Side-scan Sonar Surveys of Potential White Sturgeon (*Acipenser transmontanus*) Spawning Areas in the Lower Fraser River, 2016

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EXECUTIVE SUMMARY

Since 2013, LGL Limited (LGL) has conducted surveys using side-scan sonar technology to identify the location of potential White Sturgeon (*Acipenser transmontanus*) spawning areas in the lower Fraser River. This information is necessary for the management of lower Fraser River White Sturgeon and for protecting their critical spawning habitat. Surveys conducted during the sturgeon spawning period (June) in 2013 identified a potential spawning aggregation at a site near Seabird Island. Spawning was confirmed in 2014 using egg mats deployed downstream of a similar aggregation identified during 2014 sonar surveys. Surveys in 2015 and 2016 were conducted to identify additional potential lower Fraser River spawning areas and to guide future egg mat deployments to confirm spawning.

From 25 May to 16 June 2016, LGL conducted surveys at 45 potential sturgeon spawning areas in the lower Fraser River from Chilliwack to Yale, BC, including 13 sites in the Pitt River and Lake. Mature size sturgeon were observed in 31 out of 45 sites, with peak abundances occurring in late May to early June at most sites. Identifiable immature (<160 cm) sturgeon were less abundant (35%) than mature fish (65%). In 2016, we identified four potential spawning areas (Mountain Bar; Hamilton Bar, 289 Bar and 302 Bar) where mature size sturgeon were concentrated during the known sturgeon spawning period. Peak mature sturgeon abundance at these sites ranged from 13 (302 Bar) to 53 (Mountain Bar).

To date, a total of seven White Sturgeon spawning sites have been confirm through the collection of eggs after side-scan sonar surveys identified concentrations of large sturgeon during the spawning period. In 2016, White Sturgeon eggs were collected on mats deployed by the BC Ministry of Forests, Lands and Natural Resource Operations at the Bristol Island, Landstrom Bar and 289 Bar sites in May and June. The other four sites with confirmed spawning were Hunter Creek (2015), and the Herrling (confirmed in 2010 and 2011), Seabird Island (2014), and Ruby Creek (2015) side channels. Based on the 2016 sonar surveys results, the three highest priority new areas for egg mat deployments in 2017 are: Mountain Bar, Hamilton Bar, and 302 Bar.

Using population estimates provided by the Fraser River Sturgeon Conservation Society, and assumptions regarding the portion of the sturgeon population that spawns each year, we estimated that the locations surveyed in 2013–2016 accounted for less than 42% of the potential annual sturgeon spawners in the lower Fraser River. This suggests that there are likely other areas where sturgeon spawn in the lower Fraser River.

The 2015–2016 winter was unseasonably warmer and dryer and therefore the 2016 freshet was earlier than usual. Lower water levels and an earlier freshet in 2016 (compared with 2014 and 2015) could have resulted in earlier spawning (late May–early June). Low water made some transect areas inaccessible in mid-June 2016. We recommend that some of the 2016 sites along with additional potential spawning sites be surveyed in the future. At least two surveys per site should be conducted during the peak spawning period in June.

Funding to conduct these surveys was provided by the Habitat Conservation Trust Found (HCTF).

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. In 2013, field tests during the freshet confirmed that this technology could be used to identify and enumerate mature White Sturgeon in the lower Fraser River during the spawning period (English et al. 2014a). For example, surveys conducted during the sturgeon spawning period (June) in 2013 identified a potential spawning aggregation at a site near Seabird Island. Similar aggregations were observed in the same area during June 2014 sonar surveys (English et al. 2014b) and spawning was confirmed using egg mats deployed downstream of a the 2014 aggregations (Erin Stoddard, Ministry of Forests, Lands and Natural Resource Operations [FLNRO], pers. comm.). Side-scan sonar surveys coupled with egg mat deployments provides a proven means of identifying sturgeon spawning areas in the lower Fraser River.

In 2013 and 2014, sonar surveys were focused on potential sites in the Chilliwack and Agassiz areas (English et al. 2014a, 2014b). Surveys in 2015 and 2016 were expanded to include potential lower Fraser River sites between Chilliwack and Yale, BC (Johnson et al. 2015). In 2016, 44 sites were surveyed, including13 sites in Pitt River and Lake. The results from the 2016 surveys will guide future egg mat deployments to confirm spawning at locations with aggregations of mature size sturgeon.

