Nechako River White Sturgeon 2015 Spawn Monitoring:

Egg Mats, Radio, and Acoustic Telemetry

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for Carrier Sekani Tribal Council

2015 Annual Spawn Monitoring Report

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Executive Summary

Pre-spawning (sexually mature) fish were captured and tagged as part of 2015 broodstock capture program for the Nechako River White Sturgeon Conservation Hatchery operated by Freshwater Fisheries Society British Columbia (FFSBC). A maximum of sixty-six (66) egg mats were deployed throughout the spawning reach. Radio telemetry was conducted using boat surveys and "fixed" stations. An eighteen-receiver Vemco Positioning System (VPS) acoustic receiver array was used to monitor fine-scale habitat occupancy within a remediated zone of the spawning reach.

The purpose of monitoring in 2015 was to continue annual efforts to document spawning activity in the Nechako River spawning reach in Vanderhoof, B.C., and to confirm spawning white sturgeon were using remediated zones of the reach (Triton 2010, NHC 2013). The spawn monitoring activities are a fundamental component on the Nechako white sturgeon recovery process.

Thirty-six adult sturgeon were captured and assessed as to their sexual maturity, thirteen of which were assessed as being destined to spawn in 2015 (codes 5 or 15 for males and females respectively). Fifteen radio tags and twelve acoustic tags were deployed on fish that were released back into Nechako River between April 21 and May 19, 2015. Five "spawner" sturgeon were double tagged with radio and acoustic tags and were at large during the wild spawning period.

Eggs were detected on mats on May 19 (25), May 21 (289), and May 23 (28). Water temperatures during this period ranged between 10.5 and 12.4, while river discharge within the spawning reach was relatively high between 550 and 595 cubic meters per second. Water temperatures during the 2015 spawning period were slightly low, but within a "normal" range compared to other years (Triton 2010).

Radio and acoustic telemetry records confirm the period between May 18 and May 24, 2015 had the greatest amount of sturgeon activity in the spawning reach. Both radio and acoustic telemetry results suggest spawning and non-sexually mature males arrive at the spawning reach earlier than females, and stay slightly longer than females. Males also show more "wandering behavior", and cross through detection zones more often than females, especially during spawning period. Acoustic telemetry results confirmed white sturgeon spent a significant amount of time over the remediated zone just downstream of the island complex within the spawning reach. Together these results indicate remediation efforts have been properly located.

Table of Contents

List of Figures

Introduction

As of July 2015 the Nechako River white sturgeon population status is Critically Imperiled (S1) as assessed by British Columbia Conservation Data Center (BC CDC), and assessed as Endangered by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) and Schedule 1-listed. In 2012 COSEWIC combined the Middle Fraser, Upper Fraser, and Nechako River white sturgeon populations into one Upper Fraser group for management purposes, despite there being significant genetic distinction between those populations (Smith et al. 2002). As a result, this new Upper Fraser management unit is still being considered for listing under Schedule 1 of the Species at Risk Act (SARA).

Current understanding suggests ongoing recruitment failure in Nechako River white sturgeon population, but the exact mechanisms behind the failure aren't clearly understood.

Nechako sturgeon monitoring has entailed a multipronged approach to assess the extent of spawning activity, juvenile recruitment, and adult habitat occupancy within the Nechako River. Triton Environmental Consultants and Carrier Sekani Tribal Council (CSTC) worked together on the spring spawn monitoring project from 2004 to 2010. That work formed the basis of the spawn-monitoring program in 2015 (which has been undertaken annually from 2011-2014).

The Nechako River "spawning reach" (Figure 1) is a roughly 4.0 km stretch of river located in Vanderhoof, BC. The reach includes several different habitat types including a high water velocity single-thread channel zone with cobble-dominated substrate, a braided channel zone with several permanent islands, and a single-threaded channel within a slower water velocity zone with gravel and fine substrate (Triton 2010).

Historical alterations to the Nechako River flow regime are likely linked to the current recruitment failure the Nechako's sturgeon population has experienced. The current hypothesis suggests infilling of interstitial space in riverbed substrate at the spawning reach is contributing to poor larval survival (McAdam 2005). This infilling is a result of altered flow patterns and major tributary avulsions after the construction of Kenney Dam by RioTintoAlcan (NHC 2003). If this hypothesis is correct then altering riverbed substrate such that more interstitial space is available in areas where white sturgeon deposit eggs may have positive effects on recruitment.

Two large-cobble pads were deposited in the spawning reach in 2011 (NHC 2012). The exact locations for the cobble deposits were chosen based on egg detections and telemetry, but it was not known how often spawning sturgeon are located over those areas versus other areas within the spawning reach. Spawn monitoring is also designed to inform the recovery initiative about fine scale spawning site selection so use of the remediated substrates can be confirmed, and observations relating to larval survival and juvenile recruitment can be correctly interpreted. Spawn monitoring efforts in 2015 included adult sampling including radio and acoustic tagging, fixed and mobile telemetry to monitor the movements of tagged fish, and the deployment of egg detection mats. Radio telemetry can provide meso-habitat scale movemement patterns (e.g. when white sturgeon arrive at the spawning reach), and acoustic telemetry is designed to provide fine-scale habitat use and movements within the spawning reach. In order to accomplish this fine scale monitoring a Vemco Positioning System (VPS) array was deployed within the spawning reach such that one of the large-cobble deposits was included in the detection zone.

Materials and Methods

Egg Mats

Egg collection procedures in 2015 were the same procedures used in previous years (Triton, 2010). Egg mats were constructed using 1m by 1m polyurethane industrial filter material sandwiched between two angle iron frames. Each frame had one or two wooden cross-members to provide stability for the filter material. Two egg mats were joined end to end using a carabineer and deployed together at particular sites. A bright orange buoy was also attached using ~8 m buoy line tied to the upstream end of the mats, which allowed for easy identification and retrieval.

Deployment depths were recoded using depth sonar sensor onboard the deployment boat. Water velocities were not recorded in lieu of discharge measurements recorded continuously at Burrard Bridge and downloaded from Government of Canada's Water office website using station number 08JC001.

Brood Capture – Acoustic and Radio Tag Deployment

Adult white sturgeons were targeted using 20-80m setlines with 6-24 hooks per line; 16/0 circle hooks were used. Captured adults were processed and internally assessed for their state of sexual maturity. All adult fish were released with PIT and radio tags, and a subset were selected for acoustic tagging. The processing procedure for morphometric data was identical to 2009 procedures reported by Triton (2010). After all morphometric data had been collected a 1-2 cm incision was made on the ventral surface of the fish in between the 3rd and 4th scute from the anal fin. An otoscope was used to complete an internal exam of the gonads to assess sexual maturity. Fish assessed as being ready for spawning in 2015 were either transported to the hatchery for use as brood stock, or tagged and released immediately.

Handling treatments differed between fish held for brood or fish tagged and released immediately, however the surgical procedure for tag implantation was identical for all fish released with tags. The incision made for internal assessment was opened to approximately 4 or 5 cm. A V16-5xp VEMCO acoustic transmitter (60-80 second delay) was inserted anteriorly through the incision. Then a narrow gauge needle was inserted 2-3cm posterior to the incision, and pulled anteriorly through the incision. The radio tag antenna was fed through the hollow needle and the needle was removed leaving the antenna to trail external to the fish. Then a radio tag (Lotek) was inserted through the incision and slid anteriorly. Two or three sutures were used to close the incision.

