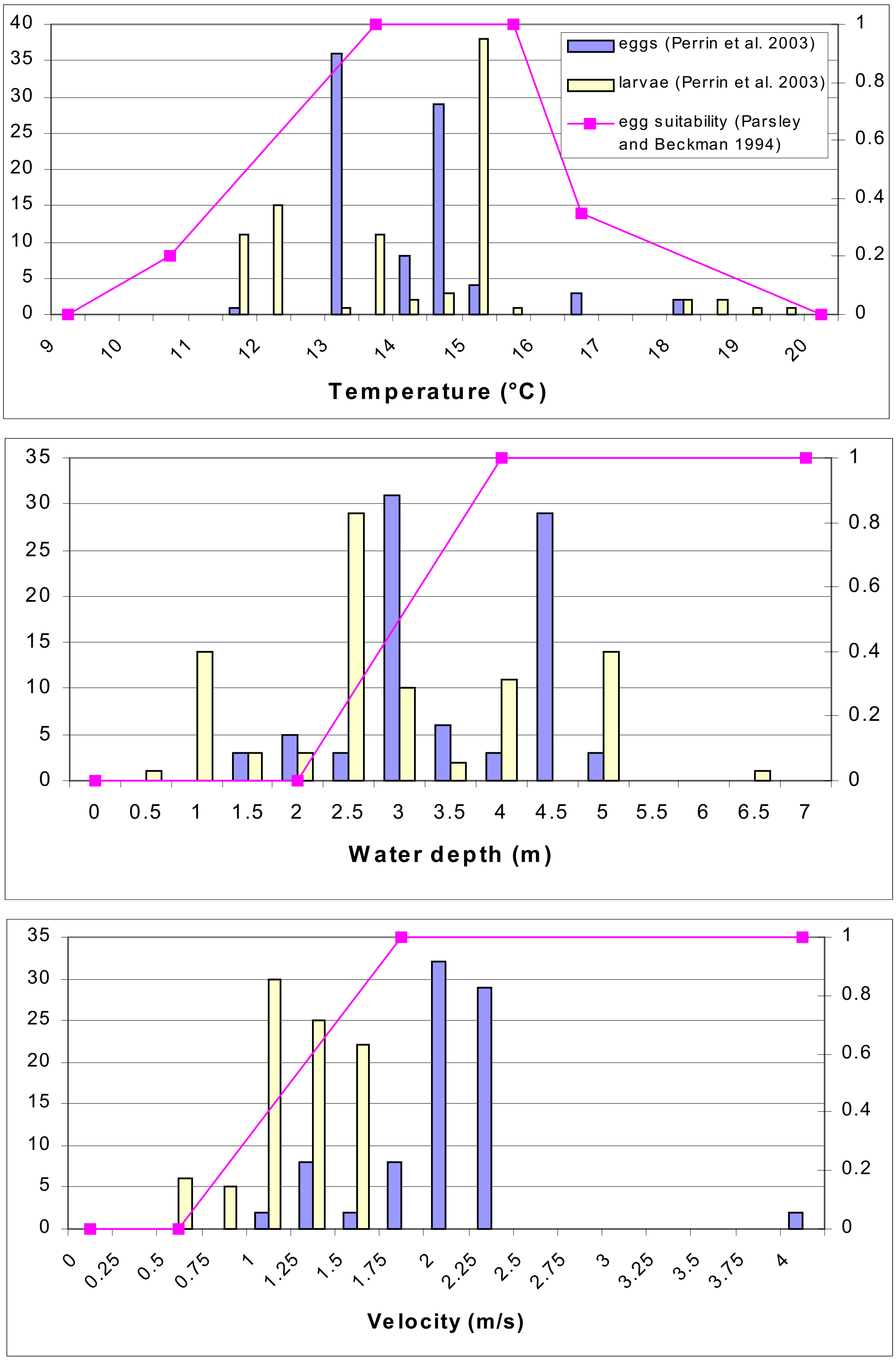
Depth and velocity preference for Nechako sturgeon spawning habitat depart from literature values. The mean maximum depth of 1.79 m is below documented values in Columbia studies, where the lower range of spawning suitability (0) was limited at 2 meters with a suitability of use of 1 noted at 4 meter depth and deeper (Parsley and Beckman 1994; Figure 10). Spawning depths in the Fraser River (based on egg capture data) indicated that water depths averaged 2.9 meters, which are noted as being less than found in other regulated rivers (Perrin *et al.* 2003).

Maximum velocities recorded at Nechako spawning sites ranged from 1.02 to 1.26 m/s. These velocities were reflective of the lower to mid range of habitat preference for Columbia River (Parsley and Beckman 1994), and lower than values measured in the Fraser River (average 1.8 m/sec, based on egg capture locations, Perrin *et al.* 2003).

Nechako spawning was observed to take place in the vicinity of existing chinook dunes (Bill Rublee, pers. obs). These dunes may supply some hydraulic complexity that is preferred by spawning sturgeon. Zones of hydraulic complexity have been noted as preferred areas for sturgeon spawning in other systems both regulated (Parsley *et al.* 1993) and unregulated (Perrin *et al.* 2003).

Turbidity in the Nechako was low (range of 1.4 to 2.3 NTU's during the week of the congregation), especially compared to Fraser River spawning locations where turbidity averaged 42 NTU's (Perrin *et al.* 2003). In the Fraser system it is hypothesized that increased turbidity may provide cover and result in the selection of spawning habitats that are generally shallower than found in the Columbia where water clarity is high. Due to low turbidity and shallow depths in the Nechako, spawning sturgeon were easily observed. No actual record of visual observation of white sturgeon spawning was found in the literature reviewed. It is possible that the combination of shallow water depth and low turbidity may have some effect on the short duration spawning period documented in the Nechako River. Sturgeon activity in the Vanderhoof area has been observed (2004 and anecdotally) over several years, it is not clear whether this is an annual event, as more years of observation will be required to answer this. It is interesting to note however that local residents appear to be largely unaware of this event taking place in spite of the high river use in the documented spawning area. This lack of knowledge could be due either to intermittent activity or the short duration of the activity.

Figure 10. Water temperature, depth (primary y axis) and near-bed velocity (secondary y axis) at sites where sturgeon eggs and larvae were collected in the Fraser River (Perrin *et al*. 2003), and suitability of use conditions for spawning in the Columbia River (Parsley and Beckman 1994). Figure taken from Perrin *et al*. 2003.



The second phase of the project provided the opportunity to assess success of spawning. Egg mats placed approximately 1 day after the spawning event resulted in the capture of only one egg. This could be due to either minimal egg deposition or dispersal of eggs prior to sampling. Similarly a program of substrate sampling, kick netting, and fyke netting resulted in the capture of only 3 additional eggs and 1 yolk sack larva.

Depths at which eggs (approximately 1 m for kick netting 1.5 m for egg mat) and the larva (0.55 m) were captured were notably shallower than found in other studies where depths ranged from 2.9 meters in the turbid Fraser River (Perrin *et al.* 2003) to 4 meters and greater in the Columbia River (Parsley and Beckman 1994). Velocities at the capture sites ranged from 0.5 to 1.1 m/sec for sites where eggs were captured and near-bottom velocities ranged from 0.87 to 1.22 m/s along the kick-netting transect where the sturgeon larva was captured. Based on capture of eggs, post spawn velocities found in the Fraser averaged 1.8 m/sec. (Perrin *et al.* 2003) and from 0.6 to 2.5 m/sec in the Columbia (Parsley and Beckman 1993). Substrate was generally gravels, similar to substrates where sturgeon eggs were located in other studies. (Perrin 2003, Parsley *et al.* 1993, Paragamian and Kruse 2001).

Eggs captured were generally coated with algae or fines (Plate 13), likely due to their adhesive nature. Paragamian *et al.* (2001) had similar observations of examined eggs coated with sand, however, viability did not appear to be affected. A recent study by Kock (2004) found that a sediment cover of only 5 mm significantly reduced white sturgeon embryo survival. The two studies should not necessarily be viewed as contrary, as the Paragamian study refers to a coating of sand around the egg, while the Kock study involved burying eggs under 5 mm and 20 mm of sand. However, the topic might warrant further investigation, especially with regards to the viability of eggs coated with algae as there is currently no information on the subject in the literature.

The lack of water depth and reduced water clarity could have implications for post spawning survivals of Nechako sturgeon. In addition, substrate with large interstitial spaces that could afford early rearing protection for sturgeon is largely lacking in the stream section immediately downstream of the known spawning area. Predation of sturgeon eggs has been documented to occur in the Columbia River, by suckers, northern pikeminnow and sculpins (Miller and Beckman 1996) species all present in the Nechako River. Although no direct evidence of egg predation by piscivors was documented this risk could be present.

The 2004 study has documented that sturgeon can spawn in the Nechako River and that viable progeny (to the larval stage) can be produced. Clearly cues are available to induce spawning activity for Nechako Sturgeon, however the relative success of the activity needs further study. Important information requirements include:

- the determination of the periodicity of the congregation, and an understanding of physical parameters that may trigger a congregation (*e.g.* water temperature, discharge);
- an assessment of the effectiveness of spawning (amount of egg deposition);
- the identification of egg and larvae dispersal mechanisms;
- an assessment of the ability of the receiving environment to provide the habitat needs for eggs and larvae (level of survival of eggs and larvae).

5 Recommendations for Future Work

Recommendations for future study are directed at increasing our knowledge of spawning success as well as risks to early life histories.

Future work plans could include:

1. The continued monitoring of migration out of holding areas (*e.g.* km 116) using radio telemetry to pick up early forays in order to provide lead time for spawner documentation and egg collection.
2. The continued monitoring of temperature and flows in conjunction with overflights of the identified spawning area during periods where conditions are appropriate for spawning. The goal of monitoring would be to determine the periodicity of spawning and to get a better understanding of what physical cues are important (*e.g.* temperature, discharge).
3. The development/selection of a standard methodology to estimate adult numbers in order to accurately compare the size of spawning congregations from year to year.

4. The development and implementation of a methodology to understand downstream dispersal of eggs and larvae. This could involve setting egg mats prior to spawning, and D-ring fyke nets during spawning along a number of transects within and downstream of the spawning area.
5. The development and implementation of a methodology to determine amount of egg deposition. This could include capturing females before and after spawning to determine egg retention.
6. A detailed documentation of substrates in the vicinity of the spawning area. Substrates with interstitial spaces appear to be limited in the area (most substrates compacted with fines), and the only larva captured was located in an area where gravels were noticeably loose. If interstitial spaces are determined to be important for egg/larvae development, investigations into appropriate artificial substrates for early rearing could be completed (*e.g.* gravel/cobble baskets could be placed downstream of the spawning location with the objective of capturing eggs).
7. Sampling with D-ring fyke nets for emergent larvae, to determine their habitat preference and distribution.

Ancillary to the data collection:

1. Explore the opportunity of developing a program to capture sufficient eggs for supplementation.
2. Develop a predictive dispersal model for eggs and larvae. A better understanding of dispersal would allow for more targeted sampling for eggs or larvae.
3. Consider the effect recreational boating may have on the congregating sturgeon (6 river boats were observed passing through the congregation in a 3-hour period on the evening of May 18).

Report reviewed and approved by:

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<u>Personal Communication</u>

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Appendix 1

Water Temperature and Discharge Data

Table 2. Daily mean discharge, and daily mean, minimum and maximum temperature at the Vanderhoof bridge (Water Survey of Canada station 08JC001) from April 1 to June 30, 2004

Date	Discharge (m^3/sec)	Mean Daily Temperature (°C)	Maximum Daily Temperature (°C)	Minimum Daily Temperature (°C)
4/1/03	61.9	3.9	5.70	2.50
4/2/03	59.9	4.7	6.70	3.00
4/3/03	60.0	5.4	7.50	3.60
4/4/03	61.3	5.8	7.80	4.30
4/5/03	62.0	6.0	7.90	4.30
4/6/03	62.2	5.9	7.40	4.40
4/7/03	62.0	6.3	8.20	4.70
4/8/03	63.2	6.6	8.60	4.70
4/9/03	63.9	6.9	9.00	5.10
4/10/03	65.2	7.0	8.20	5.40
4/11/03	67.1	8.0	10.00	6.10
4/12/03	69.4	8.7	10.70	6.90
4/13/03	72.8	8.0	8.70	7.40
4/14/03	75.5	6.5	7.20	5.60
4/15/03	77.0	5.8	7.60	4.40
4/16/03	79.4	5.7	7.70	4.00
4/17/03	80.5	6.5	7.90	5.10
4/18/03	81.2	7.2	8.60	6.00
4/19/03	81.5	7.3	9.00	5.80
4/20/03	81.4	8.0	10.30	6.00
4/21/03	81.2	8.9	10.90	7.10
4/22/03	82.7	8.7	9.70	7.50
4/23/03	83.2	8.2	8.60	7.90
4/24/03	84.8	7.4	8.00	6.80
4/25/03	84.8	7.0	7.70	6.30
4/26/03	85.2	7.0	7.70	6.30
4/27/03	86.5	7.1	8.50	6.70
4/28/03	89.3	8.5	10.60	6.60
4/29/03	92.4	9.5	11.80	7.30
4/30/03	94.9	10.6	12.70	8.70
5/1/03	96.3	11.3	12.90	9.70
5/2/03	98.9	11.7	13.10	10.50
5/3/03	102.0	11.8	13.00	11.10
5/4/03	105.0	10.6	11.20	10.00
5/5/03	112.0	10.2	12.00	8.70
5/6/03	117.0	9.9	11.90	8.00
5/7/03	120.0	10.8	12.80	8.80
5/8/03	122.0	10.4	11.30	9.90
5/9/03	125.0	9.3	10.00	8.90
5/10/03	127.0	9.6	10.90	8.70
5/11/03	130.0	9.5	11.40	7.80
5/12/03	132.0	10.0	11.60	8.20
5/13/03	134.0	10.5	12.20	8.70
5/14/03	133.0	11.1	12.70	9.50
5/15/03	134.0	12.1	14.00	10.40

Date	Discharge (m^3/sec)	Mean Daily Temperature (°C)	Maximum Daily Temperature (°C)	Minimum Daily Temperature (°C)
5/16/03	133.0	12.8	14.80	11.00
5/17/03	**132.0**	**13.1**	**15.30**	**11.10**
5/18/03	**131.0**	**13.9**	**16.00**	**11.90**
5/19/03	**130.0**	**14.9**	**16.80**	**12.90**
5/20/03	**129.0**	**15.2**	**16.70**	**13.40**
5/21/03	129.0	13.7	15.30	12.80
5/22/03	127.0	12.3	14.10	10.90
5/23/03	126.0	11.6	13.50	9.70
5/24/03	125.0	13.1	15.30	11.20
5/25/03	124.0	13.6	14.50	12.90
5/26/03	123.0	13.4	14.60	12.20
5/27/03	122.0	13.0	14.30	11.50
5/28/03	123.0	13.2	14.30	12.40
5/29/03	123.0	13.4	15.00	11.70
5/30/03	121.0	13.6	15.10	12.50
5/31/03	121.0	13.1	14.20	11.90
6/1/03	120.0	13.6	15.00	12.30
6/2/03	119.0	13.7	15.60	11.80
6/3/03	117.0	14.6	16.80	12.40
6/4/03	116.0	15.8	17.80	13.80
6/5/03	114.0	15.9	16.90	15.00
6/6/03	116.0	14.1	15.00	13.60
6/7/03	119.0	14.5	16.80	12.50
6/8/03	120.0	15.9	18.20	14.00
6/9/03	122.0	16.6	18.30	14.90
6/10/03	121.0	17.6	19.60	16.00
6/11/03	120.0	17.3	19.10	15.70
6/12/03	119.0	16.6	17.80	15.40
6/13/03	119.0	15.6	16.30	14.70
6/14/03	119.0	14.7	16.40	13.40
6/15/03	117.0	15.4	17.60	13.40
6/16/03	117.0	16.4	18.50	14.30
6/17/03	116.0	17.3	19.50	15.10
6/18/03	113.0	18.4	20.70	16.30
6/19/03	111.0	19.0	21.40	16.90
6/20/03	109.0	20.0	22.10	17.90
6/21/03	108.0	20.8	22.80	19.00
6/22/03	108.0	21.2	23.40	19.30
6/23/03	107.0	21.7	23.90	19.70
6/24/03	106.0	22.0	23.80	20.10
6/25/03	104.0	21.7	23.40	20.10
6/26/03	103.0	21.6	23.40	19.80
6/27/03	102.0	19.7	20.90	18.40
6/28/03	104.0	18.7	20.70	17.70
6/29/03	104.0	18.8	21.10	16.90
6/30/03	103.0	19.7	21.90	17.80