METHODS

Prior to starting field surveys, potential sites were identified between Chilliwack and Yale, BC, in consultation with FLNRO's sturgeon biologist (Erin Stoddard). Sites were selected based on the presence of large gravel-cobble bars (at low water) or alluvial fans at the mouths of tributaries. Additional sites were added during the field component based on local knowledge and field observations. All surveys were conducted between 25 May and 16 June 2016.

All surveys were conducted using an EdgeTech 4125 dual-frequency (600 kHz and 1600 kHz) side-scan sonar (Figure 1) and data were recorded using EdgeTech Discover software. Each survey transect was conducted by attaching the towfish (transducer) to the boat's anchor chain and winch on the bow so the depth of the towfish could change rapidly during deployment. All surveys were conducted with the sonar range set to 25 m, the optimal range for producing high quality images at 1600 kHz. The optimal altitude for the towfish is 10–20% of the range (25 m) or 2.5–5.0 m above the bottom. The sonar and GPS systems provide a precise location of every sturgeon detected. Depth adjustment via the anchor winch worked 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. Due to the low water levels experienced this year (Figure 17), full transects could not always be completed. High velocities in the mainstem would sometimes cause the tow fish to sway, interfering with the imagery. In these incidences the sonar technician and boat operator would communicate and alter the course if it was deemed safe.

Data Analysis

EdgeTech Discover software was used during surveys and preliminary data review to enlarge sonar images and provide a quick record of target location (latitude and longitude), survey heading, vessel speed, fish length, distance from the towfish, and filename for the survey segment. Each survey transect was further reviewed by a trained data technician using SonarWiz software. SonarWiz 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. Figure 5 and Figure 6 provides several examples of sturgeon targets from the May and June 2016 surveys.

RESULTS AND DISCUSSION

From 25 May to 16 June 2016, survey crews completed 1 to 4 surveys of 42 potential sturgeon spawning areas from Chilliwack to Yale, BC, including 13 sites in the Pitt River and Lake (Figure 2 and Figure 3). Mature size sturgeon were observed at 25 (60%) sites, with peak abundances occurring in mid-June at most sites (Table 1). 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.

The side-scan sonar system provided clear images of large sturgeon detected in known and suspected spawning areas within the lower Fraser River (Figure 5 and Figure 6). In addition to providing clear images of individual sturgeon, each fish >60 cm was measured and information on the river bottom substrate was recorded (Figure 5 and Figure 6). While most of the sonar images for targets in the 60–90 cm range could not be clearly identified as sturgeon, we assumed that most of the fish >60 cm length detected during the sturgeon spawning period would be sturgeon.

Immature (<160 cm) sturgeon were generally less abundant (35%) than mature fish (65%). We identified four potential spawning areas (Mountain Bar, Hamilton Bar, 302 Bar, and 289 Bar) where mature size sturgeon were concentrated during the known sturgeon spawning period (Table 1). Figure 7–Figure 16 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. Peak mature sturgeon abundance at these sites ranged from 13 (302 Bar) to 53 (Mountain Bar).

In total, 1203 mature size (>160 cm) sturgeon were observed in the various locations surveyed. In many instances, multiple sturgeon were detected in close proximity to each other but were clearly distinguishable (Figure 5).

Similar to 2015 (Johnson et al. 2015), the highest abundances of mature size sturgeon observed in 2016 at Bristol Island and Landstrom Bar; (Table 1; Figure 9 and Figure 13). The next highest numbers of large sturgeon were observed in the Herrling side channel, a known sturgeon spawning area (Figure 11). Of the remaining areas, only Mountain Bar had fairly consistent numbers of large sturgeon during the survey period (Table 1).

The size distribution for all sturgeon detected during the 2016 surveys shows that 65% were >160 cm in length (Figure 19). Size distributions were produced for the Mountain Bar, Herrling, Bristol Island, and Landstrom sites (Figure 20). Mountain Bar was the site with the lowest portion of mature (>160 m) sturgeon of the four sites. The size distributions were similar for the sturgeon detected at Bristol Island and Landstrom Bar (Figure 19).

The 2014–2015 winter was unseasonably warmer and dryer and therefore the 2016 freshet was earlier (Figure 17). Lower water levels and an earlier freshet in 2016 (compared with 2014 and 2015) could have resulted in earlier spawning (mid-May–early June). Low water made some transect areas inaccessible in late-June 2016.

