EA3480

Side-scan Sonar Surveys of Spawning White Sturgeon (*Acipenser transmontanus*) in Fraser River Side-Channels

Final Report

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INTRODUCTION

Information on the location of White Sturgeon (*Acipenser transmontanus*) spawning areas, along with the abundance of mature size (>160 cm) sturgeon in these areas during the spawning period, are important for the management of lower Fraser River White Sturgeon and for protecting their critical spawning habitat. Until recently, the technology required to detect and enumerate White Sturgeon in turbid waters during their high water (freshet) spawning period did not exist. Flowers and Hightower (2013) demonstrated that side-scan sonar could be used to reliably enumerate Atlantic Sturgeon (*A. oxyrinchus*) in rivers in North and South Carolina. We conducted initial testing of an EdgeTech 4125 high frequency side-scan sonar system in the Fraser River in March and early June 2013. These tests provided positive results for identifying and enumerating mature White Sturgeon in potential spawning areas within the Fraser River.

From 17 June to 10 July 2013, survey crews completed four surveys of nine potential sturgeon spawning areas (Figure 1) above Chilliwack using the EdgeTech 4125 side-scan sonar system. The potential sturgeon spawning areas surveyed included two major side channels (Herrling and Jesperson) and seven smaller areas located near Agassiz, Minto, Log Dump, Seabird Island, Powerline Bar, Ruby Creek, and Tranmer. Mature size sturgeon were observed in each of these areas with peak abundances occurring in mid-late June at most sites (Figure 2; Table 1). Identifiable sturgeon in the 60–160 cm size range were generally half as abundant as those >160 cm (Figure 3). The only exception was the Jesperson side channel where surveys consistently recorded more small sturgeon than large sturgeon (Table 2). We were able to identify specific areas where large sturgeon were concentrated during the known sturgeon spawning period. We were also able to produce quantitatively comparable estimates of the number of sturgeon detected in each survey area.

Using population estimates and assumptions regarding survey frequency, we estimated that the locations surveyed in 2013 could only account for 13.5% of the potential annual sturgeon spawners in the lower Fraser River. This suggests that there are likely many more areas where sturgeon spawn in the lower Fraser River. Consequently, we recommend that many more potential spawning sites be surveyed during June 2014 using these side-scan sonar techniques. Based on the data collected in 2013, two surveys per site focused on the peak spawning period in June should be adequate to determine the relative number of large sturgeon in each area and potentially identify additional important spawning areas for lower Fraser River sturgeon.

METHODS

The 2013 field effort was comprised of two test survey days in early June and three days of survey effort planned for each of the following 5 weeks. The first full survey scheduled for 10–12 June was cancelled due to a problem with the EdgeTech cable that connects the topside computer with the towfish. The likelihood that this was an equipment issue was confirmed quickly on 10 June in consultation with Richard Graham (Mosaic Geo) and technicians from EdgeTech. The equipment was shipped back to EdgeTech at no cost to the project and EdgeTech promptly determined the problem and returned the gear with a new tow cable in time for the 17–19 June survey period. During the last survey week (8–10 July), a problem with the GPS unit prevented the collection of geo-referenced data on 10 July. As a result, accurate counts or size classifications could not be determined for this date.

Each survey transect was conducted by attaching the towfish (transducer) to the boat's anchor chain and winch on the bow so we could change the depth of the towfish rapidly during deployment. The optimal altitude for the towfish is 10–20% of the range (25 m) or 2.5–5.0 m above the bottom. Depth adjustment via the anchor winch worked very well at keeping the towfish within the optimal recording range and to quickly move the towfish up when water depth suddenly decreased or when potential snags were encountered. The anchor chain also acted as a second safety line, in addition to the towfish cable, and greatly reduced the potential for losing the towfish.

On most survey days, the field crew was comprised of the boat operator and the sonar technician. The boat operator was responsible for maintaining a consistent survey speed along each pre-determined transect, monitoring the water depth, and adjusting the depth of the towfish.

All surveys were conducted with the sonar range set to 25 m which was the optimal range for producing high quality images at 1600 kHz. Figure 5 shows the computer display produced by the EdgeTech software showing the 25 m detection zone on each side of the tow vessel. A 2.1 m sturgeon was located at 12 m on the Port side of the survey vessel. The EdgeTech software can be used to enlarge the image and provide a quick record of the target location (latitude and longitude), survey heading, vessel speed, fish length, distance from the towfish, and filename for the survey segment (Figure 6, Figure 7). The EdgeTech software was a very effective tool for real-time monitoring of the sonar images during the surveys and preliminary data review. However, more sophisticated sonar data processing software (SonarWiz) was used to rapidly review, capture and record the sonar images for the numerous transects and areas surveyed during this project.

Each survey transect was reviewed by a trained data technician using SonarWiz software. The software facilitates the data review process by allowing the user to quickly scan a series of geo-referenced survey tracks and mark all the sturgeon targets detected. Each sturgeon target can then be measured and information on target angle and substrate can be recorded for each image.

RESULTS AND DISCUSSION

The side-scan sonar system can provide very clear images of large sturgeon detected in known and suspected spawning areas within the lower Fraser River (Figure 8). In addition to providing clear images of individual fish, the length of each fish can be measured and information on the river bottom substrate can be recorded (Figure 8a, Figure 8b, Figure 8c). In total, 619 mature size (>160 cm) sturgeon were observed in the various locations surveyed. Most mature fish (89%) were 160–300 cm. Whenever possible, fish length was determined directly from the sonar reflection (Figure 8f). However, there were many instances when the sonar reflection image was not visible but a sonar shadow was clearly visible behind the target

(Figure 8a, Figure 8b, Figure 8c). Generally, these sonar shadows were very similar in length the sonar reflection when the fish is relatively close to the river bottom and roughly parallel to the direction of the survey vessel (Figure 6). The sonar shadows for fish detected at oblique angles to the survey vessel are typically longer than the sonar reflection or actual fish (Figure 8e, Figure 8f). This accounts for most fish greater than 3.5 m in Figure 3.

In many instances, multiple sturgeon were detected in close proximity to each other but were clearly distinguishable (Figure 8d, Figure 8e, Figure 8f). At several locations in the side-channels, we observed aggregations of large (2+ m sturgeon) and smaller sturgeon in close proximity that could be related to spawning activity (Figure 7).

Of the nine areas surveyed in 2013, the Herrling Island side-channel consistently produced the largest number of sturgeon in the >160 cm size category (Table 1; Figure 2 and Figure 9). The next highest numbers of large sturgeon were observed in the side-channels adjacent to Seabird Island in the vicinity of a previous in-channel gravel mining site (Figure 2 and Figure 11), and in the surveyed portions of the Minto side-channel (Figure 2 and Figure 12). Of the remaining areas, only Ruby Creek had fairly consistent numbers of large sturgeon during the survey period (Figure 2 and Figure 16). Figure 4 shows the size distributions for sturgeon detected in each of these four side-channels. No significant differences were detected in the size distributions for mature-sized (>160 cm) sturgeon between the known sturgeon spawning area (Herrling side-channel) and the other three side-channels ($F_{3, 427} = 1.26$, $p = 0.29$). This size distribution data, the survey timing (peak spawning period), spatial location and number of large sturgeon detected at these sites all support the conclusion that each of these locations are likely spawning locations for sturgeon.