Appendix 2

Telemetry Data

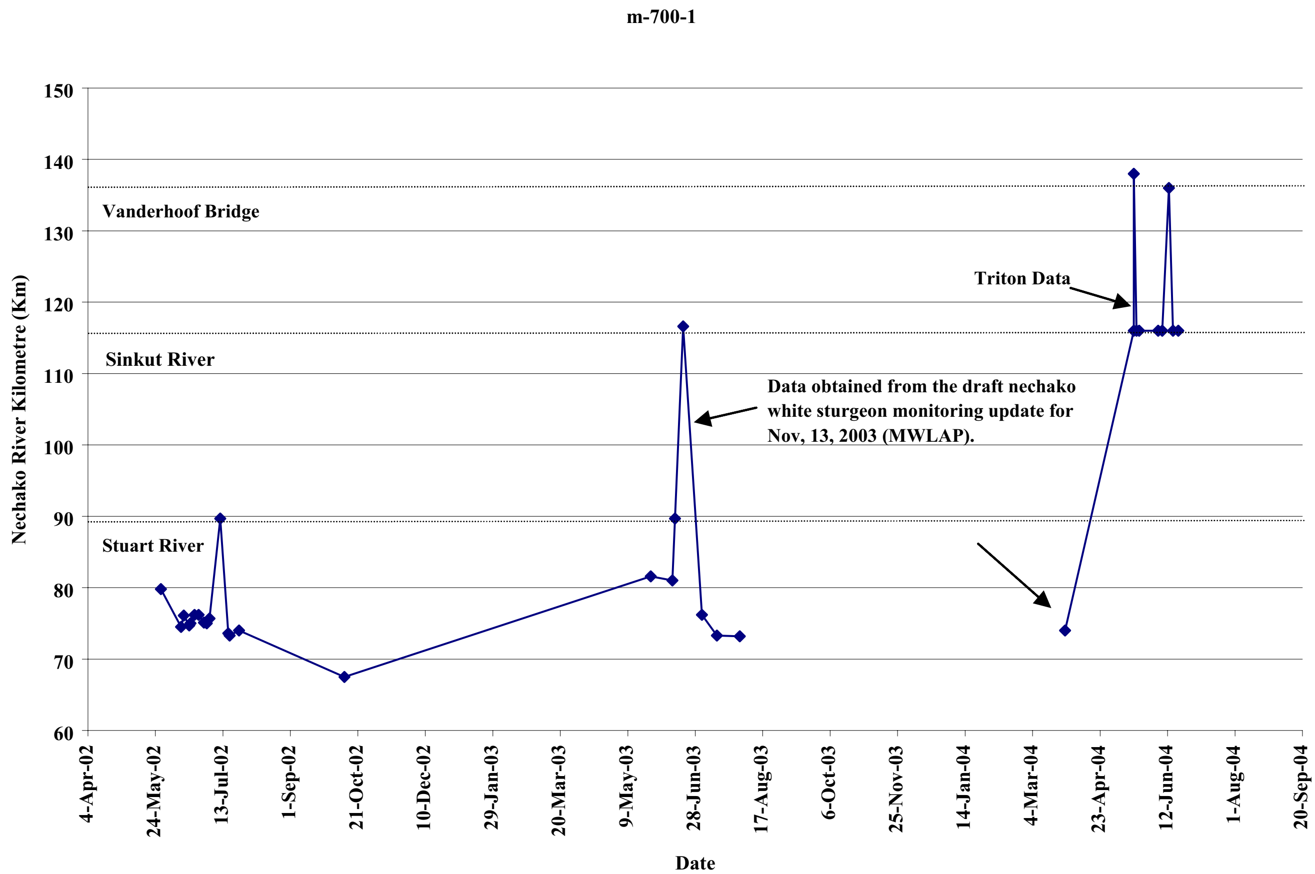


Figure 11. Detailed telemetry data for 149.700 – 1.

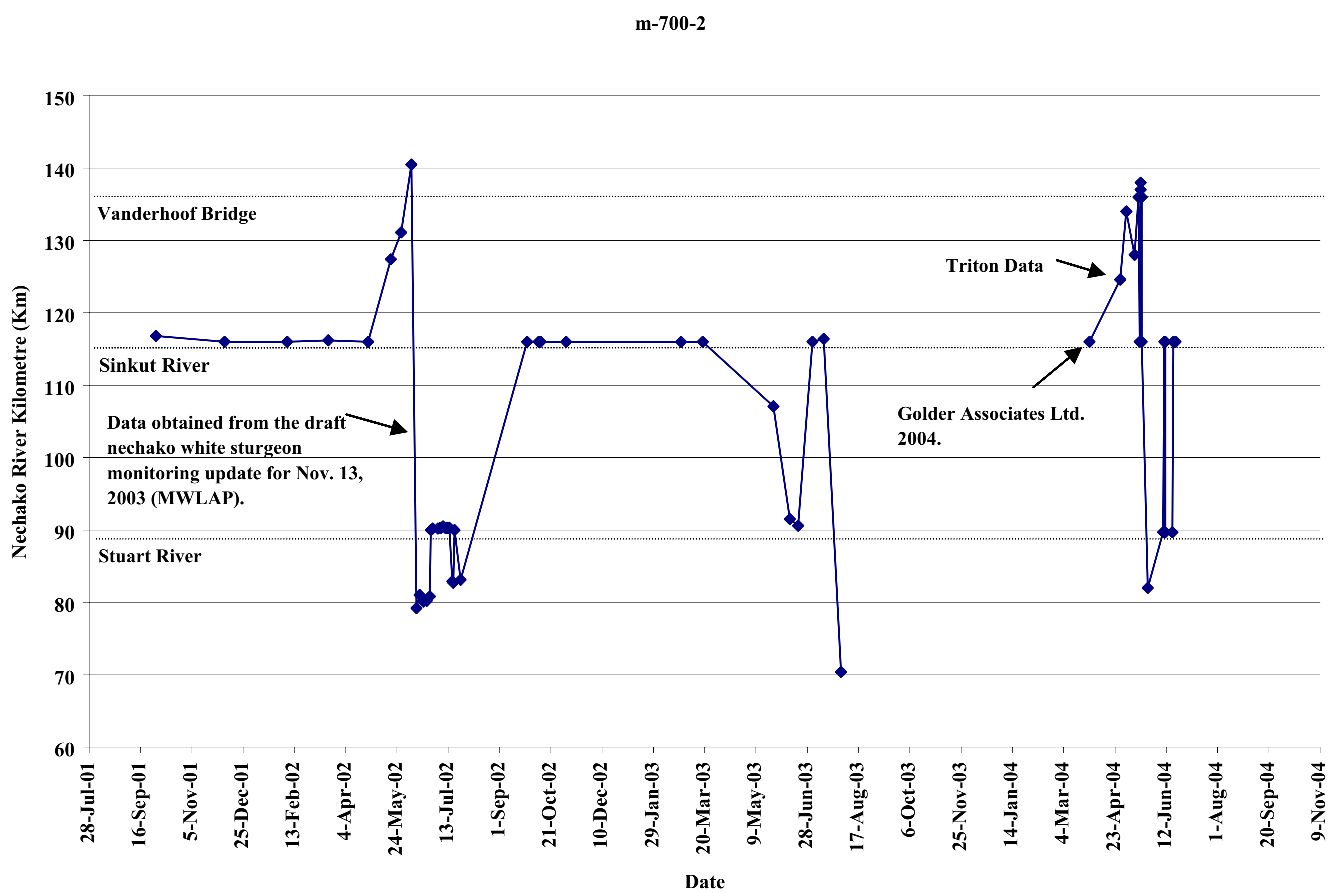


Figure 12. Detailed telemetry data for 149.700 – 2.

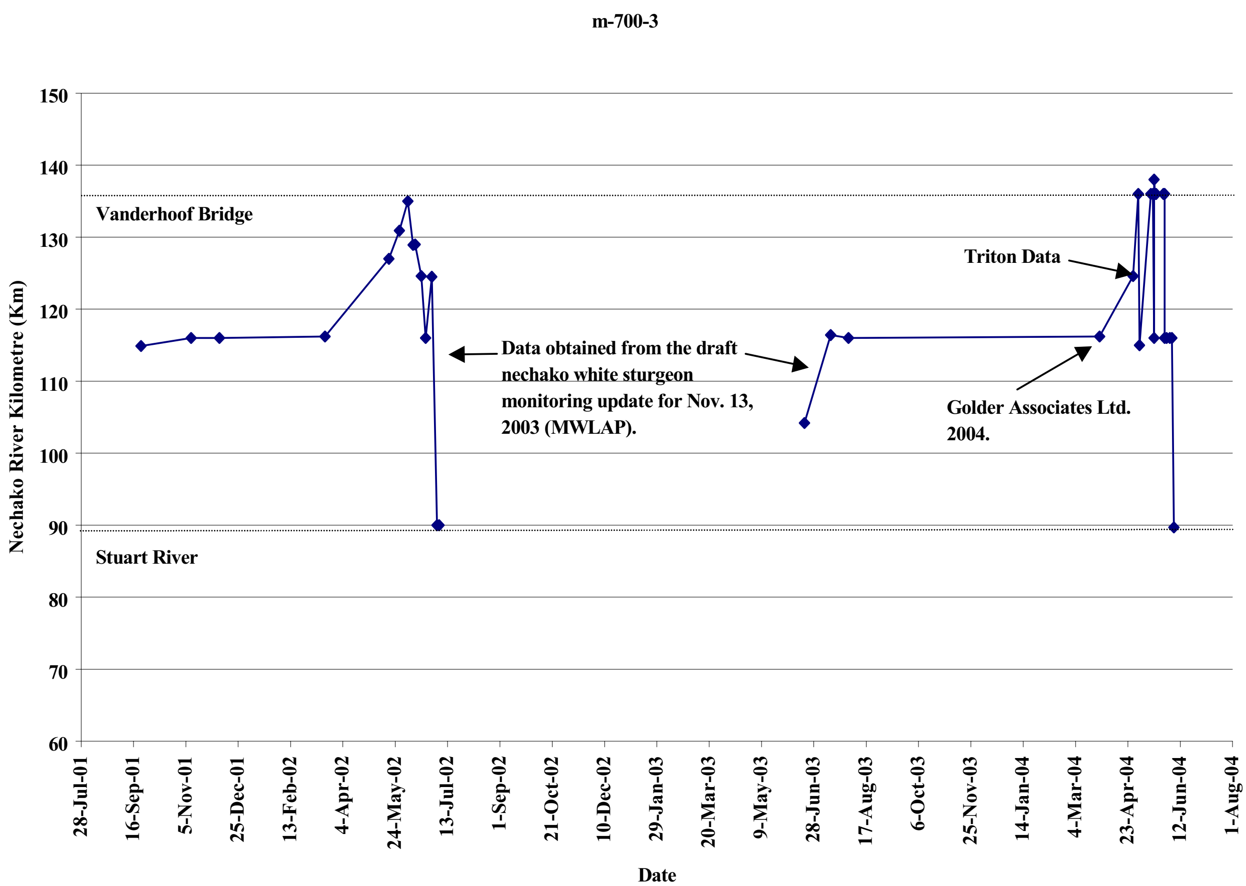


Figure 13. Detailed telemetry data for 149.700 – 3.

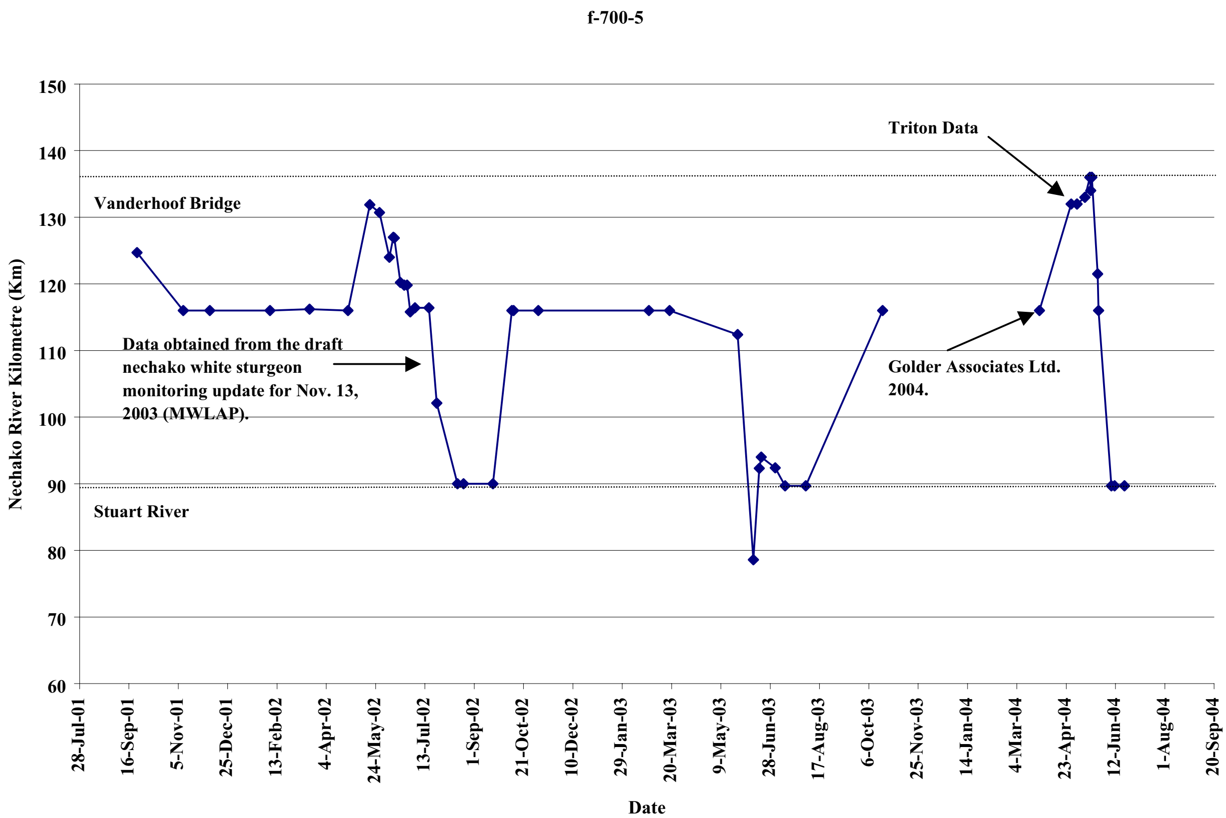


Figure 14. Detailed telemetry data for 149.700 – 5.