Sturgeon eggs were collected on mats deployed by the FLNRO at the Landstrom Bar, Bristol Island, and 289 Bar in 2016 (Erin Stoddard, FLNRO, pers. comm.). Landstrom Bar and Bristol Island were identified as potential sturgeon spawning areas during the 2015 side-scan sonar surveys (Johnson et al. 2015). Egg mats studies conducted from 2010 to 2016 have detected sturgeon eggs at seven sites. The other four sites were Hunter Creek (2015), Herrling (confirmed in 2010 and 2011), Seabird Island (confirmed in 2014 and 2015), and Ruby Creek (confirmed in 2015) side-channels.

The annual PIT mark-recapture estimates for the lower Fraser River suggest that there are approximately 15,000 sturgeon >160 cm (Nelson et al. 2016). If only 20% of these sturgeon are detectable in spawning areas in 2016 because they spawn once every 4–6 years (Scott and Crossman 1973; Jager et al. 2007), the total number of detectable spawners would be 3000 in 2016. The sum of the 2016 peak counts for each of the areas surveyed (514; Table 2) suggests that the 2016 survey areas accounted for roughly 17% of the potential annual sturgeon spawners. After combining the peak counts of >160 cm sturgeon for all potential spawning sites surveyed from 2013–2016 (Table 2), suggests that these site account for approximately 25% of the potential annual sturgeon spawners. These calculations suggest that there are likely other areas where sturgeon spawn in the lower Fraser River.

RECOMMENDATIONS

Side-scan sonar surveys conducted since 2013 have helped identify a number of important sturgeon spawning areas in the lower Fraser River. Yet, temporal variability of site-use remains largely undocumented. It is not known whether sites are used consistently each year, or whether sites vary in overall importance with flow conditions or other factors. It is also not known how the timing of a survey within a given spawning period can affect the resulting abundance estimates. We recommend that the 2017 surveys be focused on 10 sites, including all of the confirmed spawning sites and other sites where our surveys have detected high abundance and concentrations of adult sturgeon during the spawning period. These sites would include: side channels at Herrling Island, Seabird Island, Hamilton Bar, and near Ruby Creek; and mainstem locations near Minto, Bristol Island, Landstrom Bar, Coquihalla, 289 Bar, and 302 Bar. Each of these sites should be surveyed at least three times during the peak spawning period between late-May and mid-June. The results from these proposed 2017 surveys would be combined with those from previous surveys to examine the intra- and inter-annual variability in site-use. This information will assist managers with their efforts to minimize the disturbance of spawning sturgeon during the spawning period and protect these critical habitats for Lower Fraser White Sturgeon.

With regard to efforts to confirm sturgeon spawning, we recommend that egg mats be deployed at each of the four sites where large sturgeon were consistently abundant during the spring 2016 surveys. These sites were Mountain Bar, Hamilton Bar, 289 Bar and 302 Bar (Table 1).

ACKNOWLEDGEMENTS

This project would not have been possible without funding from the Habitat Conservation Trust Fund (HCTF). We would like to thank HCTF for their contribution to this study. We thank the BC Sportfishing Group and specifically, Tony Nootebos, Yves Bisson, and Anthony Sprangers 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 also thank Hannah English and Lucia Ferreira for their review and analysis of all the sonar data files, Yury Bychkov for technical support and Dawn Keller for formatting the final report. We thank the Fraser River Sturgeon Conservation Society, specifically Sarah Schreier, for assistance with the planning and administration of this project.

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Table 1. 2016 counts of mature size (>160 cm) White Sturgeon by day and location. Grey shading indicates a transect was not conducted on that day.

