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Visual surveys for hatchery reared juvenile sturgeon, one week after release into the Nechako River.

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1. INTRODUCTION

This letter report presents the findings of surveys for hatchery reared four month old white sturgeon (*Acipenser transmontanus*), approximately one week from their release into the Nechako River. Approximately 4,200 sturgeon were released in stages at 3 separate locations (river kilometer [rkm] 145, 136, and 116) within the Nechako River as part of a pilot conservation fish culture program spearheaded by the Nechako White Sturgeon Recovery Initiative (NWSRI).

Surveys presented in this report were conducted after the release of the first cohort of fish (n = 1,958), of which 22% (n = 431) were released from the Highway 27 Bridge (rkm 145), 56% (n = 1,096) from the Vanderhoof boat launch (rkm 136) and 22% (n = 431) from the overwintering hole adjacent to Steve Legg's property (rkm 116.7).

Surveys were initiated in order to assess the dispersal of the juveniles from the release locations. The main objectives of this pilot survey were to determine the effectiveness of various equipment and methods for visually locating juvenile sturgeon, and to assess the movement of and habitat used by the juveniles shortly after release. Design, mobilization and implementation of the study were almost immediate, precluding a rigorous peer-reviewed study design. However, the pilot surveys should facilitate future planning and study design geared towards meeting specific objectives of the NWSRI.

2. METHODOLOGY

The following methodologies were used to determine the location and activities of the released juvenile white sturgeon in the Nechako River. The study area for the project was the length of the Nechako River between the Highway 27 Bridge (rkm 145) downstream to km 116.

2.1 Snorkel surveys

Surveyed sections of river were divided into six lanes, with one half of the river (three lanes) surveyed at a time. After the first half of the channel was snorkeled, crews were returned to the top of the same section to float down the second half of the channel. Initially three swimmers were used, but it was soon determined that observations from the boat were more effective (compared to snorkeling) in shallow (*e.g.* < 1.5 m) calm water as a wider area could be effectively viewed by standing on the bow of the boat (Appendix 2, Plate 4). The boat crew (driver and observer) was assigned to the shore lane.

The speed of the snorkel surveys was largely dependant on water velocity. Velocity was the greatest in the vicinity of the Highway 27 Bridge, with surveyors covering up to 3 km in an hour (approximately 0.8 m/s). Downstream of the Vanderhoof boat launch, water velocities slow to less than 0.3 m/s and kicking with fins was required to maintain an efficient survey rate.

Visible depth was approximated each day at the first location where the channel bottom could not be effectively seen. A swimmer would orient themselves vertically (approximately 2 m) and then propel themselves down until their feet touched bottom. Outstretched arms were typically slightly below water surface, which was later measured to be equivalent to 2.5 - 3 m. Lateral visibility varied somewhat based on water depth, but a snorkel survey lane typically had 6 - 8 m of lateral visibility. The boat observer was estimated to have 13 – 17 m of lateral visibility (5-7 m to each side, plus the 3 m width of the boat to the front), with the greatest lateral visibility in shallower water. Wetted width at the flows observed during the survey varied typically between 70 m to 110 m. Based on the previously described lateral visibility, the effective width of the river that was observed using the 6 lanes ranged from to 45 - 95%. During most of the conditions encountered it is estimated that 75% of the river width was effectively surveyed.

2.2 Underwater camera

An underwater camera was deployed from the boat to observe pool and deep channel habitat. For the purpose of this study, deep channel habitat was defined as portions of the channel where depth was greater than what could be viewed while snorkeling (approximately 3 m). Deep channel habitat was observed through the camera while floating, and pool habitats were observed from an anchored position. The underwater camera was connected to a video camera which allowed for the capture of relevant footage (Attachment 1).

2.3 Shallow water and river margin surveys

Shallow water surveys in the immediate vicinity of the release locations were completed by wading. Similar to snorkel surveys, the wadeable depth of the shore was split into three or four lanes (depending on how quick the channel dropped off). Selected sections of the river margins were surveyed in an upstream direction, as the ripples created by walking downstream result in surface disturbance that makes viewing the channel bottom difficult. Polarized glasses were worn to reduce glare, and improve the chances of detecting juvenile sturgeon. The use of AquaView scopes was investigated, but the narrow field of view made the equipment ineffective.