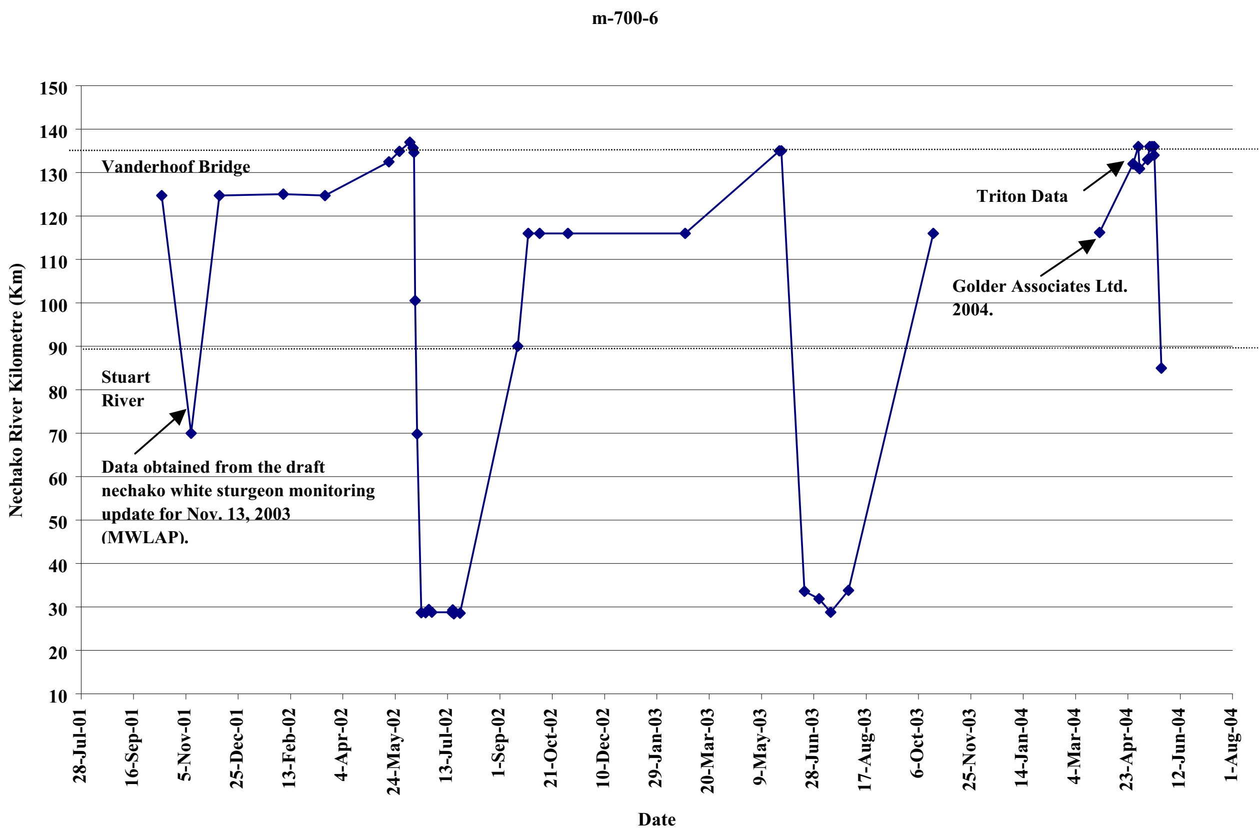


Figure 15. Detailed telemetry data for 149.700 – 6.

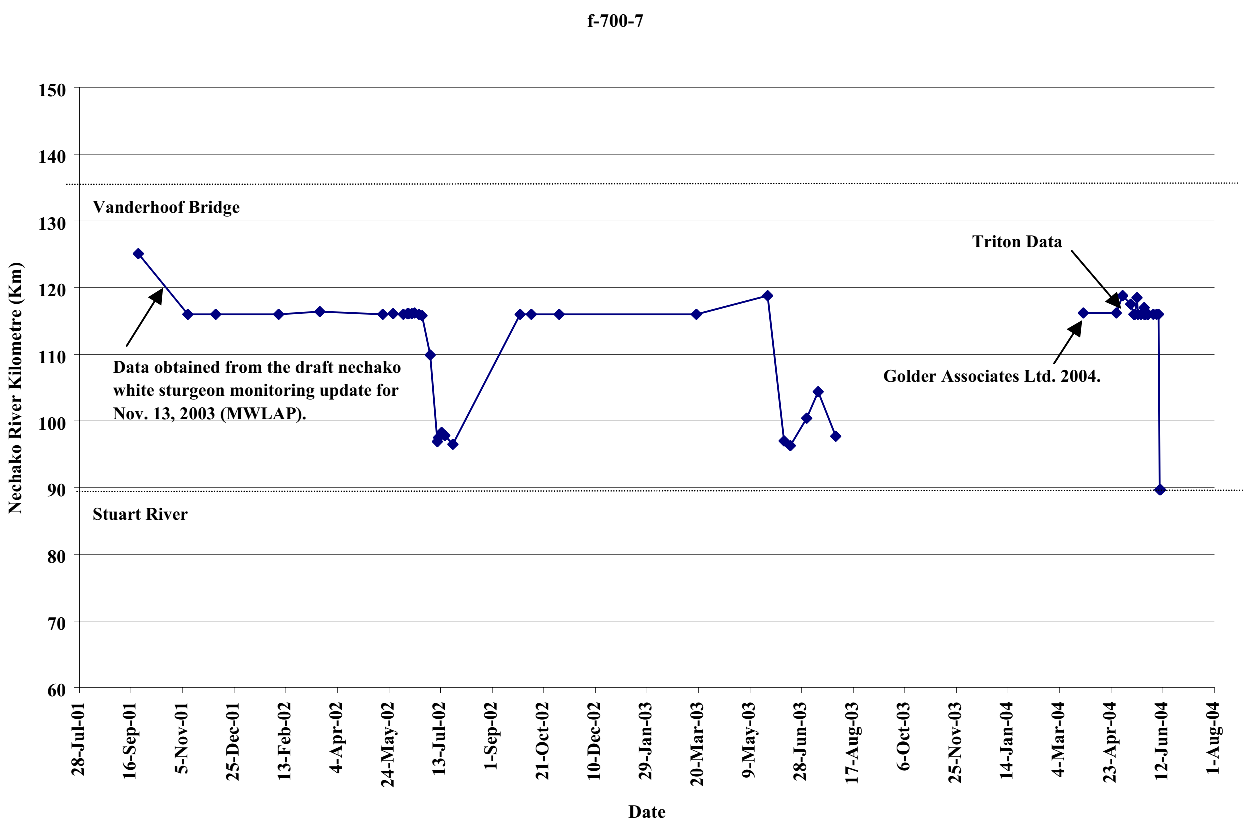


Figure 16. Detailed telemetry data for 149.700 – 7.

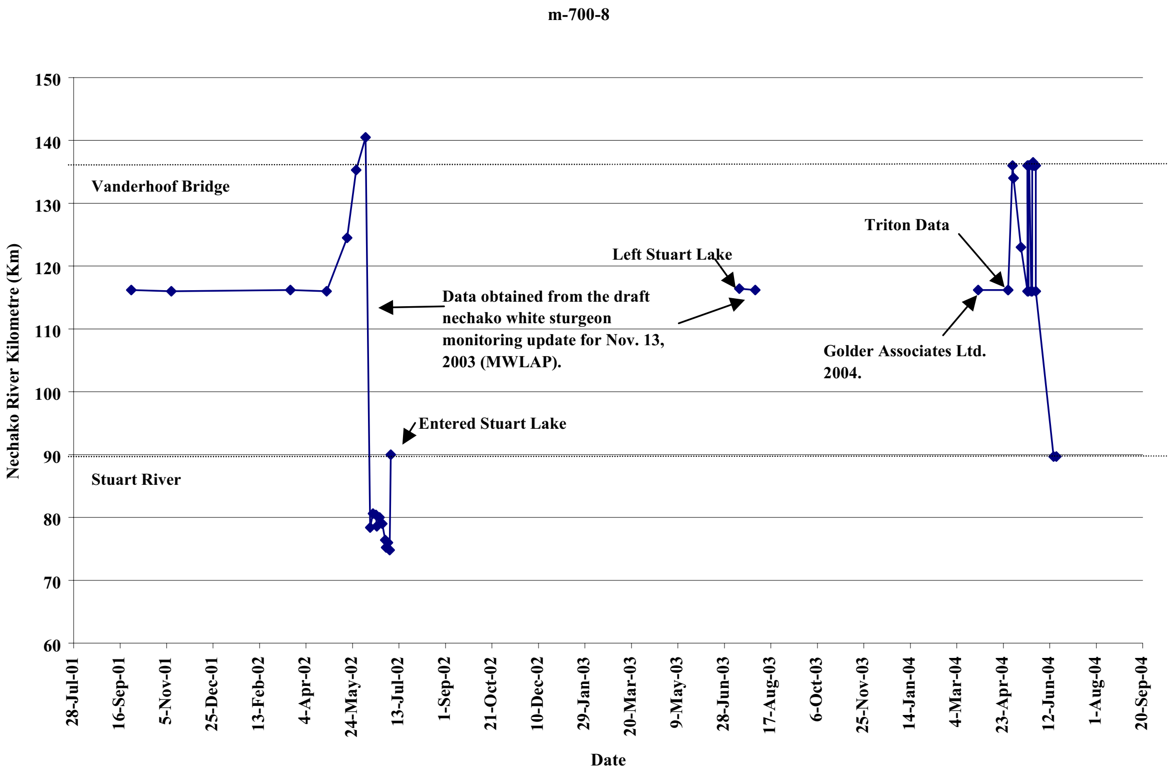


Figure 17. Detailed telemetry data for 149.700 – 8.

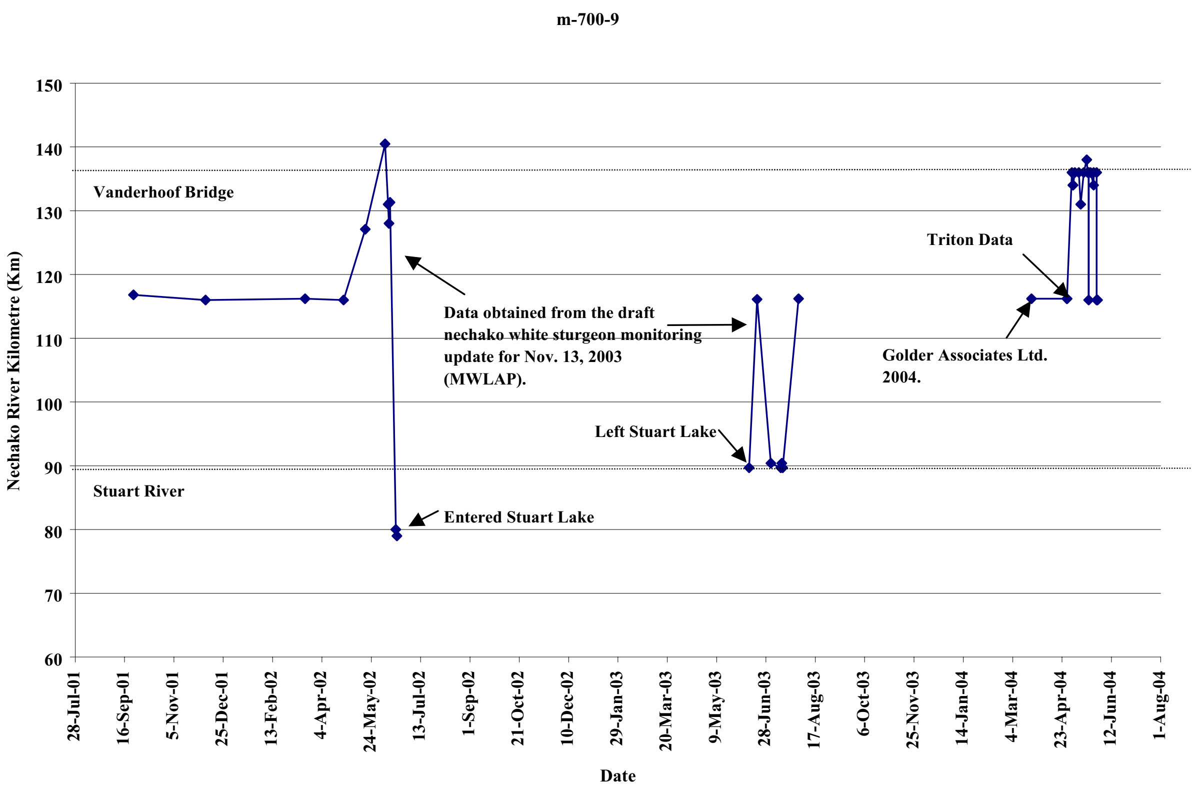


Figure 18. Detailed telemetry data for 149.700 – 9.

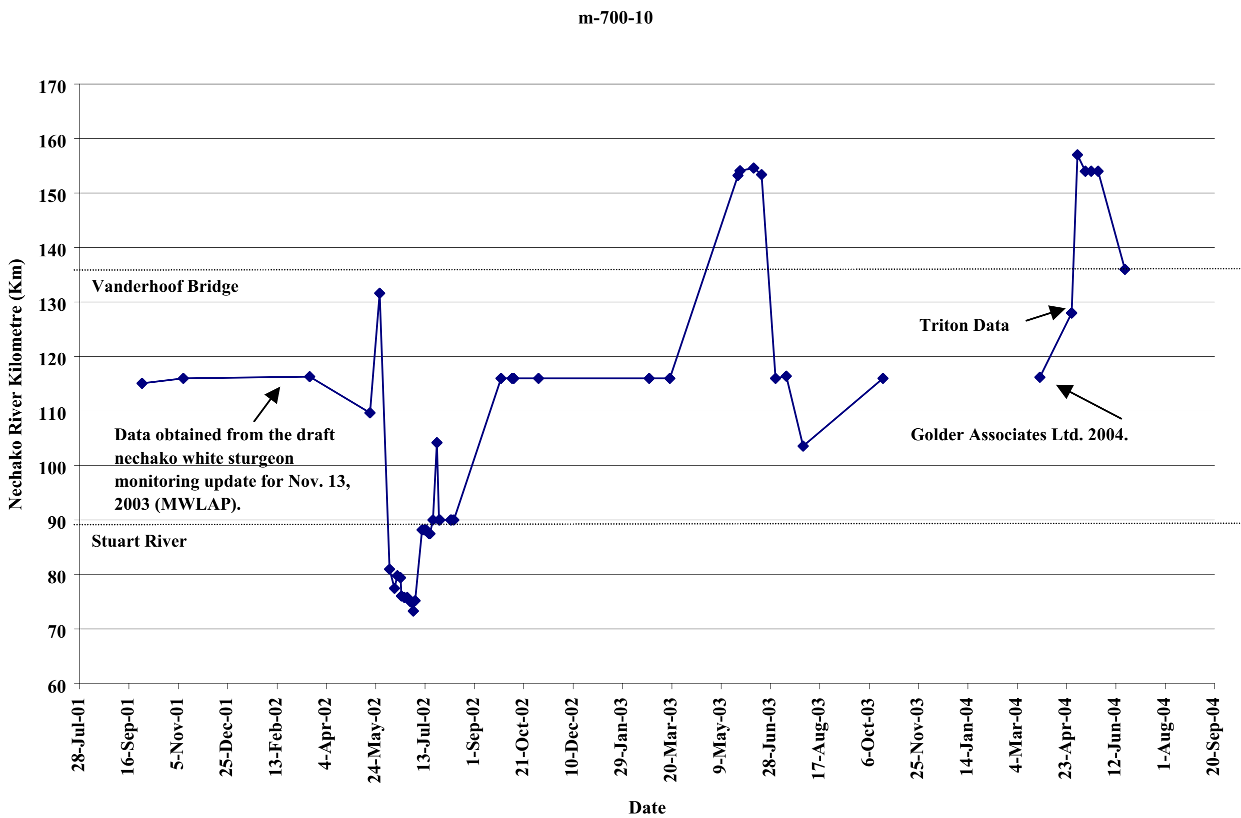


Figure 19. Detailed telemetry data for 149.700 – 10.