Location[a]	River km[b]	Week 1			Week 2			Week 3			Week 4			Total
		25-May	26-May	27-May	31-May	01-Jun	02-Jun	07-Jun	08-Jun	09-Jun	14-Jun	15-Jun	16-Jun	
Lower Pitt River	P1			2										**2**
Sturgeon Slough	P12			32										**32**
Siwash Island	P19			2										**2**
Heron Creek	P19.5			0										**0**
Pitt Lake Outlet	P21			2										**2**
Defrauder Creek Confluence	P34						0							**0**
Osprey Creek Confluence	P35.5						0							**0**
Ashby Creek Confluence	P37.5						0							**0**
DeBeck Creek Confluence	P41						0							**0**
Vickers Creek Confluence	P42.5						0							**0**
Upper Pitt River Confluence	P46						1							**1**
Upper Pitt River	P46.5						0							**0**
Upper Pitt River Slough	P46.5						0							**0**
Grassy Bar	96.5	6						4			9			**19**
Vedder River	97.5	6			28			18			1			**53**
Wellington North	102.5										0			**0**
Mountain Bar	103	35			53			9			26			**123**
Minto	108	22			22			4			23			**71**
Duncan Rock	115									0				**0**
Hamilton Bar	118	20			44			12			7			**83**
Agassiz Bridge	123									6				**6**
Herrling	125					63				62				**125**
Tranmer	132.5									3				**3**
Tranmer_2	132.5									0				**0**
Herrling Upstream_1	133									2				**2**
Herrling Upstream_2	133.5												5	**5**
Sea Bird Island South_1	134												3	**3**
Sea Bird Island South_2	134												0	**0**
Chawuthen Creek	151											2		**2**
Bristol Island	154.5		43			26			60			62		**191**
Landstrom Bar	156		42			55			45			59		**201**
Silverhope Creek	158		6			6			2			3		**17**
Hope Bridge	159											3		**3**
Hope Boat Launch	159.5								1					**1**
Coquihalla	160.5		21			8			20			6		**55**
289 Bar	163		37			26			27			19		**109**
297 Bar	167											0		**0**
302 Bar	168		13			7			8			9		**37**
Klahater Backchannel	169		2											**2**
Coka Corner	169.5		21											**21**
FN Fish Camp	170		3						10			10		**23**
Emory Creek	174		3											**3**
Qualark Creek	175.5		1											**1**
Yale	181		5											**5**
Total		**89**	**197**	**38**	**147**	**191**	**1**	**47**	**173**	**73**	**66**	**173**	**8**	**1203**

[a] The number used for naming bars (e.g., 289 Bar) refers to the 1:50 000 watershed code of the nearest stream to the sonar site.

[b] The P in front of the river km represents the Pitt River watershed.

[c] Grey shading indicates a transect was not conducted on that day.

Table 2. Peak counts of mature-sized (>160 cm) White Sturgeon observed at each side-scan sonar survey location from 2013 to 2016. Italicized values indicate that only one survey was conducted at that location. Grey shading indicates a transect was not conducted during that year.