Study System and Receiver Deployment

One "fixed" or stationary radio telemetry station (Lotek SRX800 receiver) is located near the spawning reach. This radio telemetry receiver station is located at rkm 136.1 just downstream of the Burrard Bridge (Figure 1). This station usually detects the onset and subsidence of spawning events in the spawning reach. Figure 1 shows the Nechako River spawning reach and surrounding telemetry stations (not including the radio telemetry station upstream of spawning reach – downstream of the Highway 27 bridge).

Eighteen VR2W acoustic receivers (VEMCO Ltd, Halifax Nova Scotia) were deployed in Nechako River spawning reach as a Vemco Positioning System (VPS) array. VPS arrays are capable of highly accurate 2-dimensional tracking and provide excellent information for fine-scale habitat activities. The array was deployed in a single-thread thalweg area of the river, immediately downstream of the braided-channel and Stoney Creek confluence, and immediately upstream of Burrard Bridge in Vanderhoof, BC. This area was chosen based on previous year's telemetry monitoring and egg detections and it included a remediated area of riverbed (Triton, 2010; NHC, 2011).

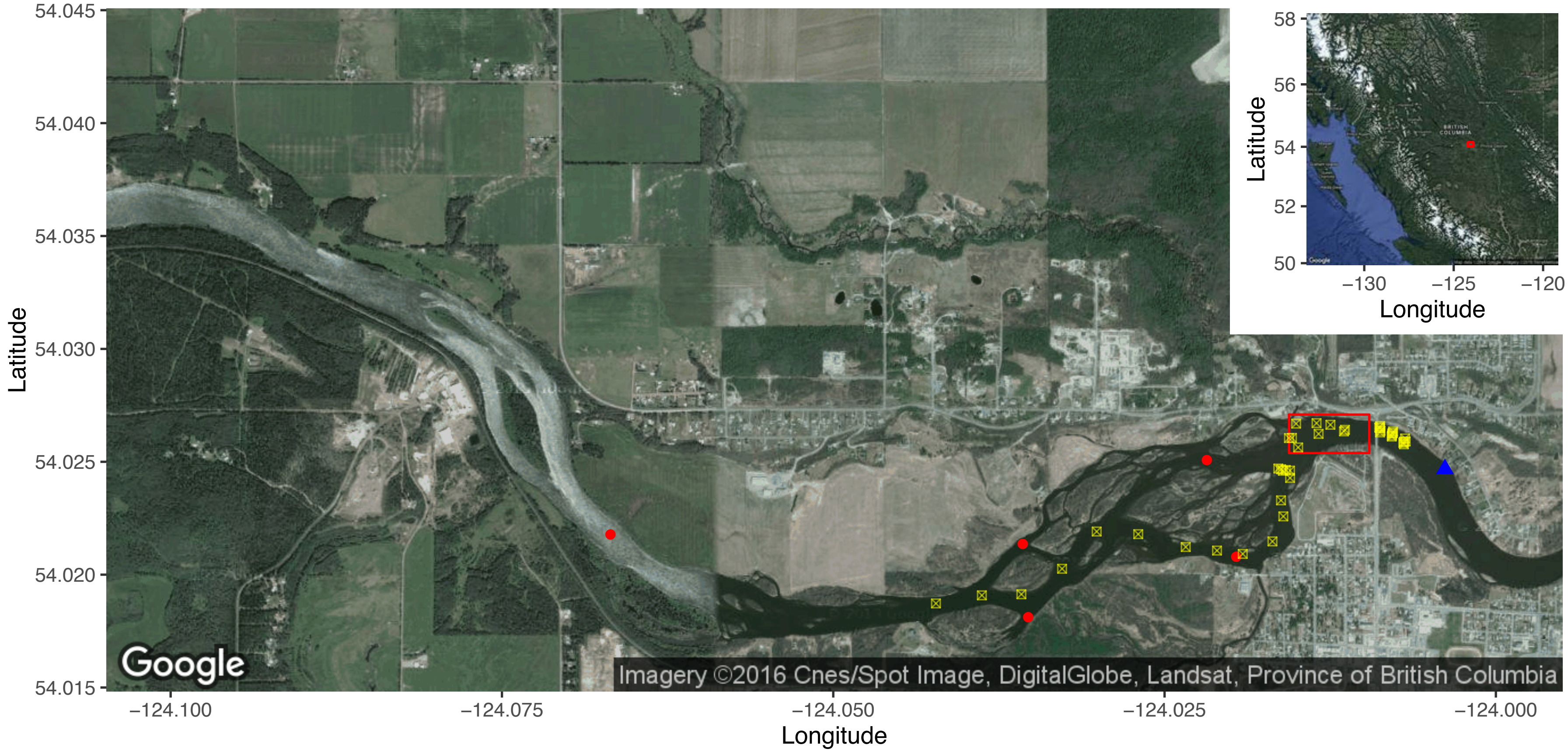

Figure 1. Map of Nechako River spawning reach in Vanderhoof, B.C. Egg mat sites are marked with yellow "x" squares. Individual acoustic receiver sites are marked with red filled circles. The Vemco Positioning System (VPS) array detection zone is represented by the red rectangle upstream of Burrard Bridge. Stationary radio receiver sites are marked with blue filled triangles. Inset map shows Vanderhoof area (red rectangle) in context of British Columbia.

A test of the array was deployed in April 2015 to assess acoustic transmission and reception performance in 2015 water conditions. Range test results indicated 80% detection efficiency at 60m spacing for most locations within the array. The exceptions were locations near Burrard Bridge pillars. Given acoustic performance and acoustic receiver resources the operational array was subsequently spaced 50m in a North-South direction through the array, and 60m in the east-west direction (Figure 2). The VR2W receivers were retrieved on July 30, 2015. Receivers were downloaded by CSTC personnel. Data files were sent to Vemco for data processing. Vemco returned data files containing calculated positions for acoustic tags throughout the operational period.