2.4 Behavioural and physical observations

When juvenile sturgeon were located, their position was recorded using a Garmin 12XL GPS unit (this was completed by the boat crew during snorkel surveys). Physical parameters such as habitat type, water velocity, water depth and substrate type were documented at each location. Water velocity was measured using a velocity sensor (Swoffer Instruments, Seattle, Washington) and depths were collected using a graduated rod. Water velocities were collected at 40% of the depth and at near-bed. Substrates were described based on visual observations according to Kaufmann and Robison (2003) as either fines (< 2 mm), gravels (2-64 mm), cobbles (64-256 mm), boulders (256 – 4,000

mm), or bedrock (> 4,000 mm). Sturgeon behaviour (*e.g.* grouping, numbers present) was recorded using a video camera (Attachment 1) and/or written documentation. The presence of predators was also recorded, when encountered.

3. RESULTS

3.1 River conditions

River discharge during the survey period (as measured at the Water Survey of Canada station at the Vanderhoof bridge; 08JC001) was approximately 43 m^3/sec, and the hydrograph was stable. Water temperature ranged between 7° and 10°C. The low and stable fall flows resulted in excellent water clarity (Table 1), with viewable depths estimated at 2.0 - 2.5 m. Due to the fall survey timing, optimal light intensity was limited to between 10:00 and 3:00 pm.

Table 1. NTU measurements taken using a LaMotte 2020 turbidimeter.

Date	NTU
Oct-11	0.62
Oct-12	0.36
Oct-12	0.58
Oct-13	0.76

3.2 Sturgeon Observations

Although the study area was approximately 30 km in length, the majority of effort was focussed around and downstream of the Vanderhoof boat launch, as this is where the majority of juveniles (n = 1,096) were released. Similarly, other areas of focus were in the vicinity of the two other release sites (the Highway 27 Bridge and rkm 116). Effort was reduced in sections of the river where there was little likelihood for success (for example, where no fish were observed for a continuous 2 km section of river). Although focussing on sections of river where fish were observed (or likely to be observed) introduced bias into the sampling, the survey time was limited so this approach helped ensure excessive time was not spent in habitats where field results indicated there were likely no fish.

A total of 43 juveniles were observed over the 3 day survey period (Table 2) between rkm 145 and rkm 116 (Figure 1). Fish were observed at depths of 0.5 to 2.8 m, and at near-bed water velocities less than 0.5 m/sec. Observed fish were not associated with cover, and there were no predators observed in the immediate vicinity of the juvenile sturgeon. The majority of fish were observed within 30 m of the river margin, however, numerous individuals were observed within the mid-channel lanes. All observed sturgeon were associated with the bottom of the channel, and exhibited very little movement (even when the flow metering pole was placed beside them). No groups of juveniles were observed, however there were several cases where two or more juveniles were observed within close (*e.g.* 10 m^2) proximity of each other.

Table 2. Summary of survey observations.

Release Location	Survey Date	Rkm Fish Observed	Number of Fish
135	11-Oct-06	135	13
135	11-Oct-06	135-132	13
150 (Hwy 27)	12-Oct-06	150	3
135	12-Oct-06	131	1
135	12-Oct-06	132	1
116.7	13-Oct-06	117	1
116	13-Oct-06	116	9
115	13-Oct-06	115	2

3.3 Daily summary of activities and observations

October 11, 2006

The morning of October 11 was spent wading in the vicinity of the Vanderhoof boat launch (rkm 136). Wading along the right margin was completed for several hundred meters upstream of the Vanderhoof bridge, but no sturgeon were observed. Similarly, snorkel surveys from the mouth of Stoney Creek downstream to the Vanderhoof Bridge were completed, but no sturgeon were observed. Approximately 60 adult suckers, 30 mountain whitefish, and 1 large bull trout (50 cm+ size class) was observed upstream of the bridge during snorkel surveys.