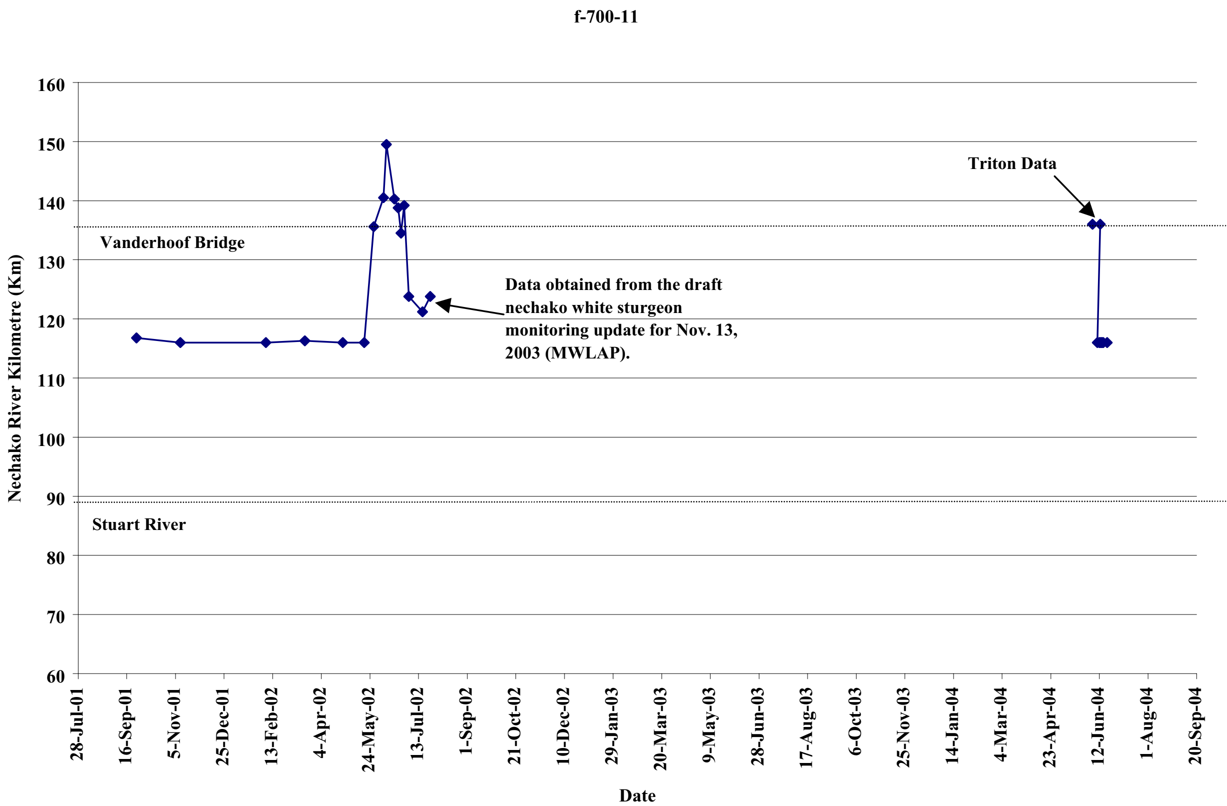


Figure 20. Detailed telemetry data for 149.700 – 11.

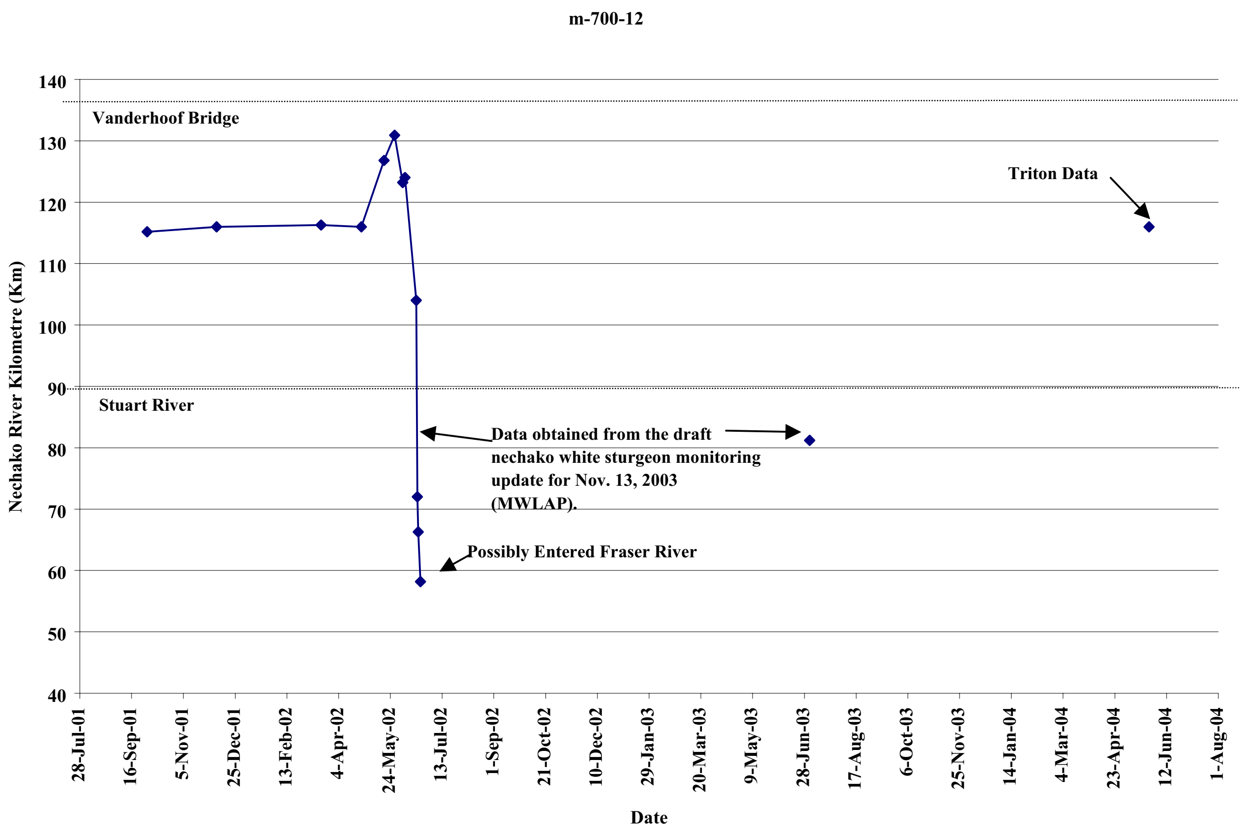


Figure 21. Detailed telemetry data for 149.700 – 12.

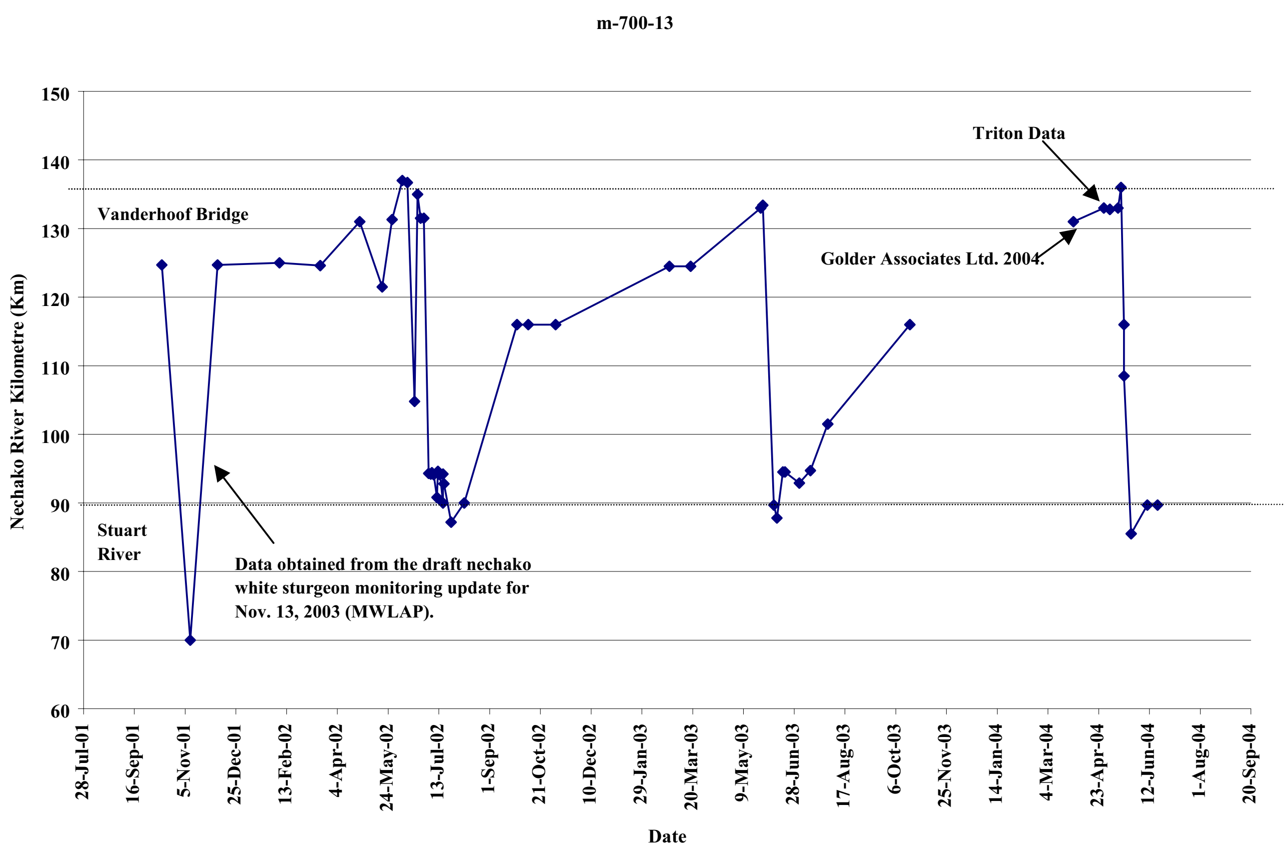


Figure 22. Detailed telemetry data for 149.700 – 13.

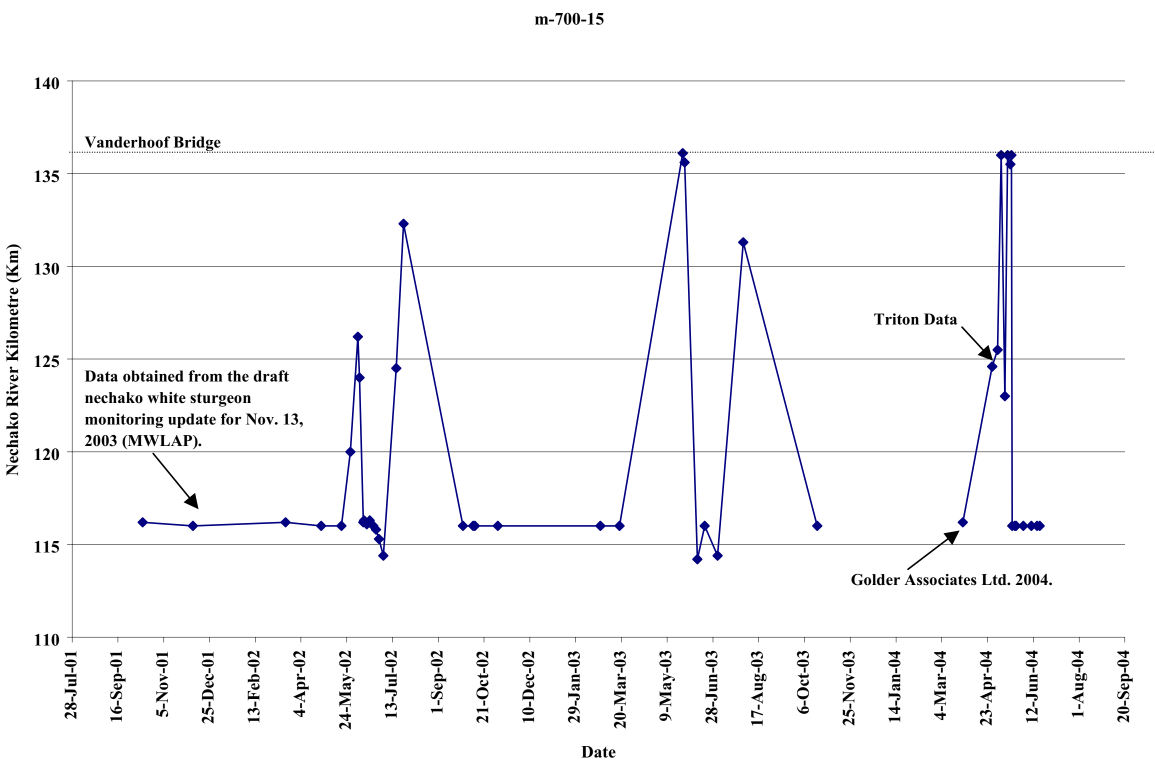


Figure 23. Detailed telemetry data for 149.700 – 15.

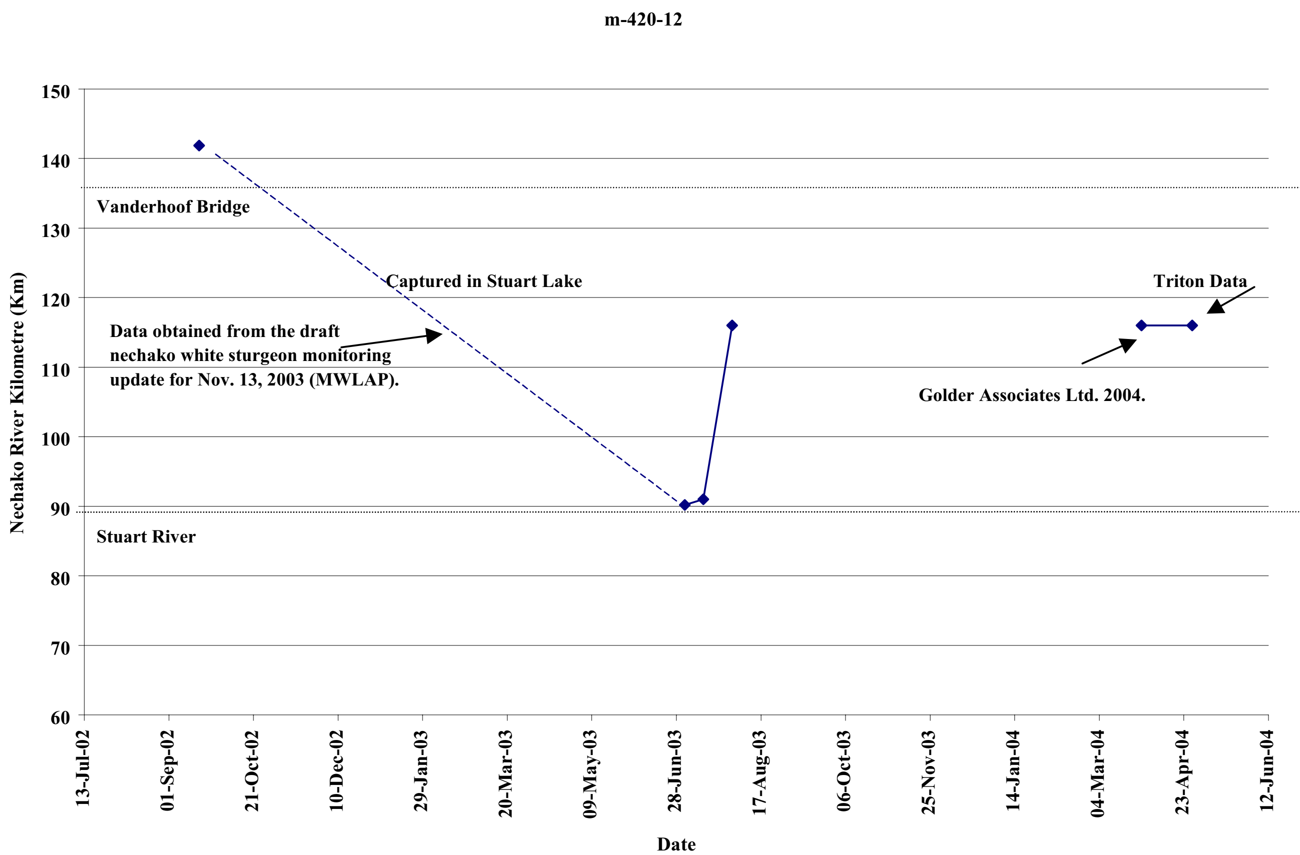


Figure 24. Detailed telemetry data for 420 – 12.