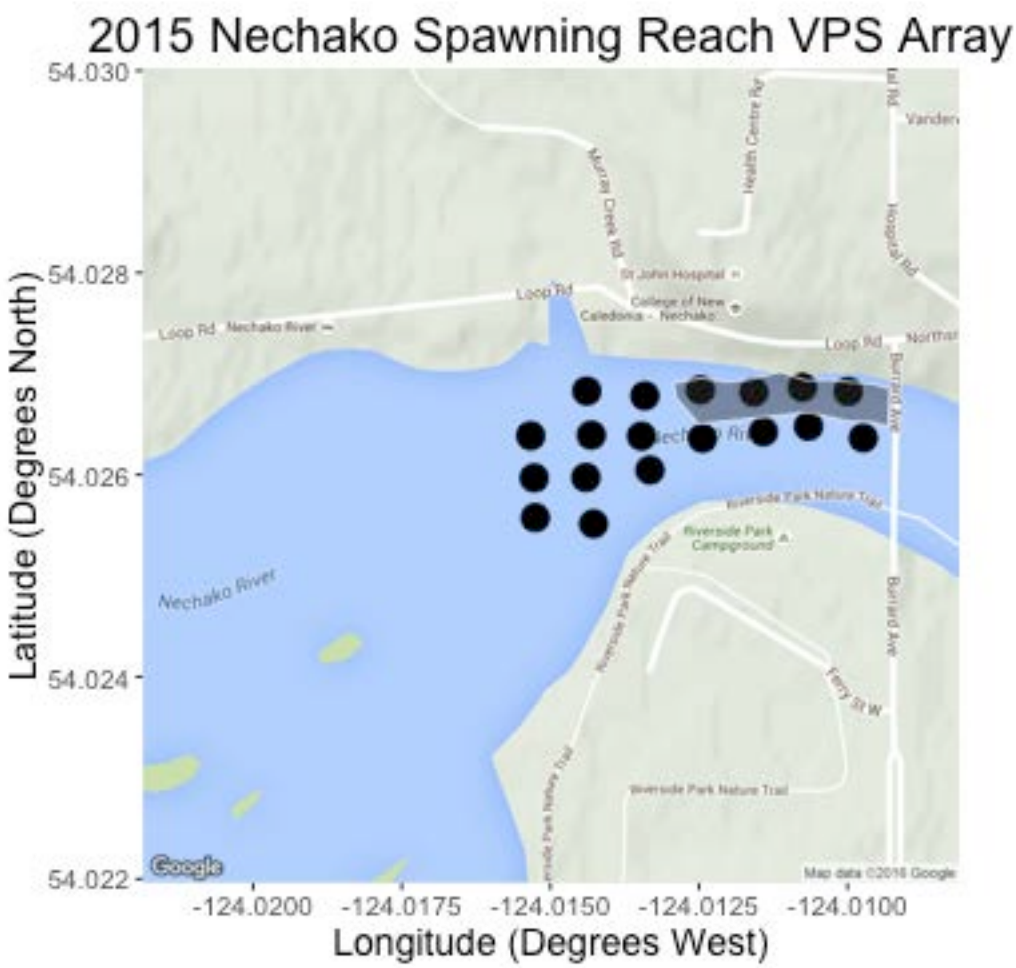

Figure 2. Black circles mark locations of acoustic receivers in the VPS array. Detection zone of VPS is limited to the outer edge of the black circles. The area shaded light gray is the location of the lower cobble stone deposit (gravel pad placed in 2011). Note that the water level was relatively high in 2015, and the mapped riverbanks in this figure reflect high water conditions.

Results and Discussion

Brood Capture and Tag Deployments

Thirty-six adult white sturgeons were captured between April 14 and May 23, 2015 (Appendix A; Table 1). Nineteen fish were males (maturity codes 1 thru 9), including six (6) that were flowing males (code 5 – prepared to spawn in 2015). Five of the flowing males were held for brood stock, and one was released immediately. The remaining 17 fish were female (maturity codes 10 thru 19), including ten (10) that were assessed as ripe females (code 15 – prepared to spawn in 2015). Six of the ripe females were held for brood stock, and four were released prior to the spawning period. Twenty-two of the 36 sturgeon captured were released the same day they were captured. Of those 22 released immediately, six were released with new radio tags, and fourteen were released with acoustic tags. Fourteen adults were initially held as brood stock at the Nechako White Sturgeon hatchery. An additional seven acoustic tags were applied to brood fish after spawning and released back into Nechako River between May 26 and June 02, 2015. Table 1 displays all of the fish captured and released or held for brood stock. Flowing males (code 5) and ripe females (code 15) are highlighted in yellow.

Egg Mat Detections

Forty-six egg mats (23 different sites) were deployed on May 11, 2015. An additional 20 mats were deployed at 10 sites below Burrard Bridge on May 19th, for a total of 66 mats deployed (33 sites) (yellow x-square in Figure 1). The initial 20 egg mat sites were checked on May 19th and all 33 sites were checked on May 21st and May 23rd. All 66 mats were pulled from the river on June 1, 2015 after having 0 eggs detected since May 24th and with radio tag detections within the reach subsiding.

Eggs were collected on May 19 (25), May 21 (289), and May 23 (28). On May 24 only mats located within the acoustic array were checked and no eggs were recovered. All of the mats were checked and pulled on June 1, 2015. Figure 3 shows which egg mats collected eggs by May 19th (highlighted in yellow). Figure 3 also shows egg mats that collected eggs between May 19 and May 21 (second panel) and egg mats that collected eggs between May 21 and May 23 (third panel).

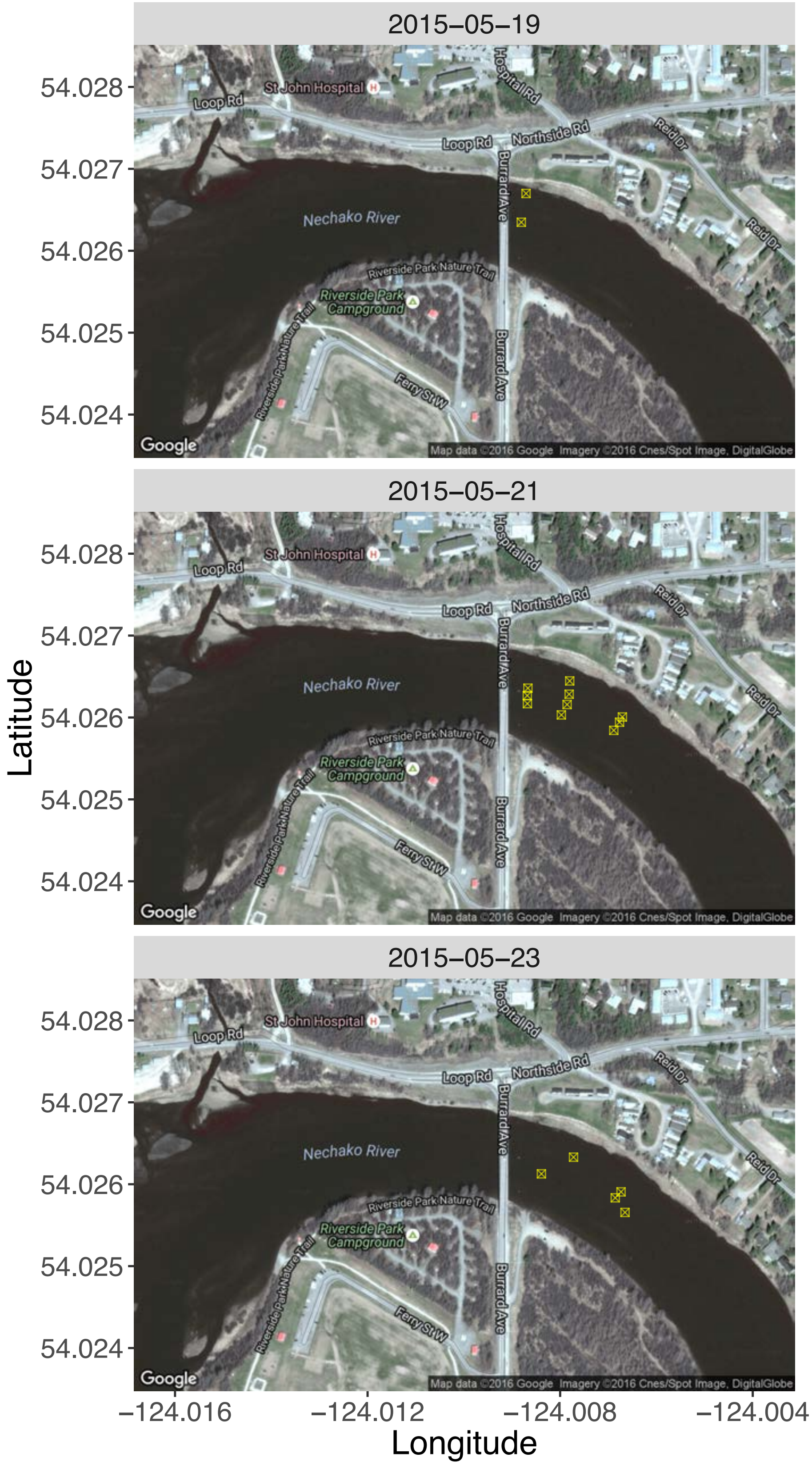

Figure 3. Egg mat sites where egges were collected during the 2015 spawning period. All egg detections occurred immediately downstream of Burrard Bridge in Vanderhoof BC.