Wading upstream along the right margin for 300 m to the Vanderhoof Bridge resulted in the observation of 13 juvenile sturgeon. The fish were typically single, in water depths of 0.5 – 1 m, and near-bed water velocities of less than 0.5 m/s. The substrates in this area are small gravels, and the fish were not associated with any functional cover.

The remainder of the day was spent conducting snorkel surveys from the boat launch downstream to rkm 132. An additional 13 individuals were observed in this section of river. Observed individuals were associated with sand substrates, at depths of 0.5 - 2.5 m and water velocities less than 0.5 m/s. Although aquatic vegetation cover was often close (*e.g.* within 10 m) to the observed individuals, sturgeon did not exhibit any fright response and were never observed to flee to cover. Snorkel surveys in this section also resulted in the observation of 105 adult suckers, 45 adult mountain whitefish, 20 juvenile mountain whitefish, 5 juvenile rainbow trout, and 1 northern pikeminnow. These fish species were never observed in the same habitat type as the juvenile sturgeon.

October 12, 2006

The morning of October 12 was spent wading in the vicinity of the Highway 27 Bridge. Wading along the right margin was completed for approximately 200 m upstream of the bridge, but no sturgeon were observed. Wading upstream along the right margin for 400 m to the Highway 27 Bridge resulted in the observation of 3 juvenile sturgeon. The fish

were all single, in water depths of 0.7 – 0.85 m, and near-bed water velocities of 0.16 to 0.25 m/s. The substrates in this area are small cobbles, with larger cobbles and boulder providing functional cover (although the observed fish did not take advantage of the cover).

Snorkeling and boat surveys from the bridge downstream to rkm 143 did not result in the observation of any sturgeon, however 68 adult suckers, 74 mountain whitefish, and 6 northern pikeminnow were recorded. Faster water velocities and boulder/cobble substrates made for difficult observation conditions as there were many hiding spots for juvenile sturgeon and a lot more objects to look at compared to a non-descript sandy bottom.

The afternoon was spent conducting snorkel and boat surveys downstream of Vanderhoof (rkm 132 - 129). There were 2 more sturgeon observed on the sandy substrate in this section of river in water depths of 2.2 – 2.8 m, and near-bed water velocities of 0.12 – 0.18 m/s. There was no functional cover in the vicinity of the sturgeon. Snorkel surveys in this section also resulted in the observation of 70 adult suckers, 13 mountain whitefish, and 1 adult bull trout.

October 13, 2006

The morning of October 13 was spent using the underwater camera to investigate various large, deep pools (rkm 133.5, rkm 132 culvert, rkm 129.5, rkm 125 and rkm 116). No juvenile sturgeon were observed using the camera. However, approximately eight adult sturgeon were observed at the km 116 hole. This footage was not recorded as the battery in the video camera had been expended at previous sites.

Snorkel and boat surveys were completed between rkm 117-115. There were 12 juvenile sturgeon observed in this section in water depths of 1.02 – 2.45 m, and near-bed water velocities of 0.0 – 0.15 m/s. There were two occasions where several (n=5, n=3) fish were observed in relatively close proximity (25 – 50 m^2) to each other occupying similar habitats. However, these fish were not paired or directly interacting with each other. The remaining fish were sufficiently isolated from each other that separate habitat measurements were recorded. All observed fish were associated with fine substrates (sand), and no functional cover.

4. DISCUSSION

Less than 1% of the released juvenile sturgeon were observed during the survey, and most were visually detected by observers in the boat. Where water depths exceed 1.5 m snorkeling was more effective, and where water depths exceed 2.5 m an underwater camera was needed. The exceptional viewing conditions from the boat were due to the placid water surface resulting from a lack of wind during the survey period. A rippled water surface resulting from even a moderate breeze would reduce the effectiveness of boat surveys.

Visibility is typically the primary factor that affects the efficiency of the snorkel surveys. Water clarity during the study period was as good as could be expected, and the river was at near record low flows during the surveys. Both factors led to ideal viewing conditions. The only case where visibility was less than ideal occurred on the last day of snorkel surveys when swimmers were ferried upstream to swim the second set of three lanes. The wake from the boat generated sufficient turbidity to reduce the visible depth, and therefore the effectiveness of the snorkel surveys.