Location[a]	River km[b]	2013		2014		2015		2016		2013-2016
		Peak Count	Peak Date	Peak Count	Peak Date	Peak Count	Peak Date	Peak Count	Peak Date	Peak Count
Lower Pitt River	P1							*2*	27-May	2
Sturgeon Slough	P12							*32*	27-May	32
Siwash Island	P19							*2*	27-May	2
Heron Creek	P19.5							*0*	27-May	0
Pitt Lake Outlet	P21							*2*	27-May	2
Defrauder Creek Confluence	P34							0	02-Jun	0
Osprey Creek Confluence	P35.5							*0*	02-Jun	0
Ashby Creek Confluence	P37.5							*0*	02-Jun	0
DeBeck Creek Confluence	P41							*0*	02-Jun	0
Vickers Creek Confluence	P42.5							*0*	02-Jun	0
Upper Pitt River Confluence	P46							*1*	02-Jun	1
Upper Pitt River	P46.5							*0*	02-Jun	0
Upper Pitt River Slough	P46.5							*0*	02-Jun	0
Grassy Bar	96.5					9	15-Jun	9	14-Jun	9
Vedder River	97.5							18	07-Jun	18
Wellington North	102.5					4	03-Jun	*0*	14-Jun	4
Log Dump	103	*16*	22-Jun							16
Minto	108	27	01-Jul					23	14-Jun	27
Mountain Bar	110					20	03-Jun	53	31-May	53
Harrison Confluence	110.5					*4*	22-Jun			4
Harrison Water Tower	110.5					0	24-Jun			0
Duncan Rock	115							*0*	09-Jun	0
Outer Hamilton	115					*1*	15-Jun			1
Jesperson	115.5	15	24-Jun							15
Hamilton Bar	118					*2*	15-Jun	44	31-May	44
Little Big Bar	119.5					*0*	18-Jun			0
Agassiz Bridge	123	22	02-Jul			*7*	24-Jun	*6*	09-Jun	22
Herrling	125	63	04-Jun					63	01-Jun	63
Tranmer	132.5	7	25-Jun					*3*	09-Jun	7
Tranmer_2	132.5							*0*	09-Jun	0
Herrling Upstream_1	133							*2*	09-Jun	2
Herrling Upstream_2	133.5							5	16-Jun	5
Sea Bird Island South_1	134							3	16-Jun	3
Sea Bird Island South_2	134							0	16-Jun	0
Seabird Island[c]	134.5	29	26-Jun	60		48	04-Jun			60
Peter's Island	135					17	18-Jun			17
Powerline Bar	139.5	22	26-Jun							22
Ruby Creek	144	19	19-Jun							19
Hunter Creek	147.5					20	23-Jun			20
Chawuthen Creek	151					0	01-Jun	*2*	15-Jun	2
Bristol Island	154.5					38	16-Jun	62	15-Jun	62
Landstrom Bar	156	29	26-Jun			38	09-Jun	59	15-Jun	59
Silverhope Creek	158					14	16-Jun	6	26-May	14
Hope Bridge	159							*3*	15-Jun	3
Hope Boat Launch	159.5							*1*	08-Jun	1
Stockholm Creek	159.5					*10*	17-Jun			10
Coquihalla	160.5					4	23-Jun	21	26-May	21
288 Eddy	162					0	02-Jun			0
289 Bar	163					16	23-Jun	37	26-May	37
297 Eddy	167					*0*	02-Jun			0
297 Bar	167					3	09-Jun	*0*	15-Jun	3
302 Bar	168					*5*	23-Jun	13	26-May	13
Klahater Backchannel	169					*3*	17-Jun	*2*	26-May	3
Coka Corner	169.5					15	09-Jun	*21*	26-May	21
FN Fish Camp	170							10	08-Jun	10
Emory Creek	174					6	17-Jun	*3*	26-May	6
Qualark Creek	175.5					6	10-Jun	*1*	26-May	6
Qualark River Left	176					*0*	17-Jun			0
Yale Backeddy #2	180					*3*	17-Jun			3
Yale	181					2	02-Jun	*5*	26-May	5
Yale Backeddy #1	181.5					*0*	17-Jun			0
Deadman's Pool	182.5					13	02-Jun			13
Total		**249**		**60**		**308**		**514**		**762**

[a] The number used for naming bars (e.g., 289 Bar) refers to the 1:50 000 watershed code index of the nearest stream to the sonar site.

[b] The P in front of the river km refers to the Pitt River watershed.

[c] In Johnson et al. (2015), the Seabird Island river km was 133; the correct river km is 135. The site location was not moved.