Given the length of the Jesperson side-channel, this location had the lowest numbers of large sturgeon per unit area for the nine survey areas (Figure 10). However, Jesperson and Herrling consistently had the largest number of 60–160 cm sturgeon (Table 2). Summing up the maximum number of large sturgeon per survey site produced an estimate of 214 spawning size sturgeon for the areas surveyed in 2013 (Table 3).

The sonar and GPS systems provide a precise location of every sturgeon detected. Figure 9–Figure 17 provide Google Earth images of each of the survey areas with overlays showing the location of the survey tracks and precise locations for each large sturgeon detected. The highest concentrations of large sturgeon in the Herrling side-channel were in areas where egg mat studies have consistently detected sturgeon eggs (Figure 9). Aggregations of mature size sturgeon were distributed throughout the side-channel on 4 and 18 June. However, over the next three surveys (25 June, 2 and 9 July), fewer mature fish were observed and their distribution became more concentrated in the lower half of the side-channel (Figure 9).

At most sites surveyed where aggregations of mature fish were observed over multiple weeks, aggregations were found in the same locations. This pattern was observed at Seabird Island (Figure 11), Minto side-channel (Figure 12), Powerline Bar (Figure 13), and Ruby Creek side-channel (Figure 16). At Seabird Island, the highest concentrations detected were just upstream from a clearly visible bridge and road location used to extract gravel from in-river gravel mining sites (Figure 11). The highest abundances were observed in the same area of this side-channel on 19 and 26 June (n = 24 and 29, respectively). Other noteworthy observations included concentrations of large sturgeon at Agassiz Bridge on 2 July (Figure 15) and at Log Dump on 19 June (Figure 14).

These observations indicate that large sturgeon likely aggregate in fairly precise areas during the spawning period. These observed concentrations are consistent with typical spawning aggregations for fish species that are broadcast spawners, like sturgeon. The distribution and timing of sturgeon spawning events in the Herling Island side-channel from egg mat studies conducted in 2013 (Erin Stoddard, MOE, pers. comm.) is very consistent with the side-scan sonar observations of large sturgeon in these exact areas during the spawning period.

The annual PIT mark-recapture estimates for the lower Fraser River suggest that there are approximately 10,000 sturgeon >160 cm in length. If these sturgeon spawn once every 4-6 years (Scott and Crossman 1973; Jager et al. 2007), and all the 214 large sturgeon detected in 2013 were part of this spawning group, our survey areas accounted for less than 13% of the potential annual sturgeon spawners. The 2013 data and these calculations suggest that there are likely many more areas where sturgeon spawn in the lower Fraser River.

RECOMMENDATIONS

We recommend that many more potential spawning sites be surveyed during June 2014 using these side-scan sonar techniques. Based on the data collected in 2013, two surveys per site focused on the peak spawning period in June should be adequate to determine the relative number of large sturgeon in each area and identify additional likely spawning areas for lower Fraser River sturgeon. The data from the 2013 and proposed 2014 surveys should be used to guide future deployments of egg mats to confirm the location of important sturgeon spawning areas in the Lower Fraser River.

ACKNOWLEDGEMENTS

This project is another example of the ongoing contribution of innovative ideas and leadership from Rick Hansen. We thank Rick for his encouragement and support throughout this study and the Rick Hansen Foundation for providing all the financial resources needed to conduct the 2013 study. We thank the BC Sportfishing Group and specifically, Tony Nootebos and Yves Bisson, for their major contributions to this study, including: knowledge of the Fraser River and potential sturgeon spawning areas, operation of the survey boat, field logistics and safety procedures. We are grateful to LGL Limited for obtaining the side-scan sonar equipment needed to conduct the project and providing that equipment at a rental rate that allowed for greater coverage of the potential sturgeon spawning areas than was initially envisioned. We thank Mike Bissette and Richard Graham with MosaicHydro Ltd. for their assistance with the operations of the sonar equipment and data processing software. We thank Elmar Plate and Shane Johnson for their assistance with field surveys, Hannah English for her review and analysis of all the sonar data files, and Dawn Keller for formatting the final report.

LITERATURE CITED

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

Flowers, H.J. and J.E. Hightower. 2013. A novel approach to surveying sturgeon using side-scan sonar and occupancy modeling. Marine and Coastal Fisheries: Dynamics, Management, and Ecosystem Science 5: 211–233.

Jager, H.I., Bevelhimer, M.S., Lepla, K.B., Chandler, J.A., and van Winkle, W. 2007. Evaluation of reconnection options for white sturgeon in the Snake River using a population viability model. Am. Fish. Soc. Symp. 56: 319–335.

Table 1. Counts of large (>160 cm) White sturgeon by day and location.

	Herrling	Agassiz	Jesperson	Log Dump	Minto	Ruby Creek	Seabird Island	Tranmer	Powerline Bar	Grand Total
06/03/2013	42		3							45
06/04/2013	63									63
06/17/2013			3		20					23
06/18/2013	57							2		59
06/19/2013				16		19	24		7	66
06/24/2013			15		23					38
06/25/2013	54	4						7		65
06/26/2013				8		13	29		22	72
07/01/2013			9		27					36
07/02/2013	43	22						3		68
07/03/2013				1		17	12		10	40
07/08/2013			3		11					14
07/09/2013	19	4						7		30
Grand Total	278	30	33	25	81	49	65	19	39	619

Table 2. Counts of 60–160 cm White sturgeon by day and location.

	Herrling	Agassiz	Jesperson	Log Dump	Minto	Ruby Creek	Seabird Island	Tranmer	Powerline Bar	Total
06/03/2013	15		5							20
06/04/2013	5									5
06/17/2013			18		6					24
06/18/2013	6							1		7
06/19/2013				10		1	9			20
06/24/2013			26		31					57
06/25/2013	30	1						6		37
06/26/2013				3		6	10			19
07/01/2013			5		5					10
07/02/2013	27	8						3		38
07/03/2013				1		7	7		12	27
07/08/2013			32		8					40
07/09/2013	24	2						1		27
Total	107	11	86	14	50	14	26	11	12	331

Table 3. Summary for 17 June to 9 July survey period.

	Herrling	Agassiz	Jesperson	Log Dump	Minto	Ruby Creek	Seabird Island	Tranmer	Powerline Bar	Total
Surveys	4	3	4	4	4	4	4	4	4	
Average Counts										
>160 cm	43.3	10.0	7.5	8.3	20.3	16.3	21.7	4.8	13.0	145.1
60-160 cm	21.8	3.7	20.3	4.7	12.5	4.7	8.7	2.8	12.0	90.9
Max Counts										
>160 cm	57	22	15	16	27	19	29	7	22	214
60-160 cm	30	8	32	10	31	7	10	6	12	146

Figure 1. 2013 Fraser River side-scan sonar survey locations.