In the vicinity of the Highway 27 Bridge, faster water velocities and larger substrates (*e.g.* cobble and boulders) decreased observer efficiency. Investigating alternate observation techniques under such conditions would be beneficial. However, it is likely that certain habitat types such as riffles with high water velocities (> 2 m/s), shallow depths, and boulder substrates may never be effectively surveyed by visual observation.

The majority of fish were observed on sandy or small gravel substrates, lacking vegetation or other cover including filamentous algae. Although areas of sandy bottom with a filamentous algae cover were more abundant, juvenile sturgeon were only observed on sandy bottoms where there was no algae or other available cover. It is unclear as to whether this is due to increased observer efficiency under such conditions (compared to dense aquatic vegetation), or active selection of such habitat by the juveniles. Such shallow areas lacking cover are typically avoided by other fish and juveniles may benefit from the reduced water velocities as well as predator avoidance. Having no history of predator interactions would suggest that this habitat selection is instinctual. Juvenile sturgeon did not exhibit any fright response (even when the flow metering rod was place immediately beside them), and did not take advantage of cover even when it was present.

A larger area (of shallows) can be searched by boat and by more than one observer. In deeper water a smaller area is searched but with good clarity by both snorkeling and the underwater camera. Proportional to the area of habitat that was effectively sampled it appears that juvenile sturgeon preferred shallow sandy areas over gravel cobble and avoided deep pools where other fish species tend to concentrate. Whether they use aquatic vegetation cover areas is unknown as observer efficiency is much lower in such habitats.

Numerous fish were observed downstream of the Vanderhoof boat launch between rkm 134 – 129. This section is often characterized by sand dunes with a rippled surface. Small pieces of bark and woody debris often accumulate behind the ripples in the sand dunes. The observed juvenile sturgeon were largely stationary (tail movements were often not discernable), and looked very similar to the debris. The lack of movement may serve both to avoid predation by appearing to be debris on the bottom of the channel, and also to reduce the energy that is expended.

One week after release, the majority of observed juvenile sturgeon were within several hundred meters of their release location. The largest identified downstream movement

was in the vicinity of the Vanderhoof boat launch, where an individual was identified 5 km downstream of the assumed release site (*e.g.* it seems reasonable to assume that the fish identified at rkm 131 was released at rkm 136, not rkm 145). The extent of the downstream movement of fish released from the Highway 27 Bridge could not be determined as no fish were observed beyond 400 m of the release location, likely due to difficult viewing conditions as previously discussed. The extent of the downstream movement of fish from rkm 116 was not determined as the study area did not extend much beyond the release site.

Although the majority of observed juvenile sturgeon were within several hundred meters of their release location, observed fish represented less than 1% of the released fish. Viewing conditions (and therefore observer efficiency) were excellent upstream (*i.e.* to the Stoney Creek confluence) and downstream for approximately 1 km from the Vanderhoof boat launch. It is unlikely that approximately 1,000 individuals would be overlooked in such conditions. Approximately 1 km downstream of the boat launch water velocity slows and there is abundant aquatic vegetation that could prevent the visual observation of juveniles. In the case of the Vanderhoof boat launch, it is likely that the majority of fish have moved at least 1 km downstream from the release location within one week of being released.

This study represents a point survey completed within 7-9 days of the release date, and as such it is unknown whether fish observed downstream of release sites had selected the habitat they were observed to be utilizing, or whether downstream movement to find preferred habitats was still occurring. The timing of future studies should be a balance of starting soon enough to increase the odds of seeing fish before they disperse to very low densities, and waiting long enough to help ensure that fish have acclimatized to the river and have selected preferred habitat. This timing will be dependant on the number of fish released, but results from the 2006 survey would suggest that the initiation of surveys does not need to be sooner than one week after release.

5. RECOMMENDATIONS FOR FUTURE SURVEYS

The continuation of a conservation fish culture program, and an increase in the number of juvenile sturgeon within the Nechako River due to the release of hatchery reared fish, should allow future surveys to gain a better understanding of habitat selection by juveniles. A better understanding of habitat selection during early life stages may provide answers to why few juveniles appear to survive to adulthood. Additionally, the preferred habitats identified during such surveys can be the focus of release locations for hatchery reared fish in the future.