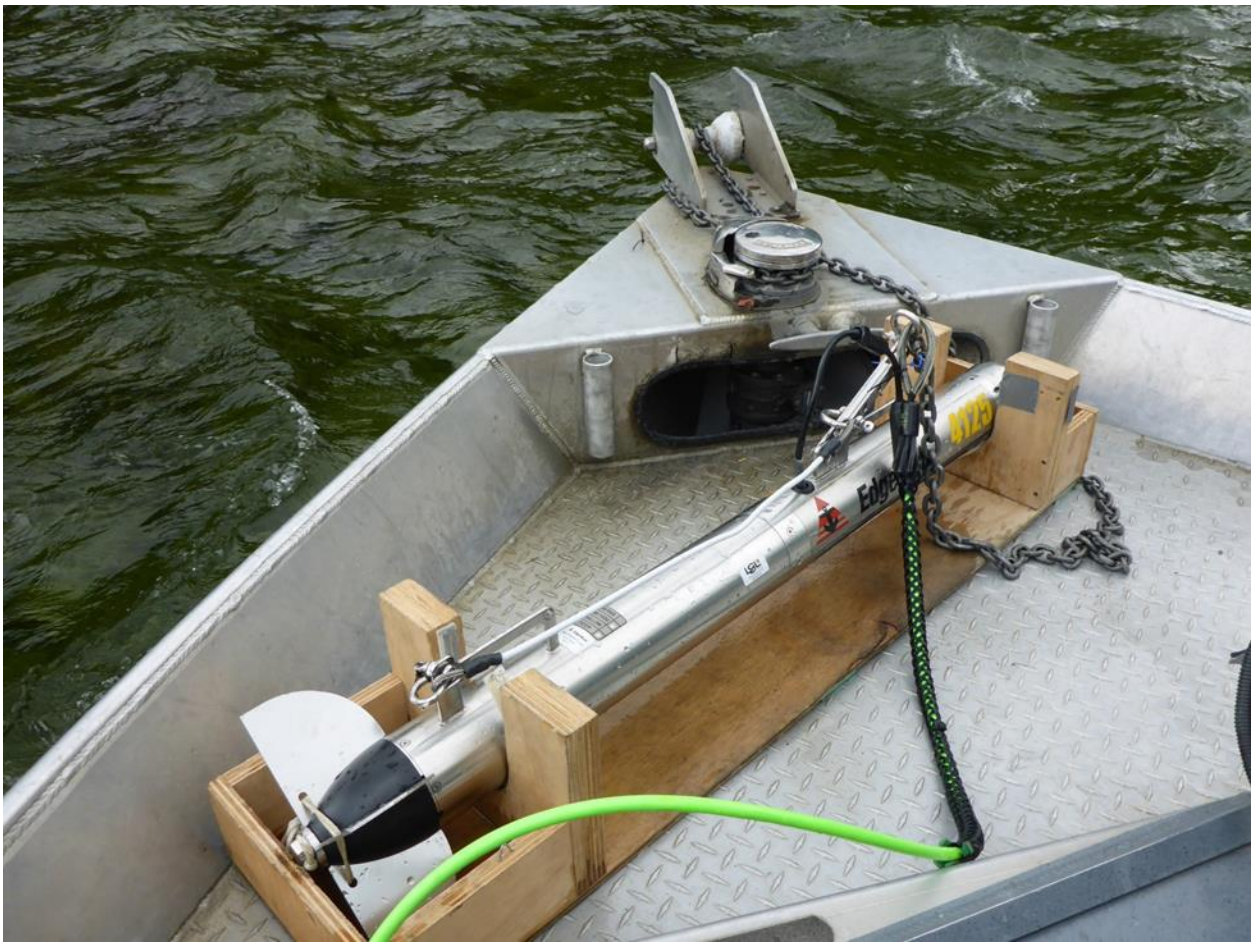


Figure 1. EdgeTech 4125 side-scan sonar setup on the bow of the survey boat.