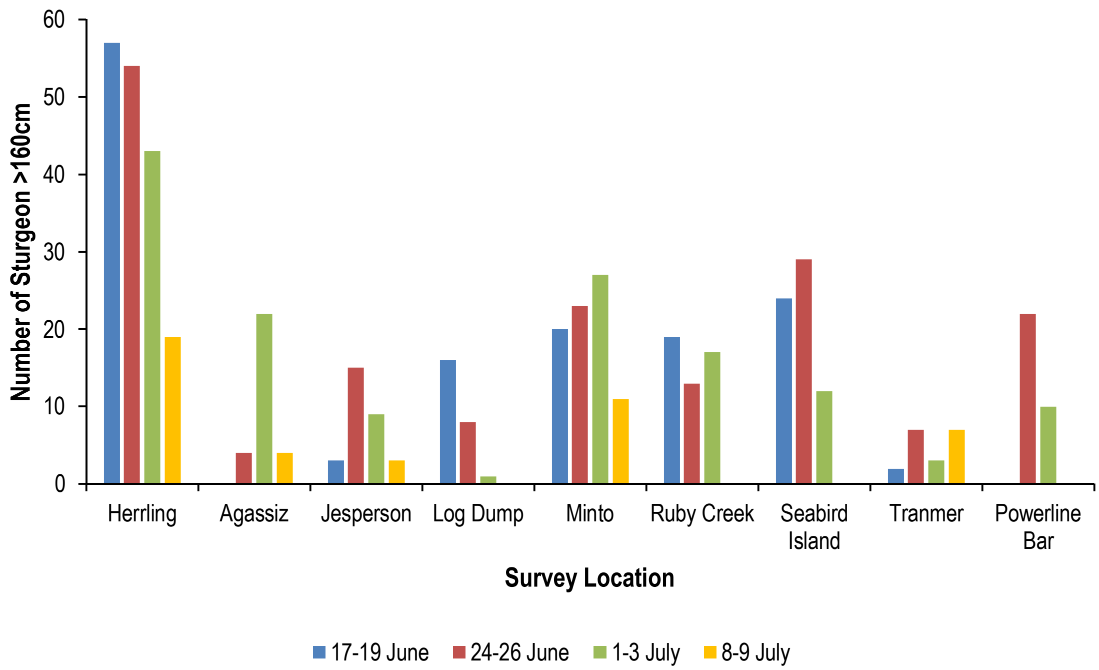


Figure 2. Trends in abundance of mature-sized (>160 cm) White sturgeon in the nine areas surveyed between 17 June and 9 July. Peak abundance occurred in mid-late June at most sites.

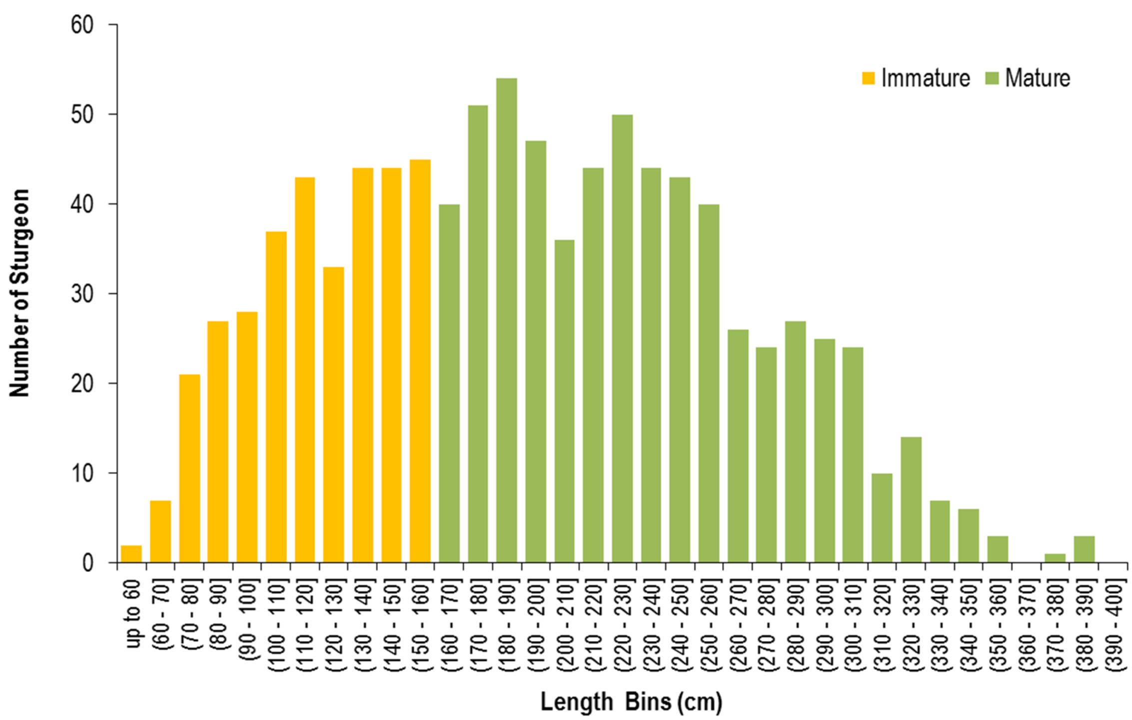


Figure 3. Length-frequency histogram for White sturgeon observed in surveyed side-channels in 2013. Most (65%) of observed fish were mature sized (>160 cm).