Hydrometric Data

River discharge was relatively high in 2015. On May 1, 2015 discharge measured approximately 500 m^3/s (1 m^3/s = 1 cms). Spawning events during the spawning period (May 11 to May 23, 2015) occurred at discharge rates between 550 and 595 m^3/s (Figure 4; green box covers spawning period). It is notable that spawning occurred during an uptrend in discharge in 2015.

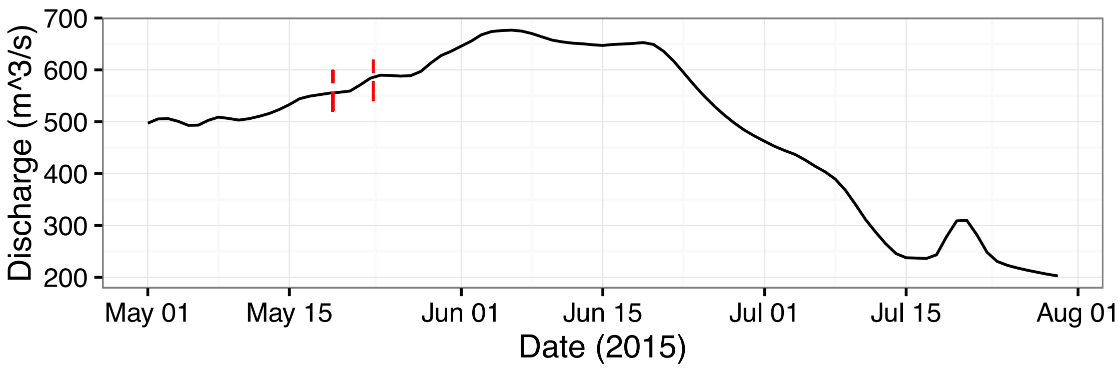

Figure 4. Mean daily discharge rates measured at Burrard Bridge, Vanderhoof, BC. Data between the vertical red dashed lines were recorded during the 2015 white sturgeon spawning period (May 19 to May 23).

Water temperature data were taken from two sources; the temperature sensor from Burrard Bridge WSC Station, and a temperature logger deployed on acoustic station 3 by CSTC. Figure 5 shows mean daily temperatures as filled circles, and the range of daily values recorded by the acoustic temperature logger as lines. Both sensors recorded temperatures between 10.5°C and 12.4°C during the spawning period (red vertical lines in Figure 5). The WSC sensor daily mean almost always matched daily mean temperatures in the lower range of those logged by the temperature sensor located in the array. Two exceptions on May 6 and May 20, 2016 are erroneous data points (May 20 WSC sensor data point not on scale, temperature = 32°C).

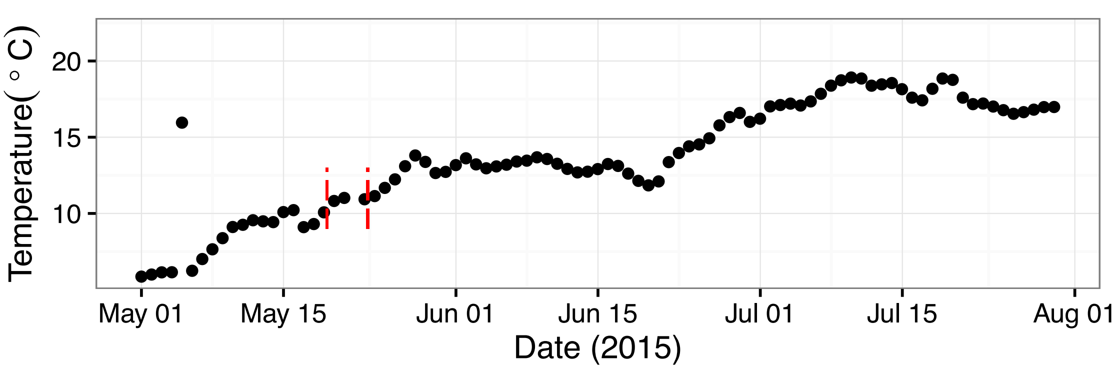

Figure 5. Mean daily water temperatures recorded by sensors located at Burrard Bridge (filled circles) and attached to acoustic receiver in VPS array (lines). The two sensors record similar temperatures. Data between the vertical red dashed lines were recorded during 2015 white sturgeon spawning period (May 19 to May 23).

Water temperatures at the time of spawning were slightly lower than, but within range of previous years spawning temperatures (Triton, 2010). The low-end range of temperatures in 2009 (10.5°C) is the same as 2015 low-end temperature range.

Radio Telemetry

During the 2015 radio telemetry efforts five adults known to be in spawning condition were detected near or within the spawning reach (Table 2, green highlighted rows occur within the spawning period). One was a flowing male (radio ID 39), and the other four were ripe females (radio IDs 29, 30, 36, and 37). The male's first radio detection was May 6, then two detections on May 11th. The mature male had 15 detections starting just before and ending during the inferred spawning period (May 18 to May 22) based on egg captures.

Three ripe females only had radio detections during the spawning period (May 18 to May 21), and one ripe female was detected as early as May 16, and as late as May 24. Females usually only had one or two detections a day, with a few exceptions. This is in contrast to the male, which had as many as 6 radio detections per day within the spawning period.

Female activity within the spawning reach appears to be more short-term concentrated, suggesting females arrive ready to spawn, do so, and then leave the spawning sites quickly. The low number of daily detections also suggests females do not spend a lot of time assessing sites within the spawning reach. Instead they may arrive, choose their site quickly, and then leave the detection zone with only a few detection crossings.

These behaviours contrast males, which appear to arrive earlier and stay longer than females. Radio detections of the one spawner male, and other immature males during the spawning period suggest males wander the spawning reach more than females, likely engaging in spawning and non-spawning behaviours.

The radio detections after the spawning period suggest that fish that migrated to the reach can remain in the area until mid-June, but eventually move downstream. Most of the tagged fish that migrated to the spawning reach were detected near the Stuart River confluence, and one post-spawner was detected at the Nechako-Fraser confluence (radio ID 30) by mid-August.

VPS Performance

The VPS deployed in Nechako River spawning reach was functional May 05, 2015 13:30:00 PST until July 30, 2015 18:00:00 PST (86 days, 4 hours, and 30 minutes). Synchronization tag (sync tag) positioning percentages varied between 12.5% and 89.0%, with a mean positioning rate of 72.7% (Appendix A Table 3). These results indicate the VPS array was successfully gathering positioning information on tags within the array approximately 73% of the time, depending on location of the tag within the array. The low positioning percentages of Stn16, 17, and 18 were expected due to acoustic interference from nearby bridge pilings. In addition, Stn17 was struck with debris and moved rendering it inoperable for a large portion of the array deployment.