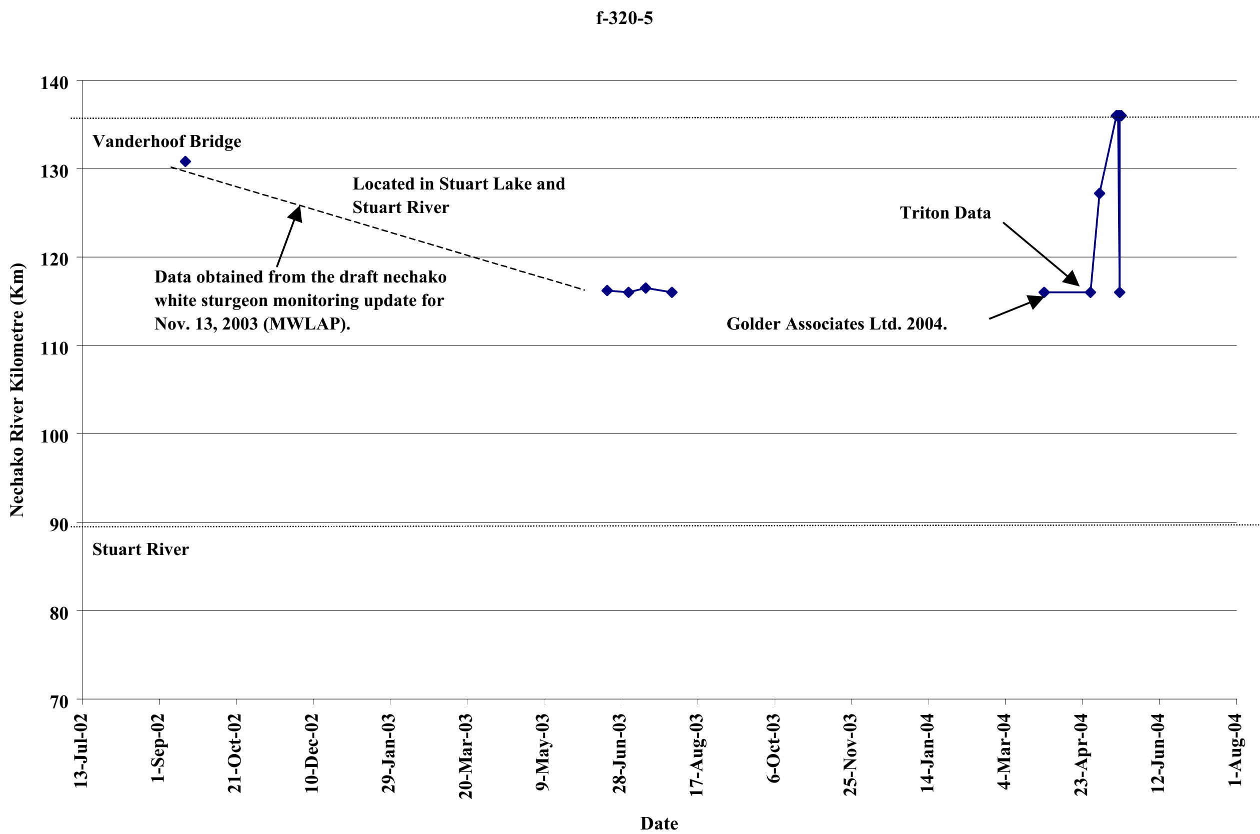


Figure 25. Detailed telemetry data for 320 – 5.

Table 3. Detailed telemetry data, by frequency and code.

Frequency	Code	Date First Recorded	Time First Recorded	Date Last Recorded	Last Recorded	Method Recorded (plane, station boat)	River Km
149.700	1	18-May-04	1:01	18-May-04	1:01	station	116
149.700	1	18-May-04	22:30	18-May-04	22:30	boat	138
149.700	1	20-May-04	19:07	20-May-04	19:07	station	116
149.700	1	22-May-04	9:10	22-May-04	9:10	station	116
149.700	1	5-Jun-04	15:23	5-Jun-04	15:23	station	116
149.700	1	8-Jun-04	14:29	8-Jun-04	14:29	station	116
149.700	1	13-Jun-04	12:11	13-Jun-04	12:11	station	136
149.700	1	16-Jun-04	7:26	16-Jun-04	7:26	station	116
149.700	1	20-Jun-04	12:07	20-Jun-04	21:01	station	116
149.700	2	28-Apr-04	12:11			plane	124.6
149.700	2	28-Apr-04	15:39			boat	124.6
149.700	2	4-May-04	11:28			plane	134
149.700	2	4-May-04	13:41			boat	134
149.700	2	12-May-04	10:45			plane	128
149.700	2	16-May-04	1:46	17-May-04	17:58	station	136
149.700	2	17-May-04	10:08	17-May-04	10:08	station	116
149.700	2	18-May-04	11:59			plane	137
149.700	2	18-May-04	20:40	18-May-04	22:30	boat	138
149.700	2	19-May-04	5:26	19-May-04	5:26	station	136
149.700	2	19-May-04	9:56	19-May-04	9:57	station	116
149.700	2	25-May-04	11:55			plane	82
149.700	2	9-Jun-04	23:58	9-Jun-04	23:58	station	89.7
149.700	2	10-Jun-04	16:54	11-Jun-04	14:32	station	116
149.700	2	10-Jun-04	0:08	10-Jun-04	0:26	station	89.7
149.700	2	11-Jun-04	23:06	11-Jun-04	23:06	station	89.7
149.700	2	18-Jun-04	18:43	18-Jun-04	18:43	station	89.7
149.700	2	19-Jun-04	19:00	19-Jun-04	21:05	station	116
149.700	2	21-Jun-04	2:17	21-Jun-04	11:12	station	116
149.700	3	28-Apr-04	15:39			boat	124.6
149.700	3	3-May-04	2:17	3-May-04	7:38	station	136
149.700	3	4-May-04	10:47			plane	115
149.700	3	15-May-04	23:59	17-May-04	8:19	station	136
149.700	3	18-May-04	1:53	18-May-04	1:53	station	116
149.700	3	18-May-04	20:40	18-May-04	22:30	boat	138
149.700	3	19-May-04	7:24	20-May-04	2:40	station	136
149.700	3	27-May-04	2:30	28-May-04	12:41	station	136
149.700	3	28-May-04	21:18	28-May-04	22:46	station	116
149.700	3	30-May-04	22:41	2-Jun-04	1:54	station	116
149.700	3	4-Jun-04	0:01	4-Jun-04	0:31	station	116
149.700	3	6-Jun-04	20:44	6-Jun-04	20:44	station	89.7

Frequency	Code	Date First Recorded	Time First Recorded	Date Last Recorded	Last Recorded	Method Recorded (plane, station boat)	River Km
149.700	5	28-Apr-04	14:50			boat	132
149.700	5	4-May-04	10:41			plane	132
149.700	5	4-May-04	13:58			boat	132
149.700	5	12-May-04	10:42			plane	133
149.700	5	17-May-04	20:20	19-May-04	6:08	station	136
149.700	5	18-May-04	10:24			plane	134
149.700	5	25-May-04	11:30			plane	121.5
149.700	5	26-May-04	0:14	26-May-04	0:58	station	116
149.700	5	8-Jun-04	6:59	8-Jun-04	18:12	station	89.7
149.700	5	11-Jun-04	6:10	11-Jun-04	23:56	station	89.7
149.700	5	21-Jun-04	8:28	21-Jun-04	8:35	station	89.7
149.700	6	28-Apr-04	12:15			plane	132
149.700	6	28-Apr-04	14:50			boat	132
149.700	6	3-May-04	21:41	3-May-04	22:00	station	136
149.700	6	4-May-04	11:27			plane	130.9
149.700	6	4-May-04	14:06			boat	130.9
149.700	6	12-May-04	10:42			plane	133
149.700	6	14-May-04	22:34	14-May-04	22:34	station	136
149.700	6	16-May-04	17:10	18-May-04	23:25	station	136
149.700	6	18-May-04	10:24			plane	134
149.700	6	25-May-04	11:52			plane	85
149.700	7	28-Apr-04	16:30			boat	116.2
149.700	7	4-May-04	11:16			plane	118.8
149.700	7	4-May-04	15:09			boat	118.8
149.700	7	12-May-04	10:49			plane	117.5
149.700	7	15-May-04	13:02	16-May-04	11:55	station	116
149.700	7	18-May-04	10:30			plane	118.5
149.700	7	19-May-04	13:38	19-May-04	13:38	station	116
149.700	7	22-May-04	18:10	22-May-04	22:19	station	116
149.700	7	25-May-04	5:15	25-May-04	19:51	station	116
149.700	7	25-May-04	11:34			plane	117
149.700	7	26-May-04	6:16	26-May-04	17:36	station	116
149.700	7	28-May-04	15:57	28-May-04	17:19	station	116
149.700	7	29-May-04	6:20	29-May-04	11:27	station	116
149.700	7	3-Jun-04	4:06	3-Jun-04	23:11	station	116
149.700	7	6-Jun-04	6:12	6-Jun-04	8:44	station	116
149.700	7	8-Jun-04	4:37	8-Jun-04	4:37	station	116
149.700	7	9-Jun-04	11:32	9-Jun-04	23:58	station	89.7
149.700	7	10-Jun-04	0:01	10-Jun-04	1:11	station	89.7
149.700	8	28-Apr-04	12:08			plane	116.2

Frequency	Code	Date First Recorded	Time First Recorded	Date Last Recorded	Last Recorded	Method Recorded (plane, station boat)	River Km
149.700	8	28-Apr-04	16:30			boat	116.2
149.700	8	3-May-04	1:20	3-May-04	7:57	station	136
149.700	8	4-May-04	11:28			plane	134
149.700	8	4-May-04	13:41			boat	134
149.700	8	12-May-04	11:17			plane	123
149.700	8	19-May-04	16:50	20-May-04	15:05	station	116
149.700	8	19-May-04	23:26	20-May-04	16:30	station	136
149.700	8	21-May-04	1:36	22-May-04	2:03	station	136
149.700	8	23-May-04	4:04	23-May-04	4:21	station	116
149.700	8	24-May-04	1:52	24-May-04	2:13	station	116
149.700	8	24-May-04	21:59	28-May-04	6:53	station	136
149.700	8	25-May-04	11:14			plane	136.5
149.700	8	28-May-04	17:59	28-May-04	18:06	station	116
149.700	8	16-Jun-04	13:02	16-Jun-04	14:42	station	89.7
149.700	8	19-Jun-04	20:21	19-Jun-04	20:23	station	89.7
149.700	9	28-Apr-04	12:08			plane	116.2
149.700	9	28-Apr-04	16:30			boat	116.2
149.700	9	3-May-04	2:44	3-May-04	8:59	station	136
149.700	9	4-May-04	11:28			plane	134
149.700	9	4-May-04	13:41			boat	134
149.700	9	6-May-04	22:43	10-May-04		station	136
149.700	9	12-May-04	11:21			plane	131
149.700	9	15-May-04	1:48	15-May-04	21:19	station	136
149.700	9	18-May-04	21:14	18-May-04	22:30	boat	138
149.700	9	19-May-04	4:03	20-May-04	2:08	station	136
149.700	9	20-May-04	8:59	20-May-04	12:27	station	116
149.700	9	20-May-04	22:44	22-May-04	4:31	station	136
149.700	9	25-May-04	11:16			plane	134
149.700	9	25-May-04	3:07	28-May-04	15:26	station	136
149.700	9	28-May-04	19:45	28-May-04	19:52	station	116
149.700	9	29-May-04	0:01	29-May-04	17:27	station	116
149.700	10	28-Apr-04	12:15			plane	128
149.700	10	28-Apr-04	15:06			boat	128
149.700	10	4-May-04	11:38			plane	157
149.700	10	12-May-04	11:37			plane	154
149.700	10	18-May-04	11:21			plane	154
149.700	10	25-May-04	12:51			plane	154
149.700	10	21-Jun-04	7:05	21-Jun-04	7:05	station	136
149.700	11	5-Jun-04	9:17	6-Jun-04	1:47	station	136
149.700	11	13-Jun-04	3:37	13-Jun-04	3:37	station	136
149.700	11	10-Jun-04	12:30	10-Jun-04	13:39	station	116

Frequency	Code	Date First Recorded	Time First Recorded	Date Last Recorded	Last Recorded	Method Recorded (plane, station boat)	River Km
149.700	11	12-Jun-04	9:55	16-Jun-04	18:39	station	116
149.700	11	20-Jun-04	5:22	20-Jun-04	23:14	station	116
149.700	12	26-May-04	6:53	26-May-04	6:53	station	116
149.700	13	28-Apr-04	14:33			boat	133
149.700	13	4-May-04	11:19			plane	132.8
149.700	13	4-May-04	13:49			boat	132.8
149.700	13	12-May-04	10:42			plane	133
149.700	13	15-May-04	3:23	15-May-04	3:42	station	136
149.700	13	18-May-04	4:20	18-May-04	4:43	station	116
149.700	13	18-May-04	10:37			plane	108.5
149.700	13	25-May-04	11:53			plane	85.5
149.700	13	10-Jun-04	20:03	10-Jun-04	20:28	station	89.7
149.700	13	20-Jun-04	0:51	20-Jun-04	13:47	station	89.7
149.700	15	28-Apr-04	12:11			plane	124.6
149.700	15	28-Apr-04	15:39			boat	124.6
149.700	15	4-May-04	11:24			plane	125.5
149.700	15	8-May-04	1:06	8-May-04	1:18	station	136
149.700	15	12-May-04	11:24			plane	123
149.700	15	15-May-04	2:27	18-May-04	4:29	station	136
149.700	15	18-May-04	10:23			plane	135.5
149.700	15	19-May-04	0:49	19-May-04	2:51	station	136
149.700	15	20-May-04	7:59	20-May-04	15:04	station	116
149.700	15	23-May-04	14:25	23-May-04	22:49	station	116
149.700	15	24-May-04	19:21	24-May-04	23:52	station	116
149.700	15	1-Jun-04	12:08	7-Jun-04	22:55	station	116
149.700	15	10-Jun-04	8:54	12-Jun-04	23:37	station	116
149.700	15	16-Jun-04	21:14	17-Jun-04	19:57	station	116
149.700	15	19-Jun-04	13:09	20-Jun-04	21:30	station	116
148.320	5	28-Apr-04	11:34			plane	116
148.320	5	4-May-04	11:25			plane	127.2
148.320	5	15-May-04	2:20	18-May-04	20:38	station	136
148.320	5	17-May-04	4:29	17-May-04	4:29	station	116
148.420	12	28-Apr-04	16:30			boat	116.2
149.480	52	28-Apr-04	12:28			plane	169.2
149.480	52	4-May-04	11:44			plane	169.2
149.480	52	12-May-04	11:42			plane	169.2
149.480	52	18-May-04	11:26			plane	169.2
149.480	52	25-May-04	12:57			plane	169.2

Frequency	Code	Date First Recorded	Time First Recorded	Date Last Recorded	Last Recorded	Method Recorded (plane, station boat)	River Km
149.480	53	28-Apr-04	11:30			plane	117
149.480	53	28-Apr-04	16:07			boat	117
149.480	53	4-May-04	10:46			plane	117
149.480	53	4-May-04	15:24			boat	117
149.480	53	12-May-04	10:48			plane	117
149.480	53	18-May-04	10:31			plane	117
149.480	54	28-Apr-04	15:35			boat	125
149.480	54	4-May-04	10:40			plane	125
149.480	54	4-May-04	14:37			boat	125
149.480	54	12-May-04	10:46			plane	125
149.480	54	18-May-04	10:27			plane	125
149.480	54	25-May-04	11:27			plane	125
149.480	56	4-May-04	10:56			plane	99
149.480	56	12-May-05	10:58			plane	99
149.480	56	18-May-04	10:40			plane	99
149.480	56	25-May-04	11:44			plane	99
149.480	57	28-Apr-04	12:00			plane	105.5
149.480	57	4-May-04	10:53			plane	105.5
149.480	57	12-May-04	10:55			plane	105.5
149.480	57	18-May-04	10:39			plane	105.5
149.480	57	25-May-04	11:42			plane	105.5

Appendix 3

Field Survey Data

Table 4. Substrate mat (egg mat) details and habitat conditions.

Site	Date Set	Set Time	Date Retrieved	Retrieve Time	Length of Set (hours)	Zone	Easting	Northing	Depth (m)	Velocity @ 20% of depth (m/s)	Comment
SM1	19-May-04	14:48	20-May-04	11:55	21.1	10	432135	5986076	1.6	0.34	
SM2	19-May-04	14:50	20-May-04	11:57	21.1	10	432151	5986070	1.5	0.58	
SM3	19-May-04	14:54	20-May-04	09:52	19.0	10	432121	5986078	1.2	0.76	
SM4	19-May-04	15:00	20-May-04	12:02	21.0	10	431853	5986108	1.2	0.89	
SM5	19-May-04	15:02	20-May-04	12:10	21.1	10	431881	5986128	1.6	0.96	
SM6	19-May-04	15:04	20-May-04	12:15	21.2	10	431918	5986150	1.3	0.84	
SM7	19-May-04	15:07	20-May-04	11:40	20.6	10	431962	5986157	1.4	0.14	
SM8	19-May-04	15:13	20-May-04	11:46	20.6	10	432195	5986101	1.1	0.74	
SM9	19-May-04	16:08	20-May-04	10:17	18.2	10	432212	5986099	1.5	0.74	1 sturgeon egg captured.
SM10	20-May-04	16:04	22-May-04	11:06	43.0	10	432547	5986421	0.7	0.10	
SM11	20-May-04	16:06	22-May-04	11:08	43.0	10	432547	5986427	0.7	0.10	
SM12	20-May-04	16:08	22-May-04	11:14	43.1	10	432551	5986437	1.0	0.20	
SM13	20-May-04	16:14	22-May-04	11:21	43.1	10	432588	5986447	3.0	NS	
SM14	20-May-04	16:16	22-May-04	11:23	43.1	10	432584	5986448	3.0	NS	
				Total Set Time:	**399.2**			**Mean:**	**1.5**	**0.53**	

Table 5. Kick-netting for sturgeon eggs site details.