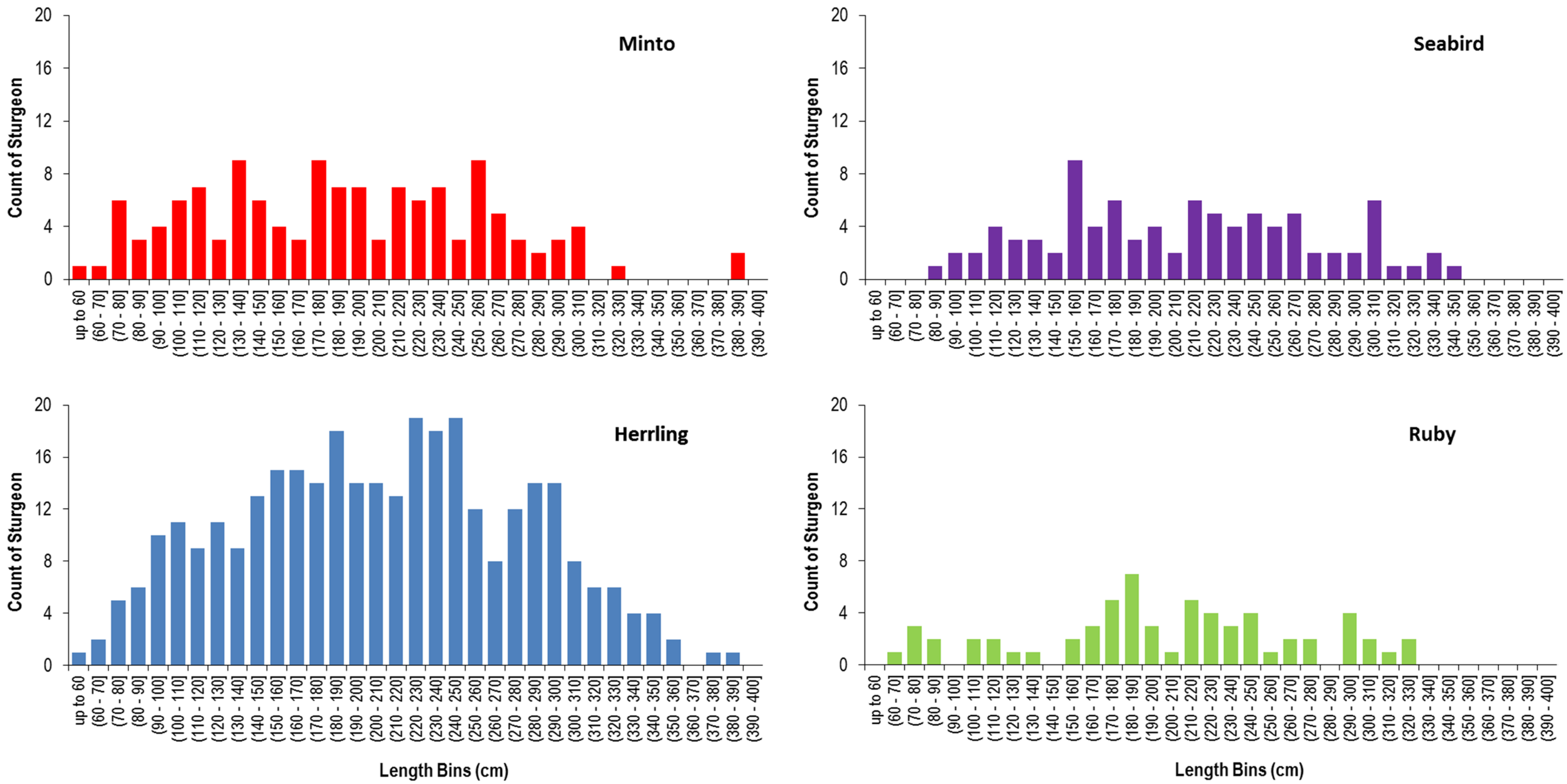


Figure 4. Size distributions for sturgeon observed in the four side-channels with the highest abundances: Minto, Seabird, Herrling, and Ruby.

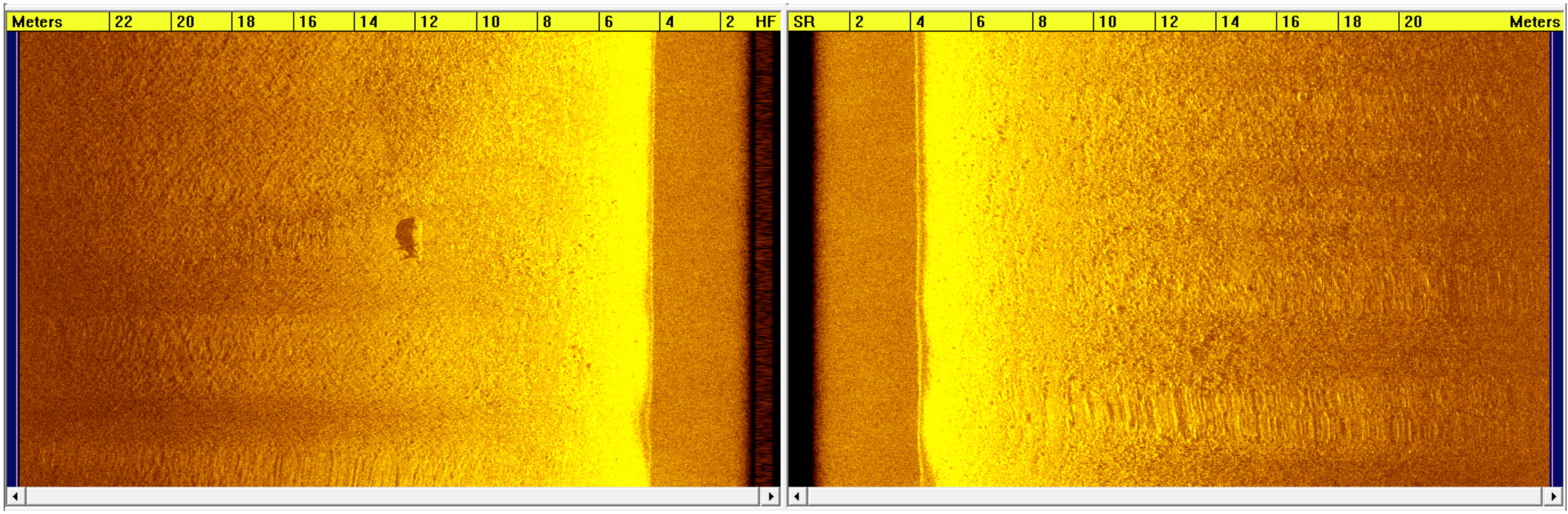


Figure 5. Screen capture of the EdgeTech display showing the full width of the 50 m transect (25 m on each side of the boat) with a 2.1 m sturgeon located on the port side 12 m from the survey vessel.

Figure 6. A closer look at the sturgeon in Figure 5 showing the detailed information in the standard target report. This fish was over a sandy bottom so both the shadow and fish (bright yellow line to the right of the acoustic shadow) are clearly visible. A fork-length measurement of the shadow was virtually identical for that of the thin yellow fish line.