Acoustic Array Detections

White sturgeon were detected within the VPS array on 44 out of the 88 of the operational days. A total of 13,106 sturgeon positions from 9 sturgeons were calculated. Deployment days did not have equal sturgeon activity. Figure 6 shows the most number of sturgeon positions were calculated for May 19th, followed by May 20th, 2015. Those two days also have the greatest number of unique sturgeon (5) positioned within the array on that day, and correlate with the dates eggs were collected.

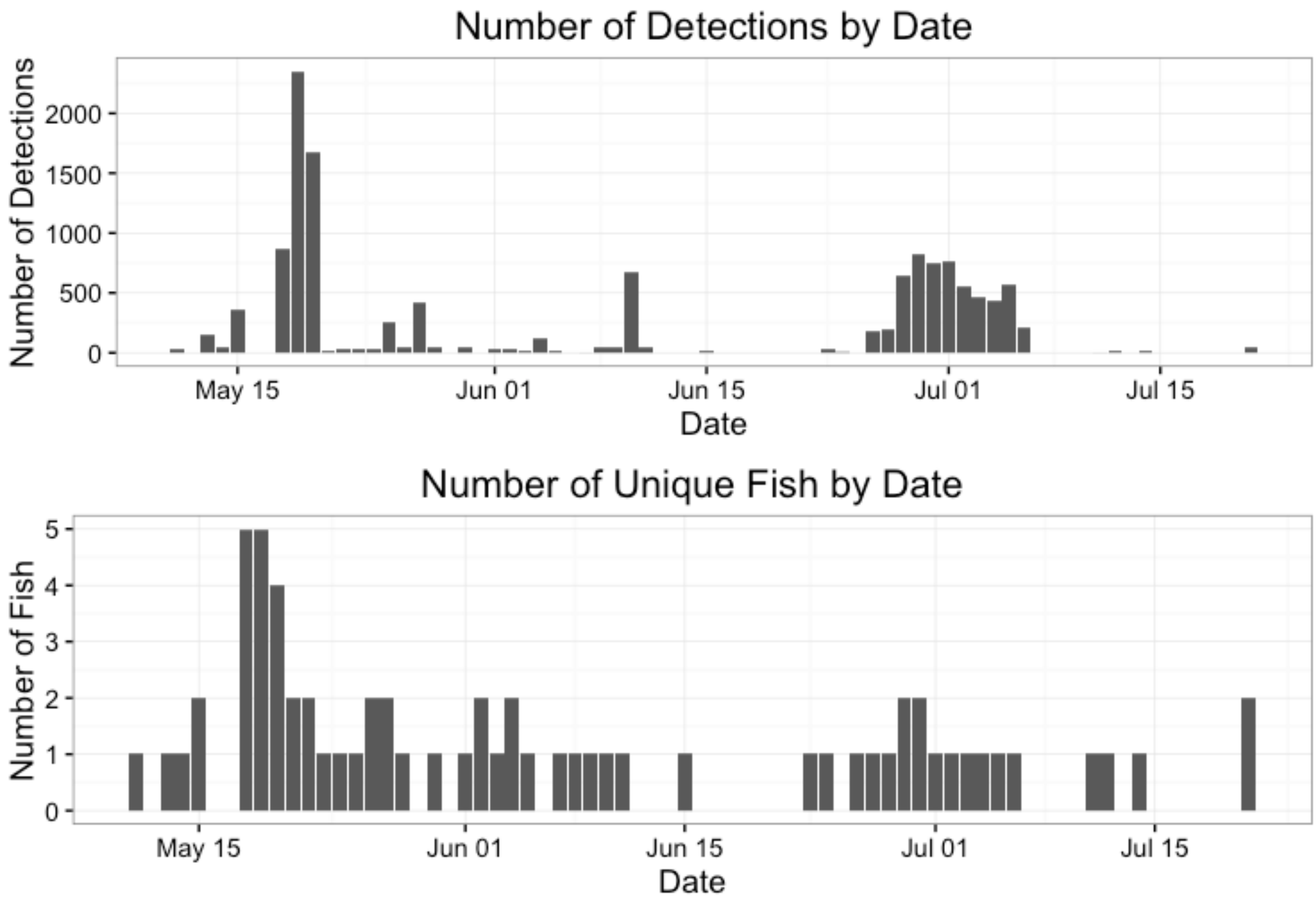

Figure 6. Number of sturgeon positions and number of unique sturgeon detected by the VPS array by date.

Filtering our data to maintain an acceptable positioning error (< 10m) resulted in a data sample of 7694 positions from 8 white sturgeons. Table 4 summarizes the biological details and detection activity of only the white sturgeon included in the filtered data sample.

Two mature females (acoustic IDs 24752 and 24750) were tagged and released in early May. Acoustic ID 24752 and 24750 were first detected in the VPS array on the 18th and 19th of May, 2015 respectively. Female radio ID 36 (148.600mhz) was then detected approximately 9 km upstream on May 20th, 2015. This is an interesting detection because it is approximately 7 rkm upstream of the known spawn locations in Nechako River, and occurred during an appropriate time for spawning. The other tagged female assessed as being prepared to spawn in 2015 was not detected within or upstream of the VPS array.

One flowing male (code 5), two mature males (code 4), and three immature males were released between April 14th and May 17th, 2015. The flowing male arrived at the VPS on May 11, and two immature males arrived at the VPS array/known spawning location between May 13th and 15th, several days before the mature females arrived. Interestingly, one mature male did not arrive at the VPS until June 3rd, and two immature males arrived June 23rd and July 21st. All radio detections of double tagged males (acoustic and radio) occurred downstream of the VPS (i.e. no mobile radio detections upstream of the lower pad in 2015).

Spatial Distribution of White Sturgeons within VPS Array

It was anticipated that the high frequency ping rate of the acoustic tags (40 – 80 seconds random delay) would enable high resolution temporal perspective of sturgeon movements within the spawning reach, and possibly use differences in selected statistics to classify behaviour types (see McLean et al. 2014). Unfortunately after filtering data to maintain position accuracy the mean time-step between relocations within a trajectory is approximately 112 seconds; too long to identify short duration movement patterns associated with spawning in sturgeon (e.g. tail thrashing, short acceleration bursts). Fine-scale spatial assessment of sturgeon positions in the VPS detection zone was pursued in lieu of classifying trajectory bursts into behavioural movements.

The extent that white sturgeon occupied habitat over the remediated lower gravel pad zone relative to other areas within the VPS detection zone was assessed. All sturgeon show activity within the lower pad zone. Figure 7 displays the full set of filtered relocations calculated for each fish, with their acoustic tag ID in the grey panel-header.