Site	Date	Start Time	Stop Time	# of crew	Total Sampling Time (hour)	Approximate area sampled (m^2)	Zone	Easting	Northing	Comment
K1	20-May-04	13:00	15:30	3	7.5	750	10	432019	5986147	2 sturgeon eggs captured.
K2	20-May-04	15:45	17:15	3	4.5	450	10	432392	5986272	1 sturgeon egg captured.
K3	22-May-04	11:46	12:16	2	1.0	100	10	432555	5986340	16 CSU eggs captured.
				Total:	**13**	**1,300**				

Table 6. Substrate grabs for sturgeon eggs site details.

Site	Date	Time	# of Grabs	Area Sampled (m^2)	Zone	Easting	Northing	Comment
G1	20-May-04	10:30	4	2	10	431864	5986105	
G2	20-May-04	11:15	4	2	10	431948	5986168	
G3	20-May-04	12:50	4	2	10	432013	5986110	
G4	20-May-04	13:00	4	2	10	432156	5986092	
G5	20-May-04	13:45	4	2	10	432177	5986117	1 CSU egg.
G6	20-May-04	14:20	4	2	10	432415	5986270	
		Total:	**24**	**12**				

Table 7. Predator analysis - minnow trapping details.

Site	Date Set	Set Time	Date Retrieved	Time Retrieved	Length of Set (hours)	Depth (m)	Comment
MT1	21-May-04	20:35	22-May-04	10:37	14.0	0.3	2 RSS.
MT2	21-May-04	20:38	22-May-04	13:49	17.2	0.4	
MT3	21-May-04	20:40	22-May-04	10:46	14.1	0.5	1 RSS.
MT4	21-May-04	20:41	22-May-04	10:47	14.1	1.5	
MT5	21-May-04	20:44	22-May-04	11:42	14.0	0.6	
MT6	21-May-04	20:45	22-May-04	11:43	14.0	1.1	1 NPM.
MT7	21-May-04	20:50	22-May-04	10:50	14.0	0.3	
MT8	21-May-04	20:58	22-May-04	10:53	13.9	0.3	2 NPM.
MT9	21-May-04	20:59	22-May-04	10:59	14.0	0.5	1 CAS.
MT10	21-May-04	21:01	22-May-04	11:00	14.0	0.4	
MT11	21-May-04	21:04	22-May-04	11:02	14.0	0.5	9 NPM.
MT12	21-May-04	21:06	22-May-04	11:05	14.0	0.3	
MT13	21-May-04	21:07	22-May-04	11:24	14.3	0.3	
MT14	21-May-04	21:08	22-May-04	11:31	14.4	1.0	
MT15	21-May-04	21:08	22-May-04	11:32	14.4	0.3	
				Total:	**214.4**	**N/A**	
				Mean:	**14.3**	**0.6**	

Table 8. Predator analysis - prawn trap details.

Site	Date Set	Set Time	Date Retrieved	Retrieve Time	Length of Set (hours)	Depth (m)	Fish
PT1	19-May-04	16:11	20-May-04	09:53	17.70	1.5	NFC
PT2	19-May-04	16:12	20-May-04	09:51	17.70	1.5	RSS
PT3	19-May-04	16:13	20-May-04	09:49	17.60	2.0	NFC
PT4	19-May-04	17:11	20-May-04	09:45	16.60	0.7	NFC
PT5	19-May-04	17:13	20-May-04	09:41	16.50	2.0	NFC
PT6	20-May-04	09:53	22-May-04	10:57	49.10	2.0	NFC
PT7	20-May-04	09:52	22-May-04	10:56	49.10	2.3	NFC
PT8	20-May-04	10:12	22-May-04	10:51	48.70	2.0	NFC
PT9	20-May-04	10:14	22-May-04	11:37	49.40	2.0	NFC
PT10	20-May-04	09:41	22-May-04	11:34	49.90	1.0	NFC
				Total:	**332.30**	**N/A**	
				Mean:	**33.23**	**1.7**	

Table 9. Predator analysis - angling details.

Site	Date	Effort (hours)	Comment
AG1	19-May-04	0.3	1 BT.
AG2	20-May-04	0.8	3 NPM.
AG3	20-May-04	0.8	1 RB.
AG4	22-May-04	0.3	1 NPM.
	Total:	**2.2**	

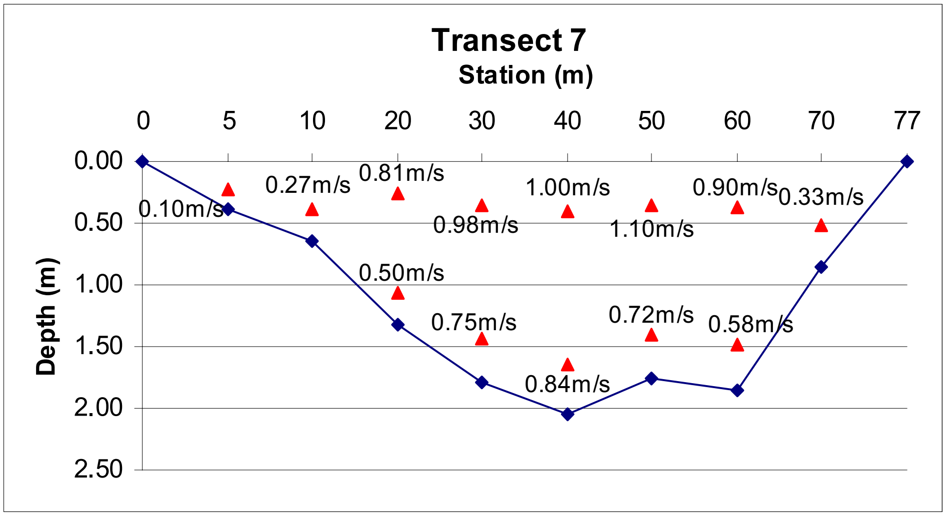
Table 10. Predator analysis - fish captured, and results of stomach analysis.

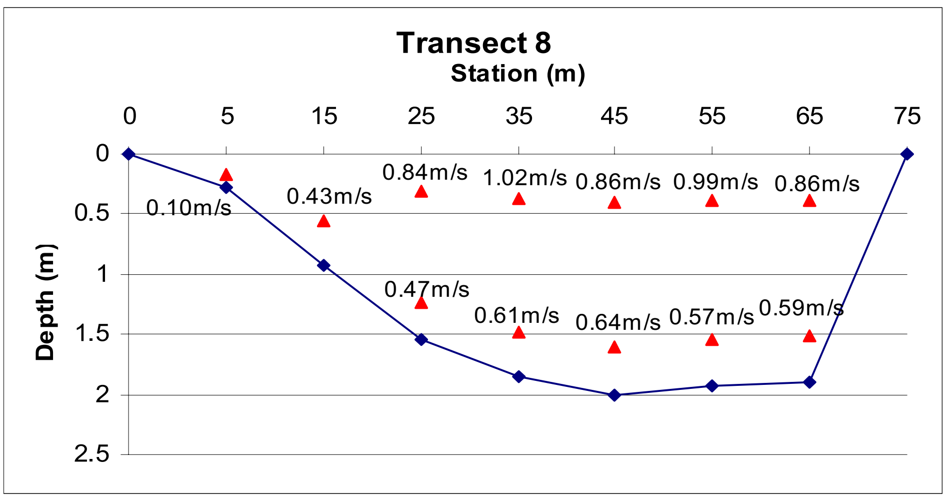
Site	Fish Species	Length (mm)	Stomach Contents
AG2	NPM	241	Empty.
AG2	NPM	272	Empty.
AG2	NPM	205	Empty.
AG3	RB	216	Invertebrates.
AG4	NPM	360	Partially digested RSS.
MT1	RSS	84	Not sampled.
MT1	RSS	86	Cat food (bait).
MT3	RSS	54	Not sampled.
MT6	NPM	87	Cat food (bait).
MT8	NPM	70	Not sampled.
MT8	NPM	82	Sardine (bait).
MT9	COTT	82	Empty.
MT11	NPM	66	Not sampled.
MT11	NPM	86	Sardine (bait).
MT11	NPM	76	Not sampled.
MT11	NPM	89	Sardine (bait).
MT11	NPM	81	Not sampled.
MT11	NPM	78	Not sampled.
MT11	NPM	91	Sardine (bait).
MT11	NPM	62	Not sampled.
MT11	NPM	58	Not sampled.

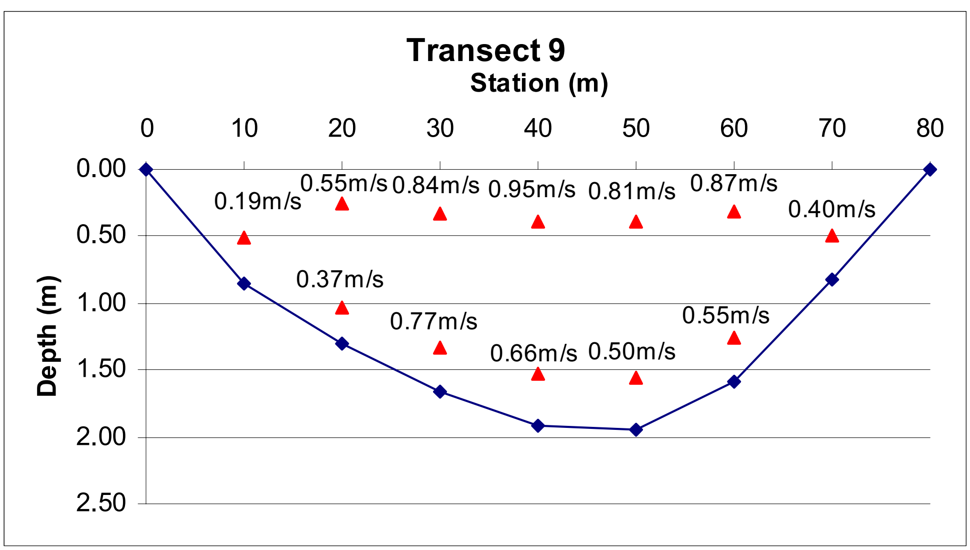
Table 11. Kick-netting details – post hatch larvae.

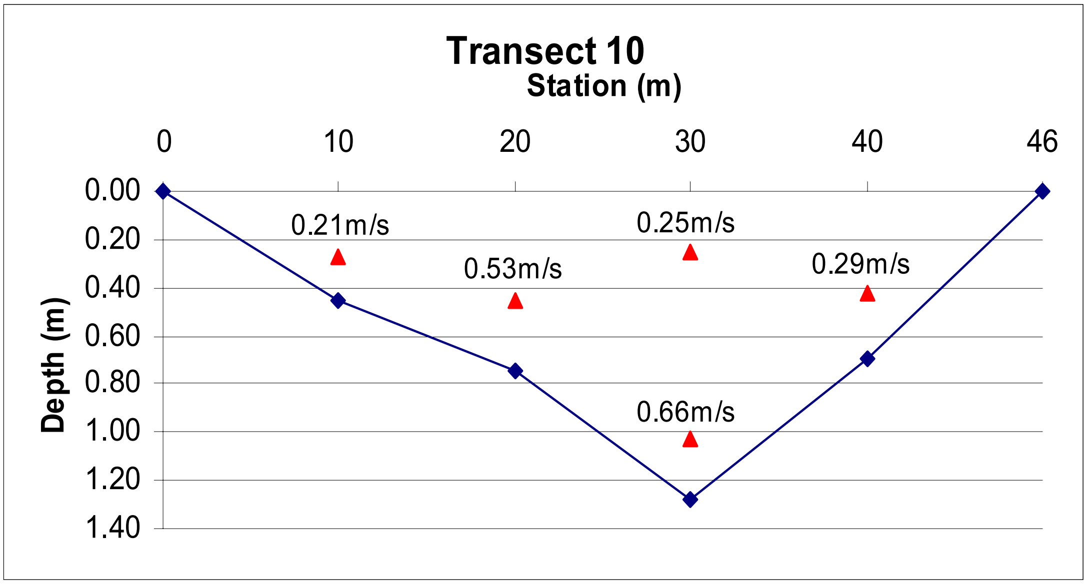
Site	Date	Start	Stop	# of crew	Time (hour)	Approximate area sampled (m^2)	Zone	Easting	Northing	Comment
K4	27-May-04	20:55	21:05	2	0.3	30	10	435892	5985094	
K5	27-May-04	21:42	22:30	2	1.6	160	10	432455	5986366	
K6	27-May-04	23:34	23:57	2	0.8	80	10	433295	5986359	
K7	28-May-04	13:00	13:30	2	1.0	100	10	432441	5986282	
K8	28-May-04	13:45	14:15	2	1.0	100	10	432431	5986335	
K9	28-May-04	14:30	15:00	2	1.0	100	10			
K10	29-May-04	12:27	13:25	2	1.9	190	10	432051	5986175	
K11	29-May-04	14:30	15:33	2	2.1	210	10	432006	5986246	
K12	29-May-04	16:17	17:09	2	1.7	170	10	432176	5986358	Sturgeon larvae captured.
K13	29-May-04	18:05	18:40	3	1.8	180	10	432605	5986425	
K14	30-May-04	9:55	11:10	2	2.5	250	10	432176	5986358	Same area where larva was captured on May 29.
K15	30-May-04	11:36	12:16	2	1.4	140	10	432329	5986348	Clean gravel on top, but sand underneath. Limited interstitial spaces.
				Total:	**17.1**	**1,710**				

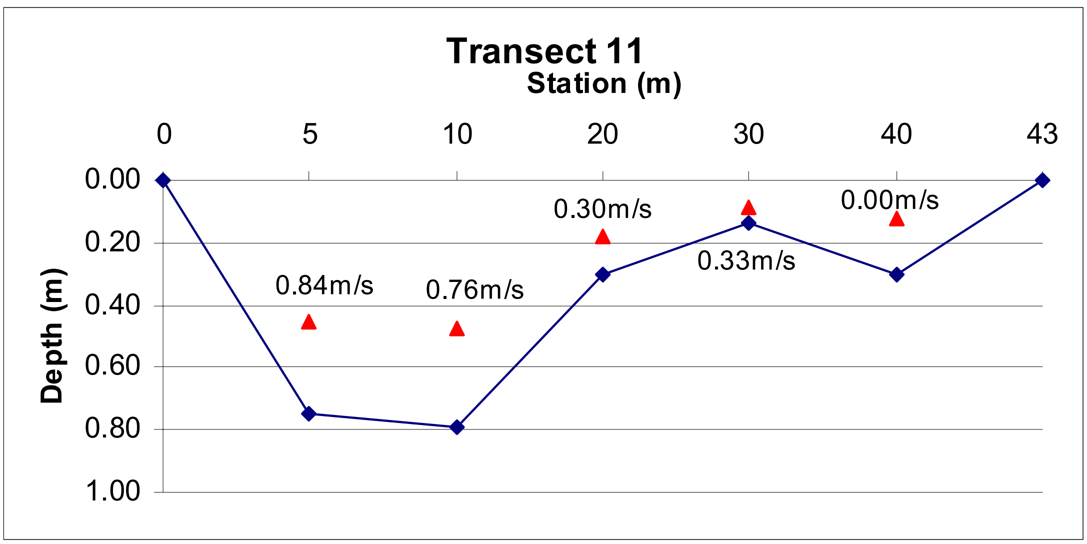
Figure 26. Detailed transect – depth and velocity.