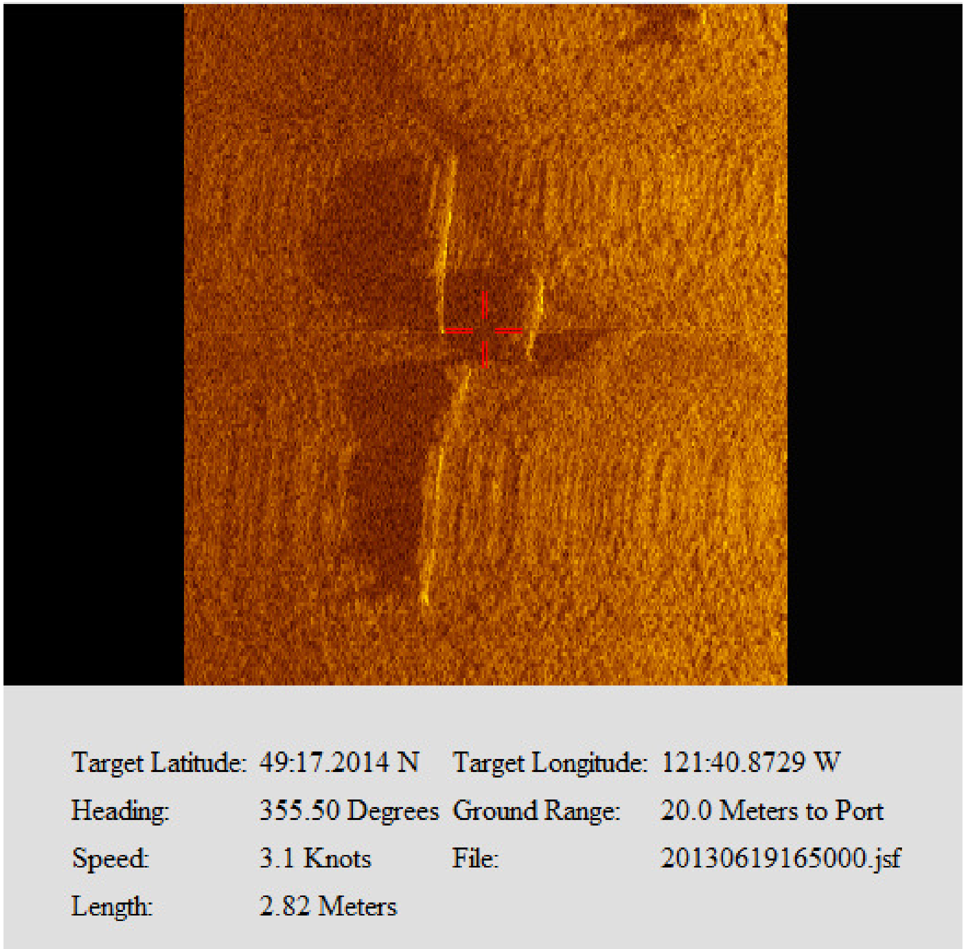
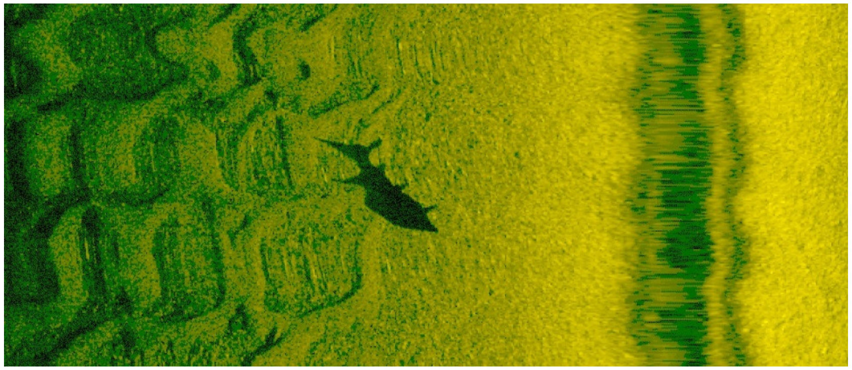
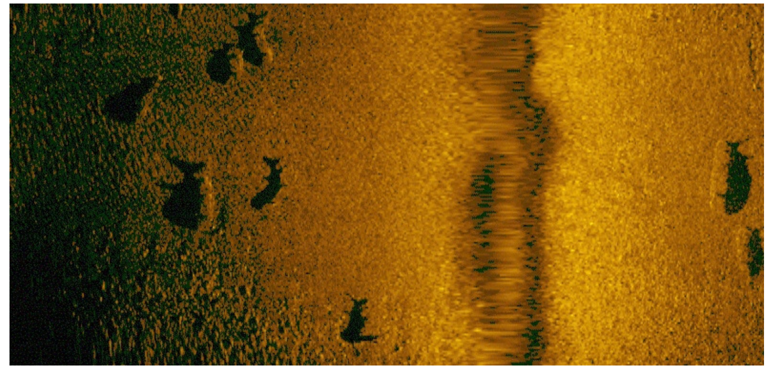


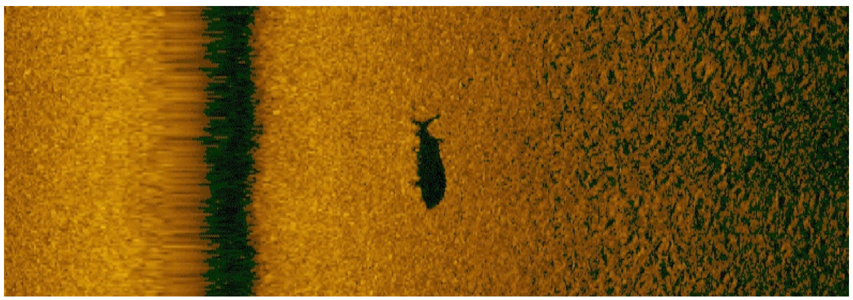
Figure 7. Side-scan sonar image showing a group of sturgeon detected in the Seabird Island side-channel on 19 June. Several of the sturgeon in this image are very close together making it difficult to distinguish the smaller size fish. The largest fish in the upper centre portion of this image was measured at 2.82 m. The tail of another sturgeon can be seen at the top of this image and several other sturgeon were detected just upstream from this group. The acoustic shadows are not as well defined for individuals in this group because of the distance of these fish from the boat (20+ m) and the overlap of their acoustic shadows.



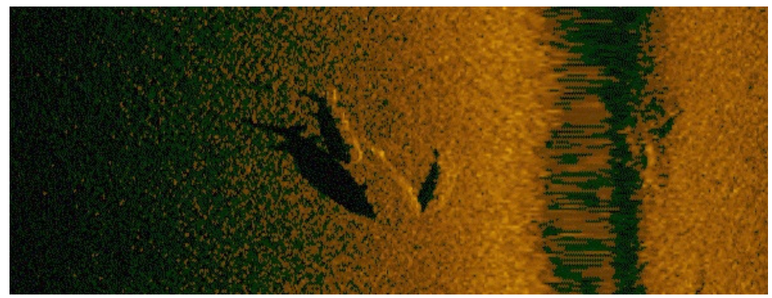
a. Single 2.56 m sturgeon over sandy bottom, Herrling, June 3