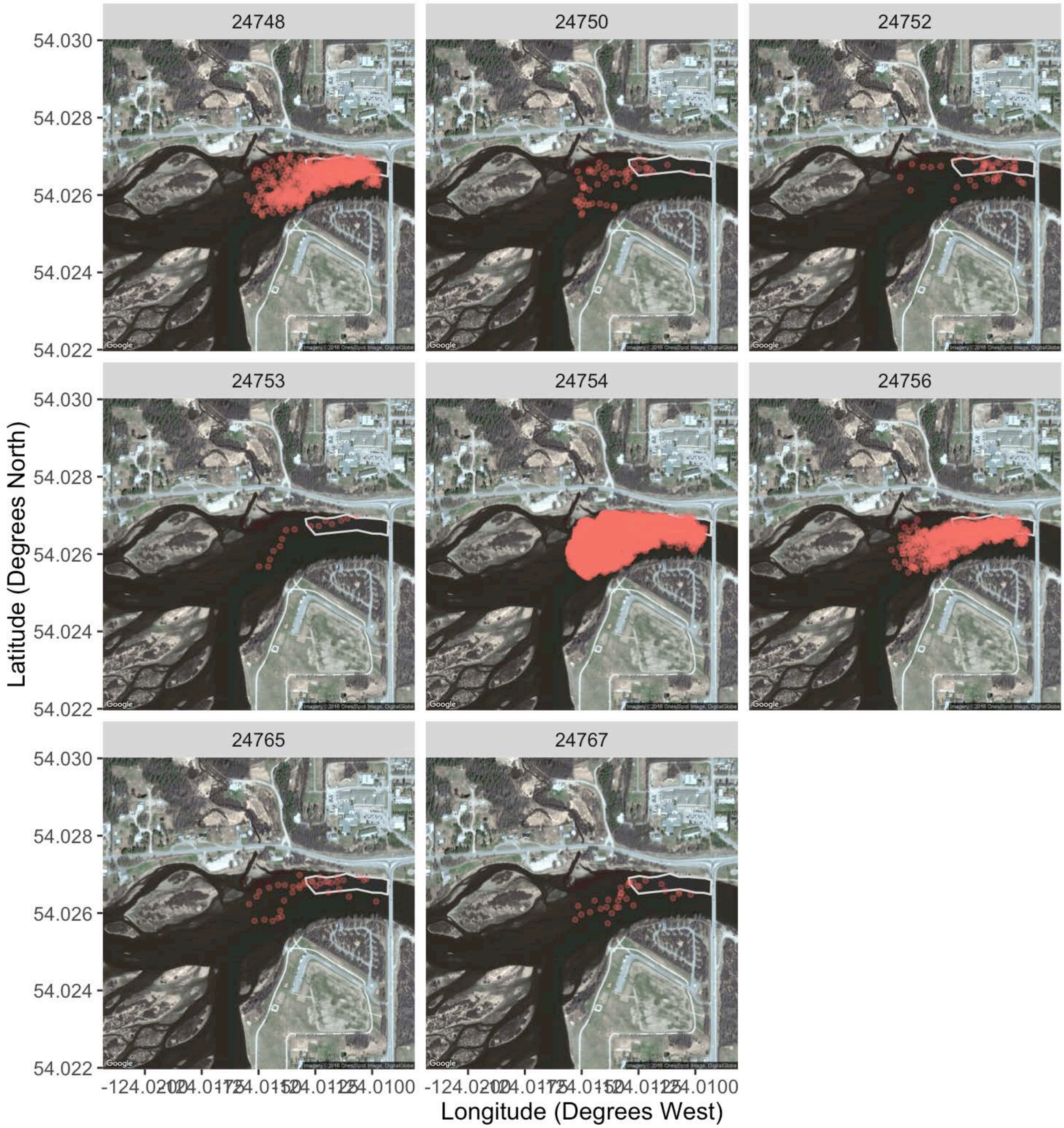

Figure 7. Dataset of location detections for each acoustically tagged white sturgeon (acoustic tag ID in grey panel-header). The location of the gravel pad is outlined in white.

The gravel pad occupies 14% of the available area within the detection zone, and the tagged white sturgeon had 31% of their relocations over the gravel pad, Using Manly's Habitat Selection test we can determine fish were occupying the gravel pad zone more often than chance (Khi2L = 1333.072, $p < 0.000$, Wi = 2.139).

Summary Discussion

Spawn monitoring in 2015 included adult capture and tagging, egg detections within the spawning reach, radio telemetry pre-spawn and during spawn, and acoustic telemetry during spawn. Adult capture data indicates white sturgeon are typically holding-staging in locations between rkm 115 and rkm 135 pre-spawn. Radio tag detections and egg captures provided the basis for determination of the timing of spawning. In 2015 both radio telemetry and egg detections suggest the spawning period occurred between May 18th and May 24th, 2015. Acoustic telemetry detections within the spawning reach show the greatest number of detections of unique sturgeon, and the greatest number of daily detections on May 20th and 21st, which corroborate radio telemetry and egg detection results. Acoustic detections also provided fine-scale spatial movements within the spawning reach.

Water temperatures during the period eggs were captured ranged from 10.5°C to 12.4°C. These temperatures are slightly cooler than spawning temperatures recorded in prior years, but within what could be considered a normal range. River discharge was high during the 2015 spawning period, which has implications for spawn monitoring activities.

Egg detections in 2015 suggest that most spawning events occurred in the downstream end of the spawning reach because only mats located below the bridge detected eggs. The 2015 VPS array was deployed upstream of the Burrard Bridge and encompassed the lower gravel pad, and therefore did not capture activity in the full range of the spawning reach, thus we have no information on spawner use/occupancy in the upper gravel pad (mid-spawning reach area, just downstream of Stoney Creek confluence). Future VPS work should consider including an array designed to monitor both the upper and lower remediated sites to assess habitat selection in both zones.

It is necessary to discuss the difference between spawning location and egg detection location. Spawning location is where eggs are deposited, and egg detection location assumes eggs will drift downstream some distance before they are picked up by a mat. In 2015 eggs were only detected on mats downstream of Burrard Bridge, and the next upstream mat was located approximately 10m upstream of Burrard Bridge. Only a single mat was deployed at that location, unlike the other locations that had a row of mats deployed across the thalweg. The likelihood of an egg being detected depends on the density of eggs in the water, and the sum of benthic space covered with egg mat at a given location. This year egg mat data suggested the primary spawning location was at Burrard Bridge, and egg detection location was just downstream of Burrard Bridge. We must be confident the egg mat just upstream of Burrard Bridge was sufficient to capture sturgeon eggs given coverage and concentration of eggs in suspension.

Radio telemetry results confirm the highest activity period within the spawning reach was between May 18 and May 24, corroborating the general timing of spawning events. Radio telemetry results also show spawning males typically arrive at the spawning reach almost a week earlier than spawning females. Immature males also arrive at the spawning reach earlier than spawning females.

Acoustic telemetry detections confirm the peak of sturgeon activity and spawning within the May 18th to May 24th period. Acoustic telemetry also provided the fine-scale spatial data needed to confirm that white sturgeon were occupying the remediated areas within the detection zone of the array. Acoustic telemetry results confirmed that white sturgeons were located over the lower gravel pad a significant amount of time relative to the total available area of habitat in that zone. This confirms that remediation efforts were targeted appropriately, and continued monitoring should provide insight on the effects of white sturgeon's use of the remediated habitat and subsequent recruitment.

Summary Findings

1. Positive egg detections were made on May 19, May 21, and May 23 indicating the spawning period was between May 11 and May 23.
2. All egg detections occurred downstream of Burrard Bridge.
3. River discharge ranged from 550 m^3/s to 595 m^3/s during the spawning period.
4. Mean daily water temperature ranged from 10.5°C to 12.4°C during the spawning period.
5. Acoustic telemetry confirmed presence of five tagged fish in acoustic array May 19th and May 20th (within the spawning period), including the single tagged female at liberty during the spawning period.
6. Acoustic telemetry covering a greater area will provide better insight on the full range of potential spawning sites sturgeon visit during the annual spawning period.