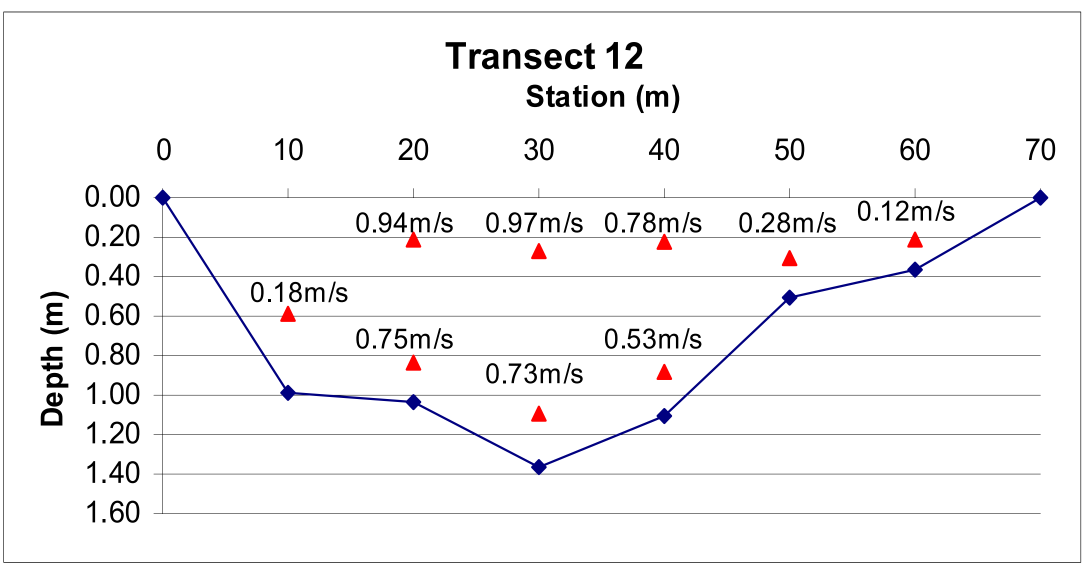


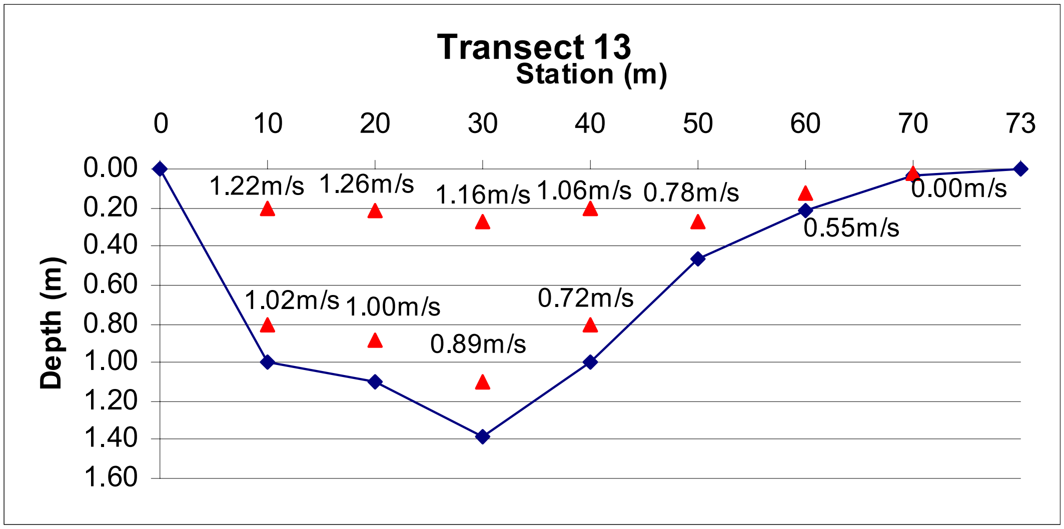


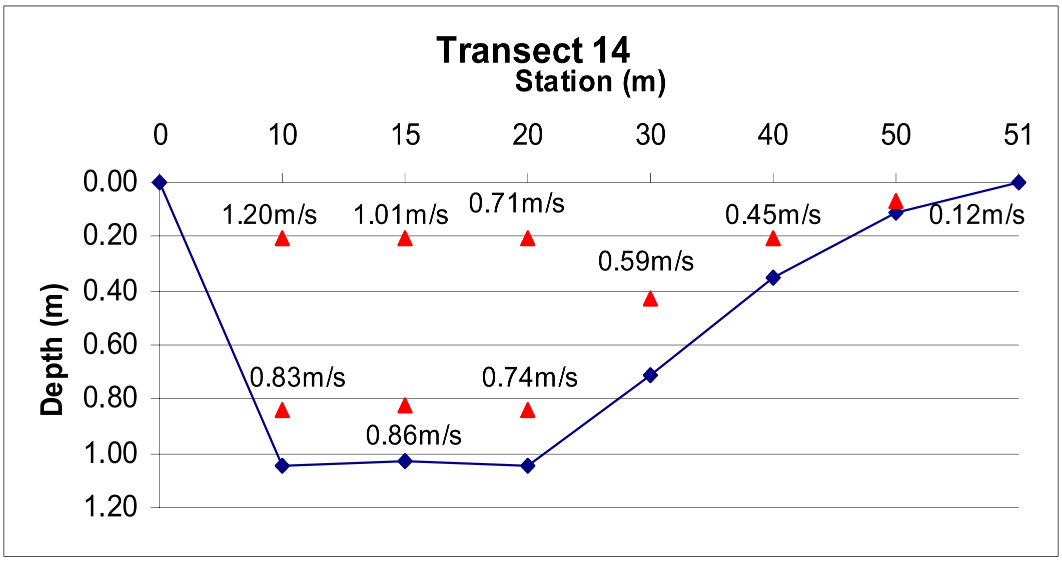


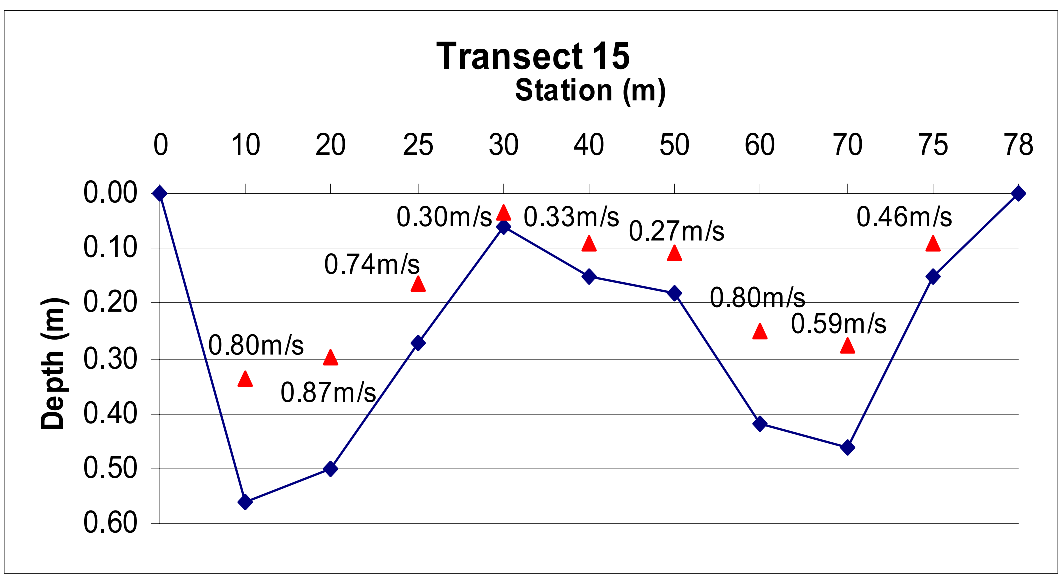

Transect 10
Station (m)
0
10
20
30
40
46
0.00
0.20
0.40
0.60
0.80
1.00
1.20
1.40
Depth (m)
0.21m/s
0.53m/s
0.25m/s
0.29m/s
0.66m/s


Transect 11
Station (m)
0
5
10
20
30
40
43
0.00
0.20
0.40
0.60
0.80
1.00
Depth (m)
0.30m/s
0.00m/s
0.33m/s
0.84m/s
0.76m/s


Transect 12
Station (m)
0
10
20
30
40
50
60
70
0.00
0.20
0.40
0.60
0.80
1.00
1.20
1.40
1.60
Depth (m)
0.94m/s
0.97m/s
0.78m/s
0.28m/s
0.12m/s
0.18m/s
0.75m/s
0.53m/s
0.73m/s


Transect 13
Station (m)
0
10
20
30
40
50
60
70
73
0.00
0.20
0.40
0.60
0.80
1.00
1.20
1.40
1.60
Depth (m)
1.22m/s
1.26m/s
1.16m/s
1.06m/s
0.78m/s
0.00m/s
0.55m/s
1.02m/s
1.00m/s
0.72m/s
0.89m/s


Transect 14
Station (m)
0
10
15
20
30
40
50
51
0.00
0.20
0.40
0.60
0.80
1.00
1.20
Depth (m)
1.20m/s
1.01m/s
0.71m/s
0.45m/s
0.12m/s
0.59m/s
0.83m/s
0.74m/s
0.86m/s


Transect 15
Station (m)
0
10
20
25
30
40
50
60
70
75
78
0.00
0.10
0.20
0.30
0.40
0.50
0.60
Depth (m)
0.30m/s
0.33m/s
0.27m/s
0.46m/s
0.74m/s
0.80m/s
0.59m/s
0.80m/s
0.87m/s

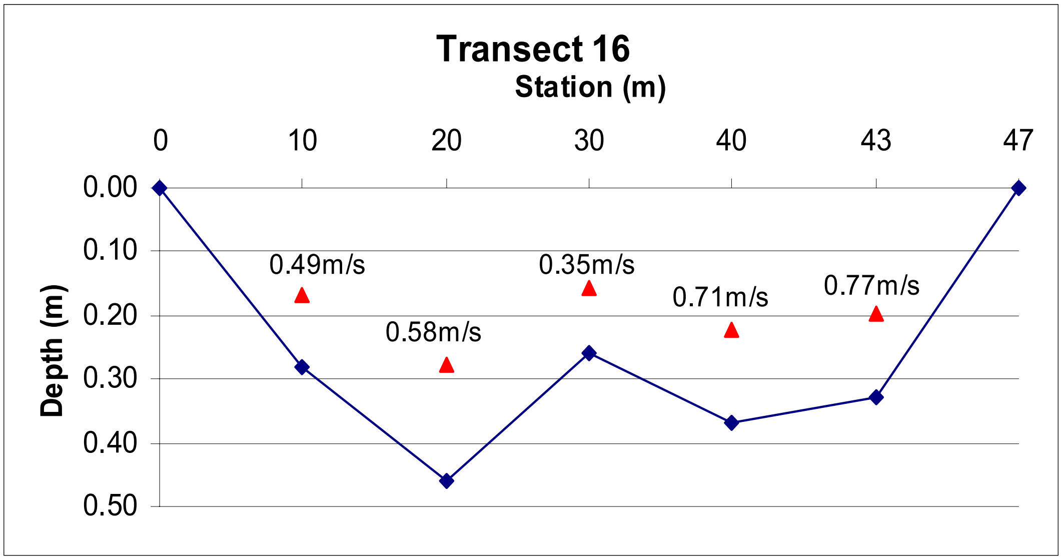

Transect 16
Station (m)
0
10
20
30
40
43
47
0.00
0.10
0.20
0.30
0.40
0.50
Depth (m)
0.49m/s
0.58m/s
0.35m/s
0.71m/s
0.77m/s

Table 12. Fyke net specifications for post hatch larval sampling.

		Net Specifications					Water Parameters			Location (UTM)			Comments
Site	Date	Round or D	Set Time	Retrieve Time	# of Sets	Total Length of Sets (min)	Depth (m)	Velocity (m/s)	Volume Sampled (m^3)	Zone	Easting	Northing	
F1	27-May-04	R	20:52	21:09	1	17	0.9	0.46	446	10	435892	5985094	2.54 km d/s of Vanderhoof bridge.
F2	27-May-04	R	21:37	22:41	1	64	0.55	0.86	3137	10	432455	5986366	
F3	27-May-04	R	21:38	22:42	1	64	0.85	1.02	3721	10	432455	5986366	
F4	27-May-04	R	23:22	0:00	1	38	0.55	0.9	1949	10	433295	5986359	
F5	27-May-04	R	23:23	23:59	1	36	0.62	1.05	2155	10	433295	5986359	
F6	28-May-04	R	11:55	14:25	1	150	0.79	0.88	7524	10	432441	5986282	
F7	28-May-04	R	12:10	14:45	1	155	0.86	0.81	7156	10	432441	5986282	
F8	29-May-04	R	12:25	13:45	1	80	0.85	0.83	3785	10	432051	5986175	
F9	29-May-04	R	12:25	13:42	1	77	0.78	0.78	3423	10	432051	5986175	
F10	29-May-04	R	13:58	15:33	1	95	0.85	1.01	5469	10	432006	5986246	
F11	29-May-04	R	14:02	15:36	1	94	0.65	0.82	4394	10	432006	5986246	
F12	29-May-04	R	15:46	17:25	1	99	0.8	1.16	6546	10	432176	5986358	
F13	29-May-04	R	15:46	17:28	1	102	0.74	0.91	5291	10	432176	5986358	
F14	30-May-04	R	9:52	11:15	1	83	0.55	0.94	4447	10	432176	5986358	
F15	30-May-04	R	9:53	11:16	1	83	0.45	0.68	3217	10	432176	5986358	
				Total:		**1,237**	**N/A**	**N/A**	**62,660**				
				Mean:		**82**	**0.72**	**0.87**	**4,177**				

Table 13. Fyke net specifications for actively feeding larval sampling.

Site		Net Specifications					Water Parameters			Substrate Composition					Location (UTM)			Comments
	Date	Round or D	Set Time	Retrieve Time	# of Sets	Total Length of Sets (min)	Depth (m)	Velocity (m/s)	Volume Sampled (m^3)	Boulder (%)	Cobble (%)	Gravel (%)	Fines (%)	D95 (cm)	Zone	Easting	Northing	
F16	07-Jun-04	D	1631	1801	4	90	1.75	0.35	945	NS	NS	NS	NS	NS	10	431824	5986142	
F17	07-Jun-04	D	1636	1758	4	82	2.05	0.5	1230	NS	NS	NS	NS	NS	10	431832	5986120	
F18	07-Jun-04	R	1640	1808	4	88	1.00	0.4	2006	0	20	70	25	NS	10	431811	5986165	
F19	07-Jun-04	D	1913	2051	5	98	0.66	0.6	1764	0	5	70	25	NS	10	432258	5986326	
F20	07-Jun-04	D	1914	2053	5	99	0.74	0.87	2584	0	15	70	15	NS	10	432259	5986345	4 CSU larvae captured.
F21	07-Jun-04	R	1916	2055	5	99	0.40	0.71	4007	0	5	70	25	NS	10	432259	5986337	
F22	07-Jun-04	R	1919	2059	5	100	0.53	0.82	4674	0	15	70	15	NS	10	432261	5986341	
F23	07-Jun-04	R	2132	2321	4	109	0.95	0.8	4970	0	5	75	20	NS	10	432798	5986452	25 CSU larvae, most captured after dark.
F24	07-Jun-04	R	2134	2322	4	108	0.85	0.8	4925	0	5	75	20	NS	10	432798	5986452	25 CSU larvae, most captured after dark.
F25	07-Jun-04	D	2134	2322	4	108	0.72	0.82	2657	0	5	75	20	NS	10	432799	5986453	5 CSU larvae, most captured after dark.
F26	07-Jun-04	D	2135	2323	4	108	0.60	0.78	2527	0	5	75	20	NS	10	432800	5986455	5 CSU larvae, most captured after dark.
F27	08-Jun-04	D	1614	1741	5	97	0.55	0.65	1892	0	10	70	20	8	10	432552	5986340	Full of insect cases and insects.
F28	08-Jun-04	R	1616	1744	5	98	0.71	0.74	4134	0	10	70	20	8	10	432549	5986343	Minimal algae/diatoms captured to other sites.
F29	08-Jun-04	D	1619	1747	5	98	0.78	0.78	2293	0	10	70	20	8	10	432547	5986346	Abundant invertebrate cases.
F30	08-Jun-04	R	1621	1750	5	99	0.75	0.86	4853	0	10	70	20	8	10	432544	5986349	1 CSU larva captured. Abundant invertebrate cases.
F31	08-Jun-04	D	1816	2020	3	124	1.50	1.04	3869	0	30	60	10	10	10	432134	5986099	8 CSU larvae captured.
F32	08-Jun-04	D	1818	2021	3	123	0.95	0.96	3542	0	30	60	10	10	10	432137	5986099	
F33	08-Jun-04	R	1832	2020	3	108	0.55	0.65	4001	0	5	80	15	10	10	432111	5986143	3 CSU larvae captured.
F34	08-Jun-04	R	1833	2022	3	109	0.65	0.68	4225	0	5	80	15	10	10	432111	5986143	
F35	08-Jun-04	D	2051	2204	5	73	0.42	0.34	745	0	2	18	80	3	10	434102	5986737	1 CSU larva captured.
F36	08-Jun-04	R	2052	2204	5	72	0.70	0.37	1518	0	2	18	80	3	10	434102	5986737	3 CSU larvae captured.