d. Nine sturgeon (1.2–2.1 m), Seabird Island, June 19



b. Single 1.86 m sturgeon near river bottom, Herrling, June 18

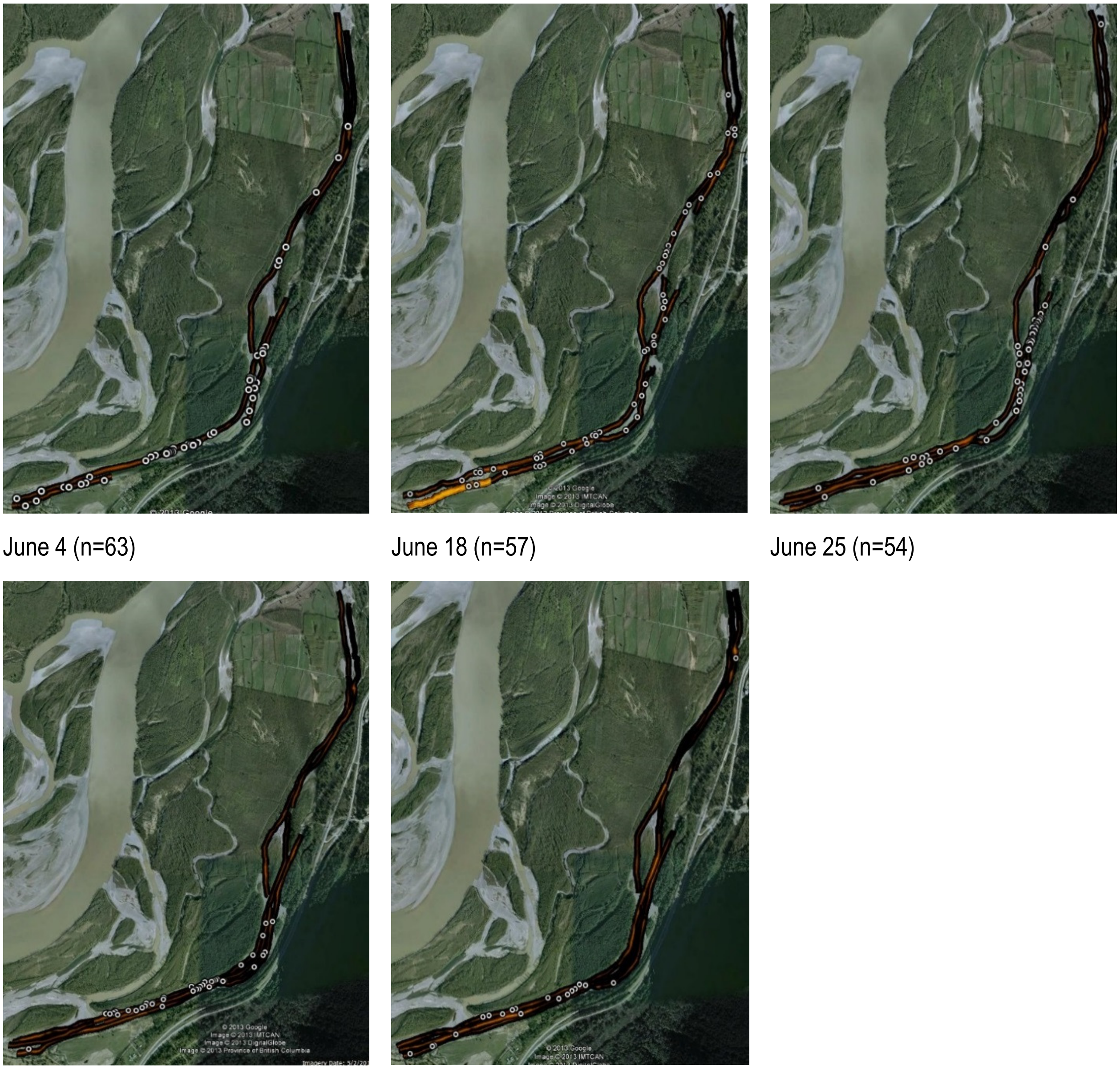


e. Three sturgeon (1.49–2.56 m), Log Dump, June 26

c. Single 2.69 m sturgeon over gravel river bottom, Minto, June 24

f. Two large sturgeon (2.4–2.9 m), Ruby Creek, June 26

Figure 8. Sample of high resolution side-scan sonar images from surveys conducted in June 2013.



June 4 (n=63) June 18 (n=57) June 25 (n=54)

July 2 (n=43) July 9 (n=19)

Figure 9. Side-scan sonar transects and mature (>160 cm) White sturgeon distribution (white circles) in Herrling side-channel during 2013 surveys. Peak sturgeon count was on 4 June (n=63) and counts decreased during subsequent surveys. Sturgeon were distributed throughout the side-channel in early-mid June. As numbers decreased, distribution shifted to the lower portion of the channel.

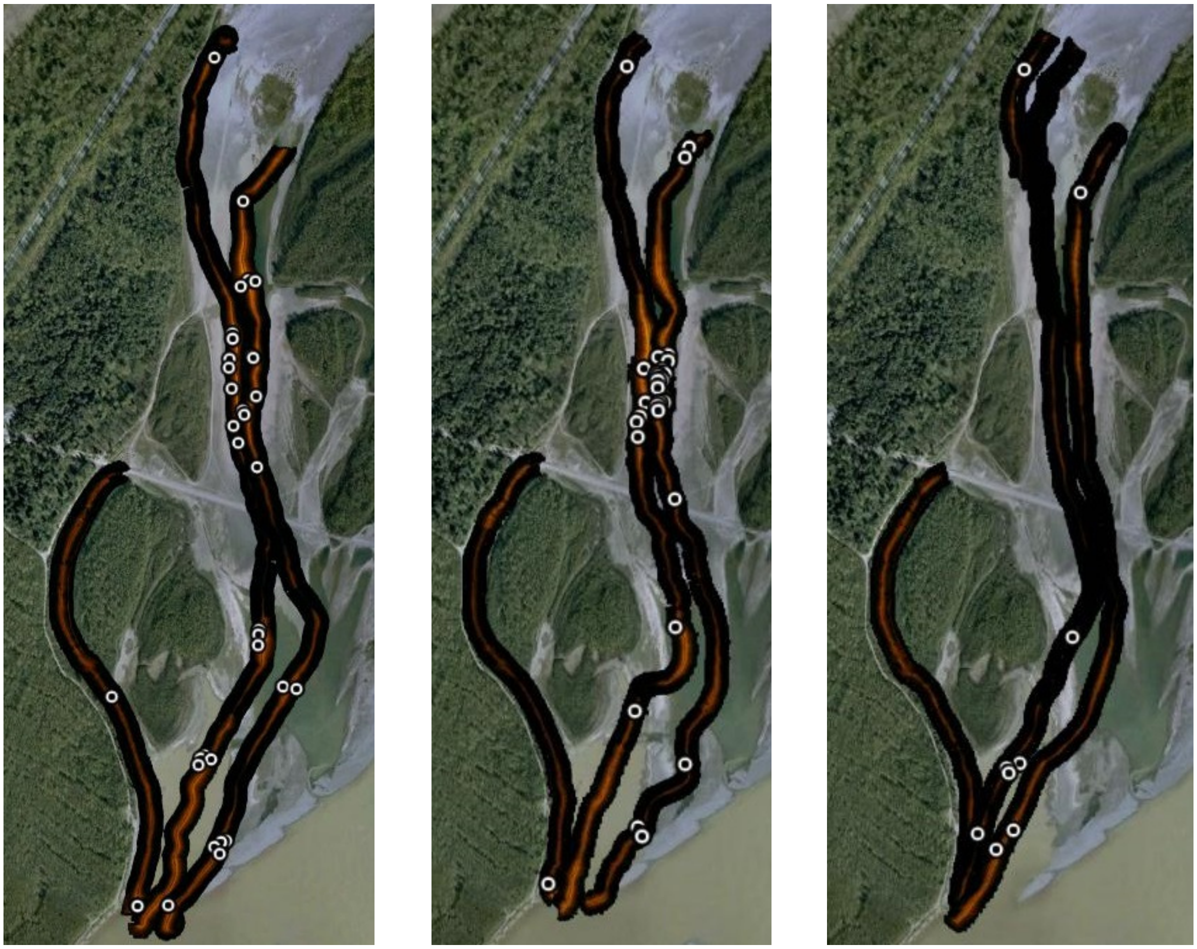
June 17 (n=3)

June 24 (n=15)

July 1 (n=9)

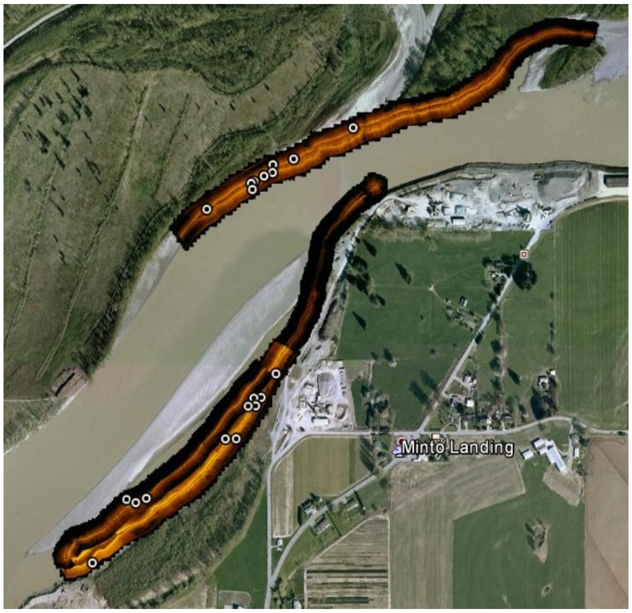
July 8 (n=3)

Figure 10. Distribution of mature (>160 cm) White sturgeon in Jesperson side-channel.