Should similar surveys for juvenile sturgeon be completed in the future, following are some general recommendations:

- The river should be divided into a minimum of six lanes.
- Shallow shore lanes are most effectively observed from a boat when the water surface is placid.

- Alternate techniques should be investigated to identify sturgeon where larger substrates and faster water velocities are present (*e.g.* rkm 145).
- Wake from the boat can generate turbidity along certain sections of the river (*e.g.* where clay banks are prevalent) that is sufficient to reduce the effectiveness of snorkeling. This was particularly noticeable in back-eddy areas.

6. REFERENCES

Kaufmann, P. and F. Robison. 1993. A quantitative habitat assessment protocol for field evaluation of physical habitat in small wadable streams. Oregon State University in cooperation with U.S. EPA ERL, Corvallis, OR.

Appendix 1

Summary Data

Appendix 1. Results from the October 2006 surveys, by river kilometer (WSG = white sturgeon, FT = foot, SN = snorkeling, BT = boat).

Date	River km	# of WSG	Easting	Northing	Time	Depth (m)	Velocity @40% (m/s)	Near Bed Velocity (m/s)	Observer	Survey Method	General Habitat Type (Pool, Riffle, Glide)	Specific Habitat Type	Substrate Description	Predators in Vicinity	Vegetation	Other Comments
11-Oct	135	13	433947	5986888	8:38	< 1.0	<0.5	< 0.5	RL/ML/DT/RM	FT	Glide	Shallow glide	Small gravel. D_{95} = 8	None observed.	None.	
11-Oct	135		433921	5986893	8:49	< 1.0	<0.5	< 0.5	RL/ML/DT/RM	FT	Glide	Shallow glide	Small gravel. D_{95} = 8	None observed.	None.	
11-Oct	135		433902	5986901	8:51	< 1.0	<0.5	< 0.5	RL/ML/DT/RM	FT	Glide	Shallow glide	Small gravel. D_{95} = 8	None observed.	None.	
11-Oct	135		433934	5986905	9:01	< 1.0	<0.5	< 0.5	RL/ML/DT/RM	FT	Glide	Shallow glide	Small gravel. D_{95} = 8	None observed.	None.	
11-Oct	135		434138	5986760	9:25	< 1.0	<0.5	< 0.5	RL/ML/DT/RM	FT	Glide	Shallow glide	Small gravel. D_{95} = 8	None observed.	None.	
11-Oct	135		434103	5986798	9:32	< 1.0	<0.5	< 0.5	RL/ML/DT/RM	FT	Glide	Shallow glide	Small gravel. D_{95} = 8	None observed.	None.	
11-Oct	134	13	435143	5986593	12:55	1.0 - 2.5	<0.5	< 0.5	RL/ML/DT/RM	SN/BT	Glide	Deep glide	Fines D_{95} = 1	None observed.	None.	
11-Oct	133		435523	5986682	13:28	1.0 - 2.5	<0.5	< 0.5	RL/ML/DT/RM	SN/BT	Glide	Deep glide	Fines D_{95} = 2	None observed.	None.	
11-Oct	133		435786	5986214	13:45	1.0 - 2.5	<0.5	< 0.5	RL/ML/DT/RM	SN/BT	Glide	Deep glide	Fines D_{95} = 3	None observed.	None.	
11-Oct	133		435788	5986141	13:52	1.0 - 2.5	<0.5	< 0.5	RL/ML/DT/RM	SN/BT	Glide	Deep glide	Fines D_{95} = 4	None observed.	None.	
11-Oct	133		435720	5985938	14:01	1.0 - 2.5	<0.5	< 0.5	RL/ML/DT/RM	SN/BT	Glide	Deep glide	Fines D_{95} = 5	None observed.	None.	
11-Oct	133		435734	5986494	14:47	1.0 - 2.5	<0.5	< 0.5	RL/ML/DT/RM	SN/BT	Glide	Deep glide	Fines D_{95} = 6	None observed.	None.	
11-Oct	133		435779	5986049	15:01	1.0 - 2.5	<0.5	< 0.5	RL/ML/DT/RM	SN/BT	Glide	Deep glide	Fines D_{95} = 7	None observed.	None.	
11-Oct	132		435613	5985710	15:12	1.0 - 2.5	<0.5	< 0.5	RL/ML/DT/RM	SN/BT	Glide	Deep glide	Fines D_{95} = 8	None observed.	None.	
11-Oct	132		435595	5985640	15:17	1.0 -	<0.5	< 0.5	RL/ML/DT/RM	SN/BT	Glide	Deep	Fines D_{95} = 9	None observed.	None.	