Recommendations

1. Egg mat monitoring confirmed spawning activity within the reach, and provided estimates of spawning locations. Continued egg mat monitoring is recommended to continue to confirm spawning activity and spawning site selection, which can become interesting when used in conjunction with telemetry.
2. White sturgeon were occupying the lower remediated zone (gravel pad) a significant amount of time. VPS detection data confirmed remediation efforts have been targeted appropriately, but be cautious generalizing detected behaviour to entire population. VPS data was limited to a fraction of the entire spawning reach and possible spawning habitat, and only a fraction of tagged fish were detected. Continued spawn monitoring activities in this area and additional areas will provide insight on spawning and non-spawning behaviours within the spawning reach.
3. Brood capture is the main sampling program allowing for the deployment of radio and acoustic tags in mature adult sturgeon. There is a need to deploy more acoustic tags so that the number of spawning-condition males and females in any given year is maximized. Brood capture and radio and acoustic tag deployment should continue to be combined activities in future years to provide more data for habitat selection within the spawning reach.
4. Opportunities to expand the area covered by the VPS array(s) should be considered so that use and movement patterns within both the upper remediated site and the lower remediated site can be documented.

Citations

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Appendix A : Tables

Table 1. Summary of 2015 brood-stock capture program operated by Freshwater Fisheries Society British Columbia (FFSBC). Flowing males (maturity code 5) and ripe females (maturity code 15) are highlighted in yellow.

PIT ID	Total Length (cm)	Maturity Code	Fate	Capture Date	Capture rKm	Release Date	Release rKm	Tags at Release
41247A5430	206.2	3	Released	15-04-21	116.8	15-04-21	116.8	Pit Radio Acoustic
7F7D7C115E	224.9	4	Released	15-04-23	110.7	15-04-23	110.7	Pit Radio Acoustic
7F7B031A21	242.1	12	Released	15-04-23	116.0	15-04-23	116.0	Pit Radio
401D52192D	224.5	5	Released	15-04-28	125.3	15-04-28	125.3	Pit Radio Acoustic
41250B2C18	244.0	4	Released	15-05-01	121.3	15-05-01	121.3	Pit Radio Acoustic
4527573D3F	253.8	3	Released	15-05-05	125.1	15-05-05	125.1	Pit Radio Acoustic
2224172A7D	210.3	15	Released	15-05-05	129.9	15-05-05	129.9	Pit Radio Acoustic
7F7D7A6A66	238.0	3	Released	15-05-07	129.2	15-05-07	129.2	Pit Radio Acoustic
152217662A	283.5	15	Released	15-05-14	132.7	15-05-14	132.7	Pit Radio Acoustic
7F7B0C6725	208.2	3	Released	15-05-14	129.2	15-05-14	129.2	Pit Radio Acoustic
7F7B031A21	NA	12	Released	15-05-15	129.8	15-05-15	129.8	Pit Radio
7F7D7D2657	236.0	11	Released	15-05-16	127.6	15-05-16	125.6	Pit Radio
45247E083C	240.5	3	Released	15-05-17	127.6	15-05-17	127.6	Pit Radio Acoustic
424F046D54	234.1	15	Released	15-05-17	130.7	15-05-17	NA	Pit Radio Acoustic
41250F5929	238.0	15	Brood Unused	15-05-05	127.6	15-05-19	135.3	Pit Radio Acoustic
4529173846	203.2	12	Released	15-05-20	129.3	15-05-20	129.3	Pit Radio
41247A5430	NA	3	Released	15-05-20	133.8	15-05-20	133.8	Pit Radio
7F7B0B2E51	220.7	3	Released	15-05-21	137.1	15-05-21	137.1	Pit Radio Acoustic
7F7B031A21	NA	12	Released	15-05-23	130.1	15-05-22	130.1	
152219662A	252.5	15	Brood	15-04-21	110.7	15-05-26	130.1	Pit Radio
6C00072572	272.5	15	Brood	15-04-23	116.9	15-05-26	130.1	Pit Radio
6C00072550	261.5	15	Brood	15-05-15	127.6	15-05-26	130.1	Pit Radio
45286C6E35	219.0	5	Brood	15-04-14	117.7	15-06-02	130.1	Pit Radio Acoustic
45284E7344	227.3	5	Brood	15-05-07	128.0	15-06-02	130.1	Pit Radio Acoustic

6C00072535	262.0	15	Brood	15-05-12	132.5	15-06-02	130.1	Pit Radio
6C00072608	245.0	5	Brood	15-05-13	132.7	15-06-02	130.1	Pit Radio Acoustic
6C00072610	277.0	15	Brood	15-05-17	134.4	15-06-02	130.0	Pit Radio
7F7B033461	230.0	4	Brood	15-04-30	130.5	15-06-02	130.1	Pit Radio Acoustic
7F7D7C631A	204.5	3	Brood	15-04-21	110.7	15-06-02	130.1	Pit Radio
7F7D781A4D	221.7	13	Brood Held	15-04-14	117.7			

Table 2. Summary of 2015 "spawner" sturgeon radio telemetry detections. Type refers to either boat-based telemetry station (B) or ground-based telemetry station (GS). Radio detections occurring between May 18 and May 24 are highlighted in green.

PIT	Type	RT Code	River Name	Detect Date (Start)	Detect Date (End)	Time (Start)	Time (End)	Location (rKm)
152217662A	B	36	Nechako R	15-05-16		13:31		133.3
152217662A	GS	36	Nechako R	15-05-18	15-05-18	20:21	20:23	136.1
152217662A	GS	36	Nechako R	15-05-20	15-05-21	23:29	0:44	136.1
152217662A	B	36	Nechako R	15-05-20		11:36		146.4
152217662A	B	36	Nechako R	15-05-21		13:56		134.5
152217662A	GS	36	Nechako R	15-05-24	15-05-24	6:03	6:06	136.1
152217662A	GS	36	Nechako R	15-05-25	15-05-25	17:44	17:54	136.1
152217662A	GS	36	Nechako R	15-06-15	15-06-15	13:00	13:02	136.1
152217662A	GS	36	Stuart R	15-06-23	15-06-23	2:58	2:58	104.9
152219662A	GS	34	Nechako R	15-06-23	15-06-23	13:51	13:51	136.1
152219662A	GS	34	Stuart R	15-07-11	15-07-11	5:34	5:34	104.9
2224172A7D	B	37	Nechako R	15-05-16		13:40		134
2224172A7D	GS	37	Nechako R	15-05-17	15-05-17	23:33	23:46	136.1
2224172A7D	GS	37	Nechako R	15-05-18	15-05-18	3:59	6:38	136.1
2224172A7D	GS	37	Nechako R	15-05-19	15-05-19	8:28	8:52	136.1
2224172A7D	GS	37	Nechako R	15-05-19	15-05-19	3:07	3:19	136.1
2224172A7D	GS	37	Nechako R	15-05-19	15-05-19	17:04	17:58	136.1
2224172A7D	GS	37	Nechako R	15-05-19	15-05-19	1:14	1:17	136.1
2224172A7D	GS	37	Nechako R	15-05-20	15-05-20	7:22	8:39	136.1
2224172A7D	GS	37	Nechako R	15-05-21	15-05-21	7:36	7:57	136.1
2224172A7D	GS	37	Nechako R	15-06-16	15-06-16	22:22	23:40	91.7
2224172A7D	GS	37	Nechako R	15-06-23	15-06-23	0:59	1:34	91.7
401D52192D	B	39	Nechako R	15-05-06		13:00		127.8
401D52192D	GS	39	Nechako R	15-05-11	15-05-11	3:59	4:03	136.1
401D52192D	B	39	Nechako R	15-05-11		11:57		134.9
401D52192D	GS	39	Nechako R	15-05-18	15-05-18	18:03	18:14	136.1