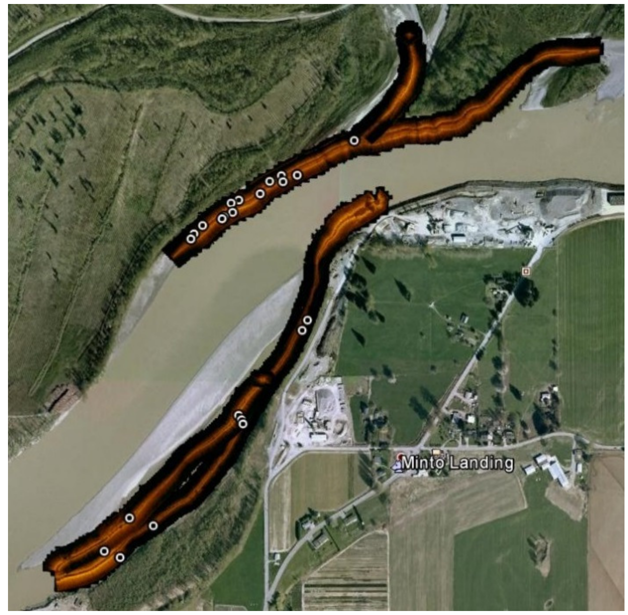


June 19 (n=24) June 26 (n=29) July 3 (n=12)

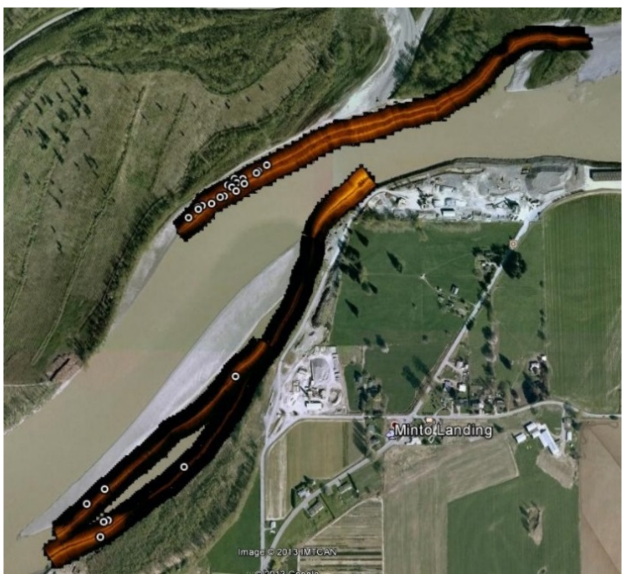
Figure 11. Distribution of mature (>160 cm) White sturgeon in the Seabird Island side-channel. Large aggregations were observed at the same location on 19 and 26 June, suggesting a potential spawning location. Abundance of mature sturgeon decreased at the start of July.



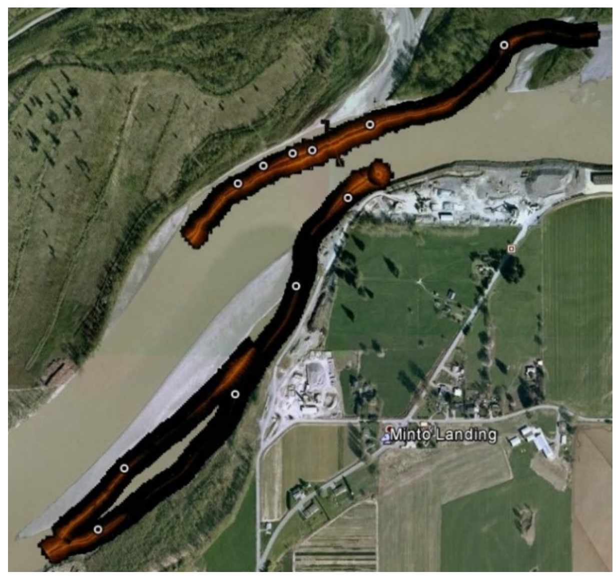
June 17 (n=20)



June 24 (n=23)

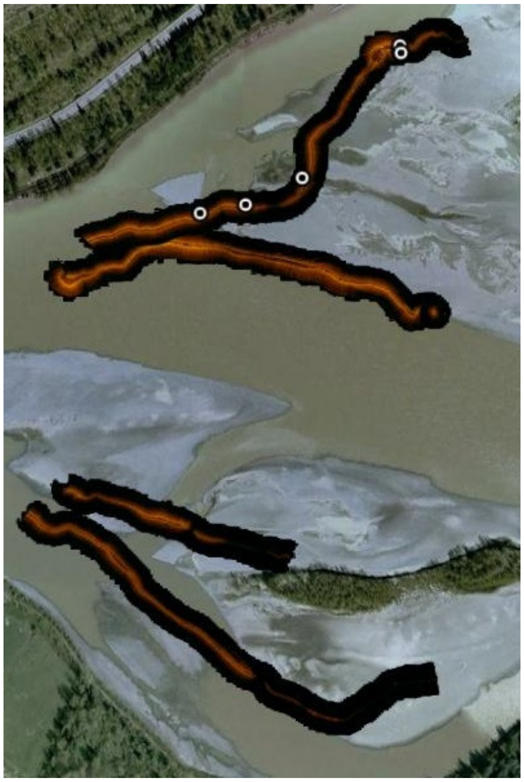


July 1 (n=27)

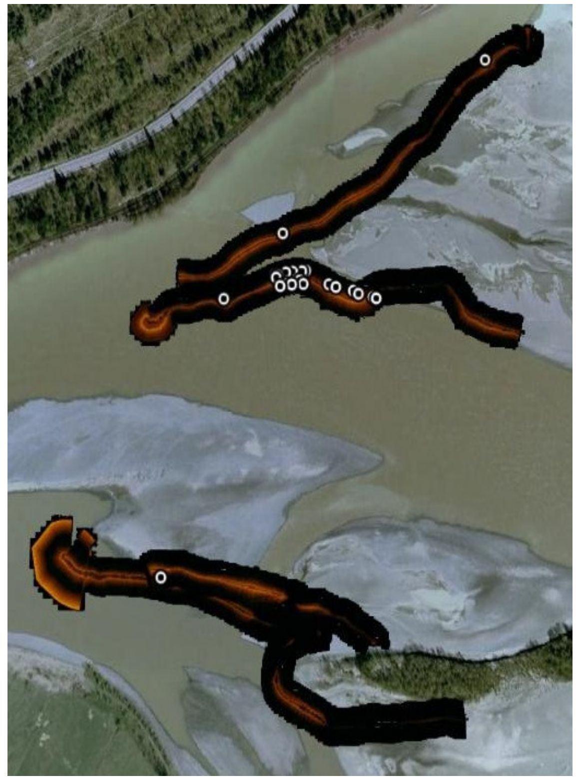


July 8 (n=11)

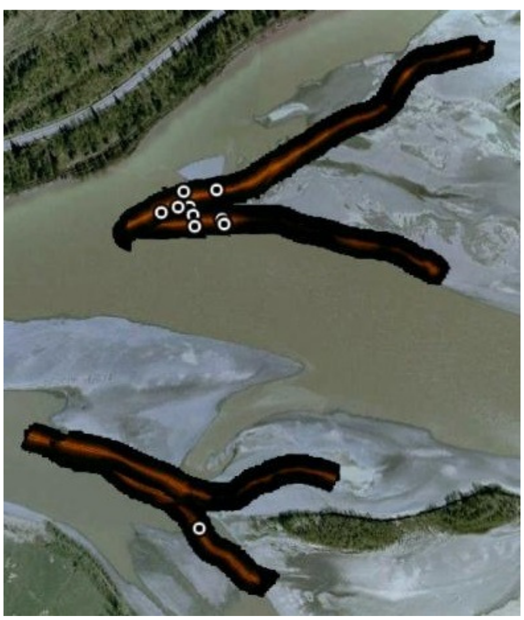
Figure 12. Distribution of mature (>160 cm) White sturgeon in the Minto side-channel. From 17 June to 1 July, aggregation of sturgeon were observed at the same location on the north side of the side-channel, suggesting a potential spawning location.