Site		Net Specifications					Water Parameters			Substrate Composition					Location (UTM)			Comments
	Date	Round or D	Set Time	Retrieve Time	# of Sets	Total Length of Sets (min)	Depth (m)	Velocity (m/s)	Volume Sampled (m^3)	Boulder (%)	Cobble (%)	Gravel (%)	Fines (%)	D95 (cm)	Zone	Easting	Northing	
F37	08-Jun-04	D	2053	2204	5	71	0.70	0.28	596	0	0	10	90	1	10	434102	5986737	1 CSU larva captured.
F38	08-Jun-04	R	2053	2204	5	71	0.91	0.53	2145	0	0	10	90	1	10	434102	5986737	
F39	08-Jun-04	D	2233	2308	4	35	0.35	0.53	557	0	0	90	10	2	10	433438	5986722	220 CSU larvae and 1 CH0+ captured.
F40	08-Jun-04	R	2234	2308	4	34	0.50	0.53	1027	0	0	90	10	2	10	433438	5986722	45 CSU larvae captured.
F41	08-Jun-04	R	2235	2309	4	34	0.70	0.77	1492	0	0	90	10	2	10	433438	5986722	30 CSU larvae and 1 CH0+ captured.
F42	08-Jun-04	D	2235	2310	4	35	0.95	0.77	809	0	0	90	10	2	10	433438	5986722	36 CSU larvae captured.
F43	09-Jun-04	R	1650	1820	4	90	1.60	0.72	3694	0	2	80	18	7	10	432907	5986346	Riprap guy
F44	09-Jun-04	R	1652	1821	4	89	1.30	0.97	4921	0	2	80	18	7	10	432916	5986367	riprap guy
F45	09-Jun-04	D	1655	1820	4	85	0.63	0.63	1607	0	2	80	18	8	10	432954	5986380	20 CSU larvae (dead).
F46	09-Jun-04	D	1657	1821	4	84	0.75	0.85	2142	0	2	80	18	8	10	432954	5986380	20 CSU larvae (dead).
F47	09-Jun-04	R	1850	2015	4	85	0.50	0.76	3682	0	2	49	49	7	10	433050	5986773	2 CSU larvae captured.
F48	09-Jun-04	D	1850	2015	4	85	0.59	0.73	1862	0	2	49	49	7	10	433050	5986773	3 CSU larvae captured.
F49	09-Jun-04	R	1850	2015	4	85	0.76	0.64	3101	0	2	49	49	7	10	433050	5986773	
F50	09-Jun-04	R	2120	2220	3	60	2.65	0.31	1060	0	0	10	90	3	10	434865	5986289	3 CSU larvae captured.
F51	09-Jun-04	R	2120	2221	3	61	3.50	0.4	1391	0	0	10	90	3	10	434865	5986289	1 CSU larva captured.
				Total:	**150**	**3,094**	**N/A**	**N/A**	**93,445**									
				Mean:	**4**	**86**	**0.95**	**0.67**	**2,596**									

Table 14. Pole seine specifications for actively feeding larval sampling.

					Water Parameters				Substrate Composition					Fish Captured								Comments
Site	Date	Time	Area (m^2)	Length Sampled (m)	Min Depth (m)	Max Depth (m)	Min Velocity (m/s)	Max Velocity (m/s)	B (%)	C (%)	G (%)	F (%)	D95 (cm)	CH0+	LSS "J"	LSS "L"	NPM "J"	RSS "J"	RMW "J"	LND "J"	LPD "J"	
PS1	7-Jun-04	1643	100	40	0	0.4	0	0.1	0	0	10	90	1									
PS2	7-Jun-04	1656	75	30	0	0.4	0	0.2	0	20	70	10	NS									
PS3	7-Jun-04	1921	75	30	0	0.3	0	0.3	0	5	75	20	NS									
PS4	7-Jun-04	1927	75	30	0	0.4	0	0.3	0	10	40	50	NS									
PS5	7-Jun-04	1944	75	30	0	0.3	0	0.2	0	8	2	90	NS									
PS6	7-Jun-04	2140	75	30	0	0.2	0	0.3	0	2	60	38	NS									
PS7	7-Jun-04	2152	75	30	0	0.3	0	0.1	0	0	20	80	NS									
PS8	7-Jun-04	2209	75	30	0	0.4	0	0.3	0	2	17	80	NS									
PS9	7-Jun-04	2235	50	20	0	0.2	0	0.3	0	5	75	20	2									
PS10	7-Jun-04	2237	75	30	0	0.6	0	0.5	0	5	75	20	2									
PS11	7-Jun-04	2318	150	60	0	0.6	0	0.5	0	5	75	20	3									
PS12	8-Jun-04	1632	100	40	0	0.3	0	0.1	0	0	5	95	2						2		5	Abundant mayfly.
PS13	8-Jun-04	1644	50	20	0	0.3	0	0.1	0	5	10	85	4	2								Abundant water boatman.
PS14	8-Jun-04	1653	50	20	0	0.3	0	0.2	0	5	30	65	5	1					2			Abundant mayfly.
PS15	8-Jun-04	1704	38	15	0	0.2	0	0	0	0	3	97	1		75		75					Abundant water boatman.
PS16	8-Jun-04	1714	50	20	0	0.2	0	0.3	0	5	55	40	6	20				20				Abundant water boatman.
PS17	8-Jun-04	1721	38	15	0	0.3	0	0.4	0	0	75	25	5	50				5				Abundant water boatman and tricoptera.
PS18	8-Jun-04	1731	38	15	0	0.4	0	0.4	0	5	75	20	5	30								Abundant water boatman and tricoptera.
PS19	8-Jun-04	1737	38	15	0	0.2	0	0.2	0	5	75	20	7	2								Abundant water boatman and tricoptera.
PS20	8-Jun-04	1742	38	15	0	0.3	0	0.5	0	5	75	20	5									

					Water Parameters				Substrate Composition					Fish Captured								Comments
Site	Date	Time	Area (m^2)	Length Sampled (m)	Min Depth (m)	Max Depth (m)	Min Velocity (m/s)	Max Velocity (m/s)	B (%)	C (%)	G (%)	F (%)	D95 (cm)	CH0+	LSS "J"	LSS "L"	NPM "J"	RSS "J"	RMW "J"	LND "J"	LPD "J"	
PS21	8-Jun-04	1746	38	15	0	0.5	0	0.3	0	7	75	17	7	2								
PS22	8-Jun-04	1827	75	30	0	0.3	0	0.2	0	5	10	85	3								1	Abundant invertebrates.
PS23	8-Jun-04	1832	75	30	0	0.5	0	0.3	0	5	20	75	5						5			
PS24	8-Jun-04	1850	75	30	0	0.2	0	0.2	0	5	65	30	6							10	20	
PS25	8-Jun-04	1901	75	30	0	0.4	0	0.3	0	5	70	25	7	2	1					1		
PS26	8-Jun-04	1915	25	10	0	0.4	0	0.3	0	3	67	30	8	2	20		15	15			10	
PS27	8-Jun-04	1907	38	15	0	0.3	0	0.3	0	10	80	10	10				6	6			6	
PS28	8-Jun-04	1921	38	15	0	0.6	0	0.1	0	6	34	60	10	30	30		30	30				
PS29	8-Jun-04	1932	125	50	0	0.6	0	0.1	0	5	60	35	8	18								
PS30	8-Jun-04	1946	75	30	0	0.2	0	0.2	0	5	60	35	8	2					1			
PS31	8-Jun-04	1954	113	45	0	0.7	0	0.5	0	10	80	10	10									
PS32	8-Jun-04	2106	63	25	0	0.4	0	0.1	0	0	5	95	3	10				1				Abundant water boatman.
PS33	8-Jun-04	2113	38	15	0	0.3	0	0.1	0	0	5	95	2	10				1				
PS34	8-Jun-04	2121	38	15	0	0.1	0	0	0	0	3	97	1		1	2		1				Abundant water boatman.
PS35	8-Jun-04	2127	38	15	0	0.2	0	0.2	0	0	30	70	2				1		2			
PS36	8-Jun-04	2135	50	20	0	0.3	0	0.3	0	0	3	97	1									
PS37	8-Jun-04	2143	50	20	0	0.2	0	0.2	0	0	5	95	1	12					10			Abundant water boatman.
PS38	8-Jun-04	2151	63	25	0.1	0.4	0.1	0.3	0	0	10	90	1	5					15			Abundant water boatman.
PS39	8-Jun-04	2200	50	20	0	0.2	0	0.1	0	0	3	97	1	5					10			Abundant water boatman.
PS40	8-Jun-04	2330	38	15	0	0.3	0	0.1	0	0	75	25	1	7								
PS41	8-Jun-04	2335	50	20	0	0.5	0	0.1	0	0	75	25	1	20	30		50	30			20	
PS42	8-Jun-04	2345	63	25	0	0.4	0	0.4	0	0	75	25	1	5			5					
PS43	9-Jun-04	1632	38	15	0	0.5	0	0.4	0	2	23	75	5	1								
PS44	9-Jun-04	1637	50	20	0	0.3	0	0.4	0	0	30	70	3	2		1					1	
PS45	9-Jun-04	1643	38	15	0	0.4	0	0.5	0	3	67	30	6	20								
PS46	9-Jun-04	1650	38	15	0	0.4	0	0.1	0	2	33	65	4		1			3	2			
PS47	9-Jun-04	1656	25	10	0	0.6	0	0.05	0	0	10	90	1	1				50				

					Water Parameters				Substrate Composition					Fish Captured								Comments
Site	Date	Time	Area (m^2)	Length Sampled (m)	Min Depth (m)	Max Depth (m)	Min Velocity (m/s)	Max Velocity (m/s)	B (%)	C (%)	G (%)	F (%)	D95 (cm)	CH0+	LSS "J"	LSS "L"	NPM "J"	RSS "J"	RMW "J"	LND "J"	LPD "J"	
PS48	9-Jun-04	1704	38	15	0	0.4	0	0	0	0	5	95	1						5			
PS49	9-Jun-04	1708	50	20	0	0.3	0	0.2	0	0	60	40	5	40					7			
PS50	9-Jun-04	1715	50	20	0	0.3	0	0.2	0	0	35	65	3	10					7			
PS51	9-Jun-04	1721	38	15	0	0.2	0	0.1	0	0	10	90	1		15				5		3	
PS52	9-Jun-04	1734	50	20	0	0.2	0	0.2	0	0	10	90	3	30	12				10			
PS53	9-Jun-04	1743	25	10	0	0.3	0	0.1	0	0	5	95	0.5	15					10			
PS54	9-Jun-04	1900	38	15	0	0.2	0	0.3	0	0	90	10	4						2			
PS55	9-Jun-04	1910	50	20	0	0.3	0	0	0	0	15	85	2						2		2	
PS56	9-Jun-04	1920	50	20	0	0.3	0	0.4	0	0	70	30	6						2	1	2	
PS57	9-Jun-04	1940	38	15	0	0.3	0	0.1	0	0	5	95	2		2				1			
PS58	9-Jun-04	1942	38	15	0	0.4	0	0.3	0	0	60	40	3							1		
PS59	9-Jun-04	1945	38	15	0	0.3	0	0.4	0	0	55	45	2	1					4			
PS60	9-Jun-04	2000	38	15	0	0.2	0	0.4	0	0	60	40	3									
PS61	9-Jun-04	2015	38	15	0	0.2	0	0.1	0	0	5	95	1				80	20				Abundant water boatman.
PS62	9-Jun-04	2024	38	15	0	0.2	0	0.1	0	0	0	100	0.1									
PS63	9-Jun-04	2130	50	20	0	0.4	0	0.1	0	0	0	100	0.1			3			1			
PS64	9-Jun-04	2149	50	20	0	0.3	0	0.1	0	0	0	100	0.1	1		3			2			Abundant water boatman.
PS65	9-Jun-04	2200	63	25	0	0.3	0	0.1	0	0	0	100	0.1	1		3			2			Abundant water boatman.
	Total:		**3,588**	**1,435**										**357**	**187**	**12**	**262**	**182**	**109**	**13**	**70**	
	Mean:		**55**	**22**																		

Appendix 4

Photograph Plates

Phase A: Detection and Monitoring Program

Plate: 1 **Date:** April 28, 2004
Comment: Downstream overview of the study area with the town of Vanderhoof in the background. H-antennae attached to the wing support of the plane is visible on the right.

Plate: 2 **Date:** April 28, 2004
Comment: Upstream overview of the study area. The red arrow points to the channel where the highest density of adult sturgeon were observed.

Phase B: Spawning Assessment

Plate: 3 **Date:** May 18, 2004
Comment: An adult white sturgeon observed from the helicopter.

Plate: 4 **Date:** May 18, 2004
Comment: A pair of adult white sturgeon observed from the helicopter.

Plate: 5 **Date:** May 18, 2004
Comment: A group of three adult white sturgeon observed from the helicopter.

Phase C: Data Collection

Plate: 6 **Date:** May 19, 2004
Comment: One of the crews taking substrate samples using a Petite Ponar grab. The grab proved to be ineffective at sampling the larger cobble substrates.

Plate: 7 **Date:** May 19, 2004
Comment: Looking for eggs by sifting through the substrates collected with the Petite Ponar (foreground). Angling for potential predators of sturgeon eggs (background).

Plate: 8 **Date:** May 19, 2004
Comment: Deploying a substrate mat immediately downstream of where the highest density of adult sturgeon were observed during the helicopter overflight.

Plate: 9 **Date:** May 20, 2004
Comment: Carefully examining a substrate mat for eggs.

Plate: 10 **Date:** May 22, 2004
Comment: Showing a dissection of a sculpin captured in a minnow trap, in order to determine stomach contents.

Plate: 11 **Date:** May 20, 2004
Comment: A close-up view of a white sturgeon egg collected by kick-netting immediately downstream of where the highest density of fish were observed.

Plate: 12 **Date:** May 29, 2004
Comment: Kick-netting for larvae. A fyke net anchored with rebar is visible at the left of the photo.

Plate: 13 **Date:** May 29, 2004
Comment: Showing the round and D-ring fyke nets anchored with rebar distributed across one of the braided channels downstream of the spawning area.

Plate: 14 **Date:** May 29, 2004
Comment: Showing the sturgeon larvae captured by kick-netting at site K12.

Plate: 15 **Date:** July 1, 2004
Comment: Showing the juvenile sturgeon in an aquarium approximately 1 month after capture (reared from the larvae captured on May 29th).

Plate: 16 **Date:** May 22, 2004
Comment: Looking downstream at the channel where the highest density of adult sturgeon were observed. Substrates in this region are dominated by cobble with maximum water velocities of 1.26 m/s and maximum depths of approximately 2 m.

Plate: 17 **Date:** May 22, 2004
Comment: Showing the typical habitat found throughout the braided portion of the study area. Maximum depth is approximately 1 m with maximum velocities less than 1.0 m/s. Substrates are primarily gravel mixed with fines.

Plate: 18 **Date:** May 22, 2004
Comment: Showing the typical braided portion of the study area. Maximum depth is approximately 1m with maximum velocities less than 1.0 m/s. Substrates are primarily gravel mixed with fines.

Plate: 19 **Date:** May 22, 2004
Comment: Looking upstream at the channel where the highest density of adult sturgeon were observed. Maximum depth in this region is approximately 2 m with maximum velocities of 1.26 m/s.