401D52192D	GS	39	Nechako R	15-05-18	15-05-18	1:29	1:56	136.1
401D52192D	GS	39	Nechako R	15-05-18	15-05-18	3:55	7:33	136.1
401D52192D	GS	39	Nechako R	15-05-18	15-05-18	9:19	9:45	136.1
401D52192D	GS	39	Nechako R	15-05-18	15-05-18	12:28	12:28	136.1
401D52192D	GS	39	Nechako R	15-05-18	15-05-18	13:40	13:42	136.1
401D52192D	GS	39	Nechako R	15-05-19	15-05-19	5:08	5:08	136.1
401D52192D	GS	39	Nechako R	15-05-20	15-05-20	16:07	21:10	136.1
401D52192D	GS	39	Nechako R	15-05-20	15-05-20	14:19	15:18	136.1
401D52192D	GS	39	Nechako R	15-05-20	15-05-21	23:54	5:10	136.1
401D52192D	B	39	Nechako R	15-05-21		14:20		135.7
401D52192D	GS	39	Nechako R	15-05-21	15-05-21	6:46	6:55	136.1
401D52192D	GS	39	Nechako R	15-05-22	15-05-22	2:21	2:21	136.1
401D52192D	GS	39	Nechako R	15-05-22	15-05-22	3:43	4:02	136.1
401D52192D	GS	39	Nechako R	15-05-22	15-05-22	5:23	6:22	136.1
401D52192D	GS	39	Nechako R	15-05-27	15-05-27	6:39	6:42	136.1
401D52192D	GS	39	Nechako R	15-06-02	15-06-02	6:55	6:55	136.1
401D52192D	GS	39	Nechako R	15-06-06	15-06-06	19:26	19:59	136.1
401D52192D	GS	39	Nechako R	15-06-06	15-06-07	23:24	1:39	136.1
401D52192D	GS	39	Nechako R	15-06-09	15-06-09	22:39	22:39	91.7
401D52192D	GS	39	Nechako R	15-06-13	15-06-13	22:44	22:44	91.7
401D52192D	GS	39	Nechako R	15-06-14	15-06-14	7:45	7:45	91.7
401D52192D	GS	39	Nechako R	15-06-17	15-06-17	5:09	11:25	91.7
401D52192D	GS	39	Nechako R	15-06-17	15-06-18	17:06	10:00	91.7
401D52192D	GS	39	Nechako R	15-06-18	15-06-18	17:22	17:42	91.7
401D52192D	GS	39	Nechako R	15-06-22	15-06-22	5:34	5:34	91.7
401D52192D	GS	39	Nechako R	15-06-23	15-06-23	1:44	1:44	91.7
401D52192D	GS	39	Nechako R	15-06-26	15-06-26	10:08	10:28	91.7
41250F5929	GS	30	Nechako R	15-05-19	15-05-20	23:42	1:50	136.1
41250F5929	GS	30	Nechako R	15-05-20	15-05-20	5:28	6:47	136.1
41250F5929	GS	30	Nechako R	15-05-20	15-05-20	21:12	21:29	136.1
41250F5929	B	30	Nechako R	15-05-21		13:54		134.4

41250F5929	GS	30	Nechako R	15-08-18	15-08-18	8:31	9:04	2.5
41250F5929	GS	30	Nechako R	15-08-18	15-08-18	10:22	10:50	2.5
41250F5929	GS	30	Nechako R	15-08-18	15-08-18	14:07	16:19	2.5
41250F5929	GS	30	Nechako R	15-08-18	15-08-18	18:10	18:49	2.5
424F046D54	GS	29	Nechako R	15-05-17	15-05-18	23:12	12:14	136.1
424F046D54	B	29	Nechako R	15-05-21		13:55		134.6
424F046D54	GS	29	Stuart R	15-07-19	15-07-19	3:04	3:10	104.9
45284E7344	GS	53	Nechako R	15-06-07	15-06-07	1:37	1:38	136.1
45286C6E35	GS	54	Nechako R	15-06-23	15-06-23	15:16	15:25	136.1
45286C6E35	GS	54	Nechako R	15-06-28	15-06-28	19:21	19:34	136.1
45286C6E35	GS	54	Nechako R	15-06-29	15-06-29	19:49	19:51	136.1
45286C6E35	GS	54	Nechako R	15-09-06	15-09-06	22:28	22:29	91.7
6C00072535	GS	56	Nechako R	15-06-11	15-06-11	12:39	13:09	91.7
6C00072535	GS	56	Nechako R	15-06-12	15-06-12	2:36	3:46	91.7
6C00072550	B	35	Nechako R	15-05-28		11:31		98.2
6C00072550	GS	35	Nechako R	15-06-07	15-06-07	0:42	0:48	91.7
6C00072572	GS	32	Stuart R	15-07-13	15-07-13	0:17	0:22	104.9
6C00072608	GS	52	Nechako R	15-07-11	15-07-11	3:08	3:32	136.1
6C00072608	GS	52	Nechako R	15-07-12	15-07-12	0:17	0:17	136.1
6C00072608	GS	52	Nechako R	15-07-14	15-07-14	13:42	13:42	136.1
6C00072610	GS	31	Nechako R	15-06-11	15-06-11	21:28	21:41	91.7
6C00072610	GS	31	Stuart R	15-07-16	15-07-16	12:56	13:03	104.9
6C00072610	GS	31	Stuart R	15-07-16	15-07-16	20:11	20:13	104.9
6C00072610	GS	31	Stuart R	15-08-12	15-08-12	18:49	19:12	104.9
6C00072610	GS	31	Stuart R	15-08-12	15-08-12	22:55	23:13	104.9

Table 3. Number of positions calculated for each stationary sync tag over the entire VPS deployment. Percent of total possible positions is calculated based on an average ping frequency of the sync tags over the deployment period.

Sync Tag ID	Stn 01	Stn 02	Stn 03	Stn 04	Stn 05	Stn 06	Stn 07	Stn 08	Stn 09	Stn 10	Stn 11	Stn 12	Stn 13	Stn 14	Stn 15	Stn 16	Stn 17	Stn 18	Average
Positioning Percentage (%)	79.94	82.36	74.79	81.9	83.71	81.46	68.82	81.67	85.26	85.42	83.7	72.26	74.12	88.98	86.04	55.97	12.61	29.31	72.68

Table 4. Biological and telemetry data for eight white sturgeon remaining after HPE < 10 filter applied to VPS data. White sturgeon were released at their capture site.

Acoustic ID	Radio ID	Radio Frequency (mhz)	Total Length (cm)	Maturity Code	Release Date	First VPS Detection	Radio Detection rkm Range
24752	37	148.600	210.3	15	2015-05-05	2015-05-18	136.1
24750	36	148.600	283.5	15	2015-05-14	2015-05-19	133.3 - 146.4
24765	54	148.600	219.0	4	2015-04-14	2015-06-23	104.9 – 136.1
24748	39	148.600	224.5	5	2015-04-28	2015-05-11	127.8 - 136.1
24754	52	149.520	253.8	2	2015-05-05	2015-05-13	NA
24756	38	148.600	238.0	2	2015-05-07	2015-05-15	NA
24767	52	148.600	245.0	4	2015-05-13	2015-06-03	136.1
24753	28	148.600	240.5	2	2015-05-17	2015-07-21	NA