June 19 (n=7)



June 26 (n=22)



July 3 (n=10)

Figure 13. Distribution of mature (>160 cm) White sturgeon at the Powerline Bar location. The aggregations at the same location on 26 June and 3 July suggests a potential spawning location.

June 19 (n=16)

June 26 (n=8)

July 3 (n=1)

Figure 14. Distribution of mature (>160 cm) White sturgeon near the Log Dump location. Peak abundance was observed on 19 June with numbers decreasing with each following survey. The aggregation observed on 19 June suggests a potential spawning location.

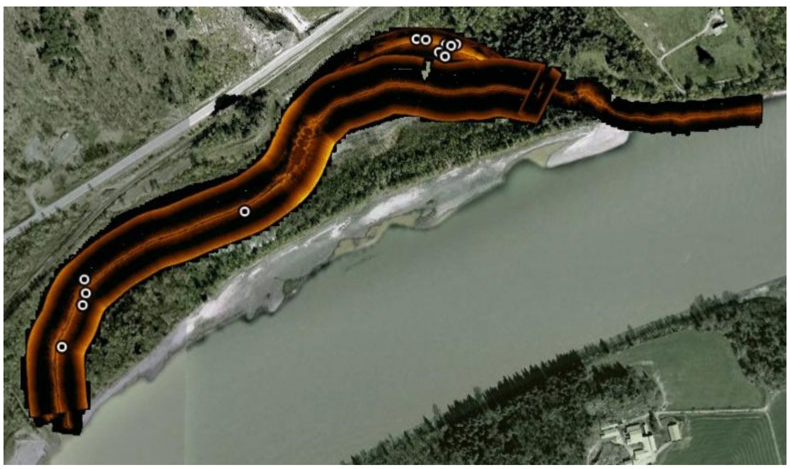
June 25 (n=4)

July 2 (n=22)

July 9 (n=4)

Figure 15. Distribution of mature (>160 cm) White sturgeon at the Agassiz Bridge. The large aggregation observed just east of the bridge on 2 July suggests a potential spawning location.

June 19 (n=19)



June 26 (n=13)

July 3 (n=17)

Figure 16. Distribution of mature (>160 cm) White sturgeon in the Ruby Creek side-channel. The abundance and distribution of mature fish remained fairly constant during surveys.

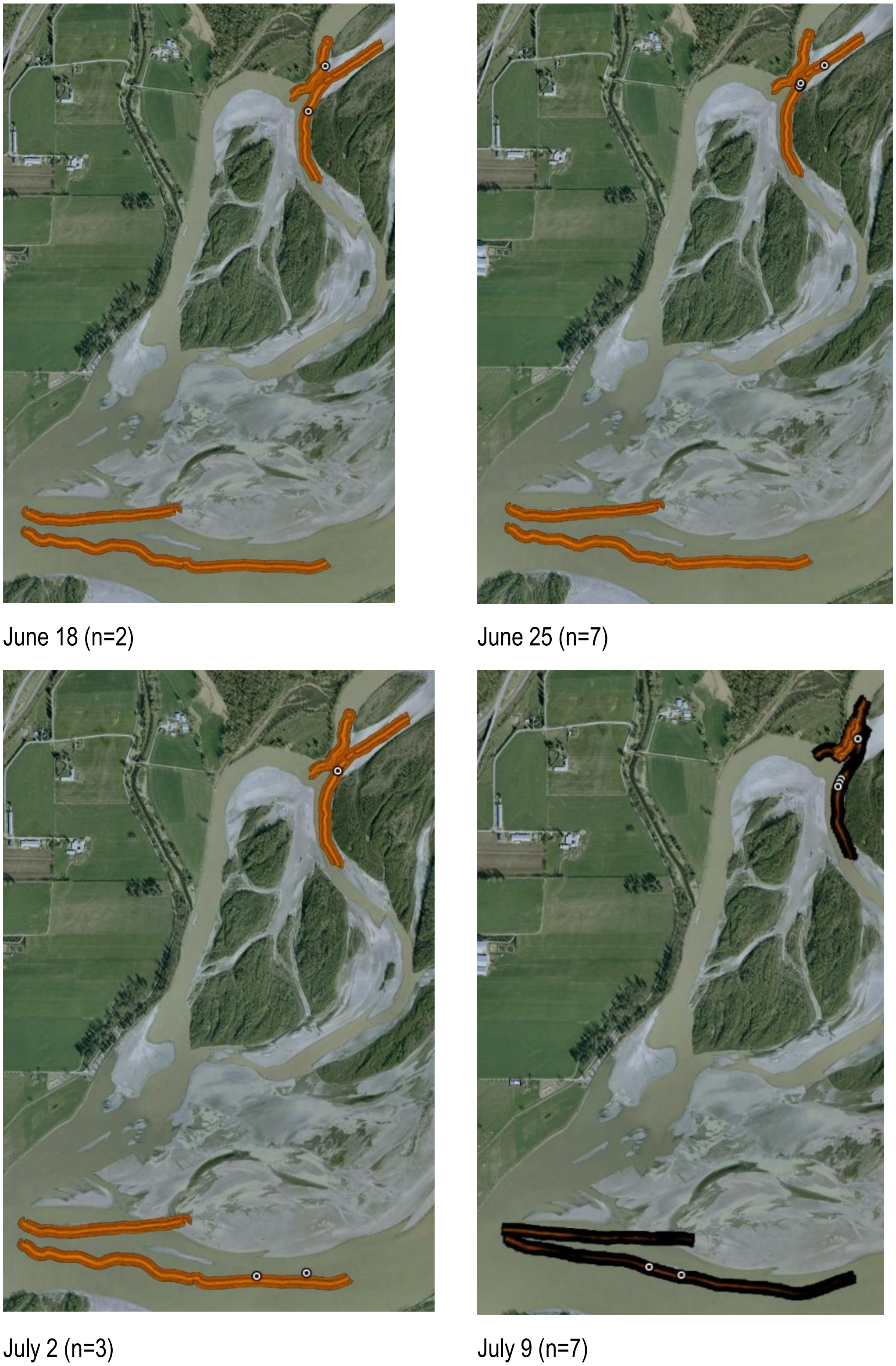


Figure 17. Distribution of mature (>160 cm) White sturgeon in the Tranmer area. Few sturgeon were observed in this area.