Date	River km	# of WSG	Easting	Northing	Time	Depth (m)	Velocity @40% (m/s)	Near Bed Velocity (m/s)	Observer	Survey Method	General Habitat Type (Pool, Riffle, Glide)	Specific Habitat Type	Substrate Description	Predators in Vicinity	Vegetation	Other Comments
						2.5						glide				
12-Oct	145	1	426920	5989176	8:31	0.71	0.35	0.16	RL	FT	Glide	Shallow glide	Cobble/fines. D_{95} = 15	None observed.	None.	30 m from right margin shore.
12-Oct	145	1	426906	5989197	8:36	0.70	0.48	0.25	ML	FT	Glide	Shallow glide	Cobble/fines. D_{95} = 15	None observed.	None.	25 m from RM shore.
12-Oct	145	1	426888	5989243	8:41	0.85	0.50	0.25	ML	FT	Glide	Shallow glide	Cobble/fines. D_{95} = 15	None observed.	None.	25 m from RM shore.
12-Oct	131	1	436525	5986440	13:55	2.20	0.33	0.18	ML	SN	Glide	Deep glide	Fines D_{95} = 1	None observed.	None.	30 m from shore.
12-Oct	132	1	436439	5985415	14:48	2.80	0.28	0.12	RL	SN	Glide	Deep glide	Fines. D_{95} < 1 cm	None observed.	None.	35 m from shore.
13-Oct	117	1	445912	5982953	12:03	1.1	0.15	0.05	JT	BT	Glide	Shallow glide	Fines. D_{95} < 1 cm	None observed.	Algae.	45 m from RM shore.
13-Oct	116	5	445864	5982319	12:15	2.45	0.23	0.05	JT	BT	Glide	Shallow glide	Fines. D_{95} < 1 cm	None observed.	None.	67 m from LM shore.
13-Oct	116	3	445816	5982309	12:23	1.25	0	0	JT	BT	Glide	Shelf	Fines. D_{95} < 1 cm	None observed.	Algae.	79 m from LM shore.
13-Oct	116	1	445890	5982326	13:56	1.7	0.29	0.15	ML	SN	Glide	Shelf	Fines. D_{95} < 1 cm	None observed.	Algae.	50 m from LM shore.
13-Oct	115	1	444847	5982497	15:13	1.08	0.22	0.12	JT	BT	Glide	Shelf	Fines. D_{95} < 1 cm	None observed.	None.	58 m form RM shore.
13-Oct	115	1	444965	5982469	15:27	1.02	0.25	0.11	JT	BT	Glide	Shelf	Fines. D_{95} < 1 cm	None observed.	None.	60 from LM shore.

Note: The data sheet for October 11 was lost. The majority of information was recovered from an email summary of the day, the GPS waypoint file, video footage and observer interviews. However, the specific # of WSG at each waypoint, and specific depth and velocity have been generalized for October 11 for this reason.

Appendix 2

Photographic Documentation

Plate: 1 **Date:** October 11, 2006 **Observation Method:** Wading
Comment: Juvenile sturgeon on gravel substrates in the vicinity of the Vanderhoof boat launch.

Plate: 2 **Date:** October 12, 2006 **Observation Method:** Boat
Comment: Juvenile sturgeon on sand substrates downstream of the Vanderhoof boat launch.

Plate: 3 **Date:** October 11, 2006 **Observation Method:** Wading
Comment: Depth, velocity and habitat measurements were taken where sturgeon were located.

Plate: 4 **Date:** October 12, 2006 **Observation Method:** Boat
Comment: Showing the boat observer in the shore lane, with two swimmers taking the center left of center lane.