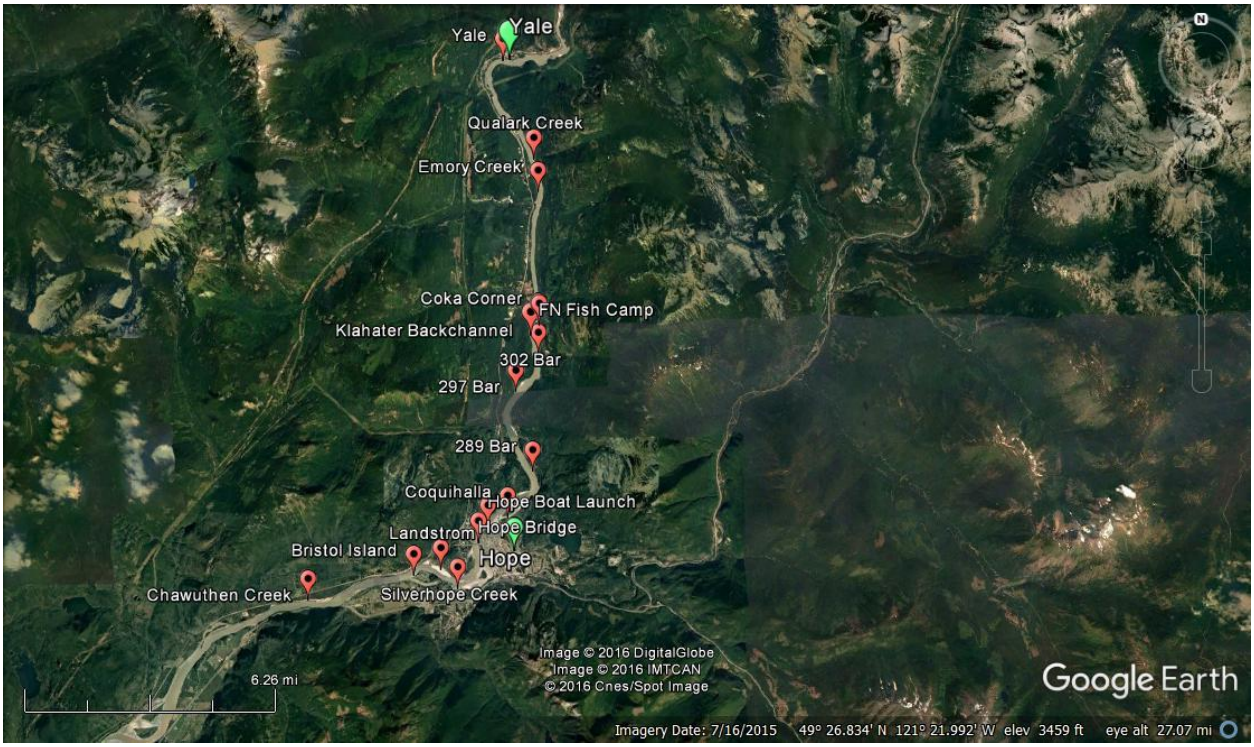


Figure 2. 2016 Fraser River side-scan sonar survey locations between Hope and Yale, BC.

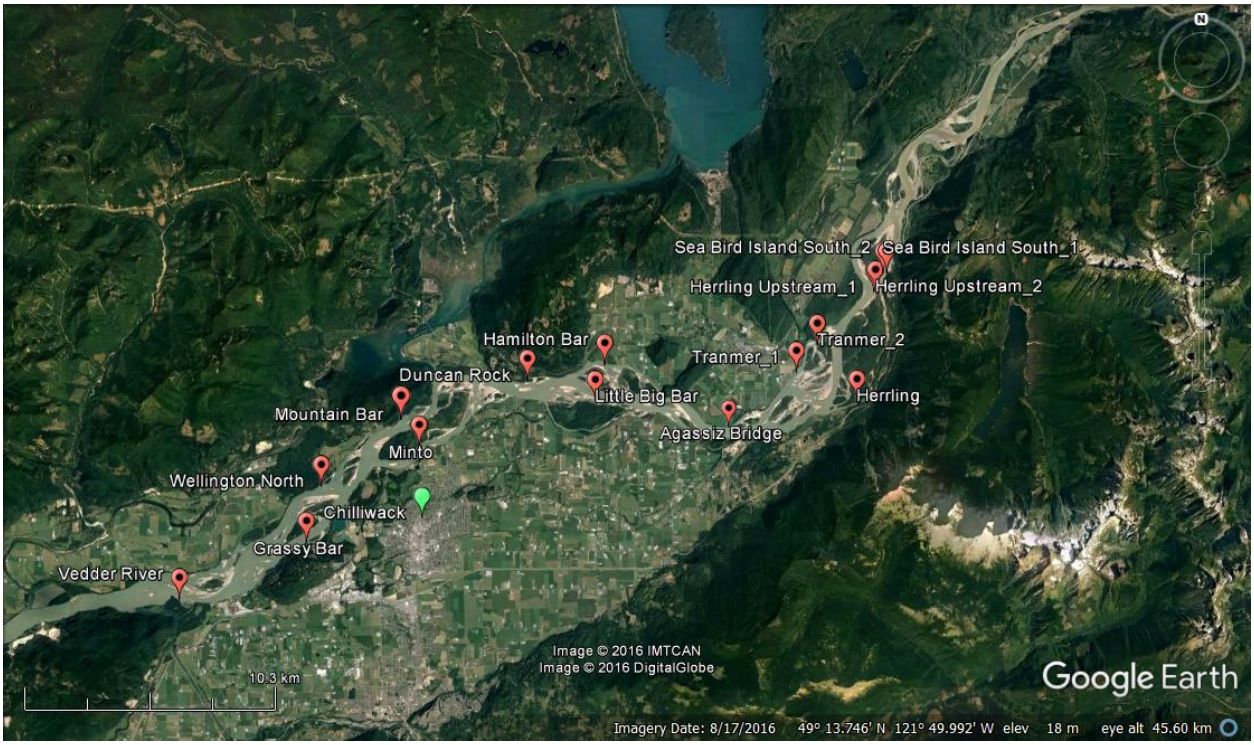


Figure 3. 2016 Fraser River side-scan sonar survey locations near Chilliwack, BC.

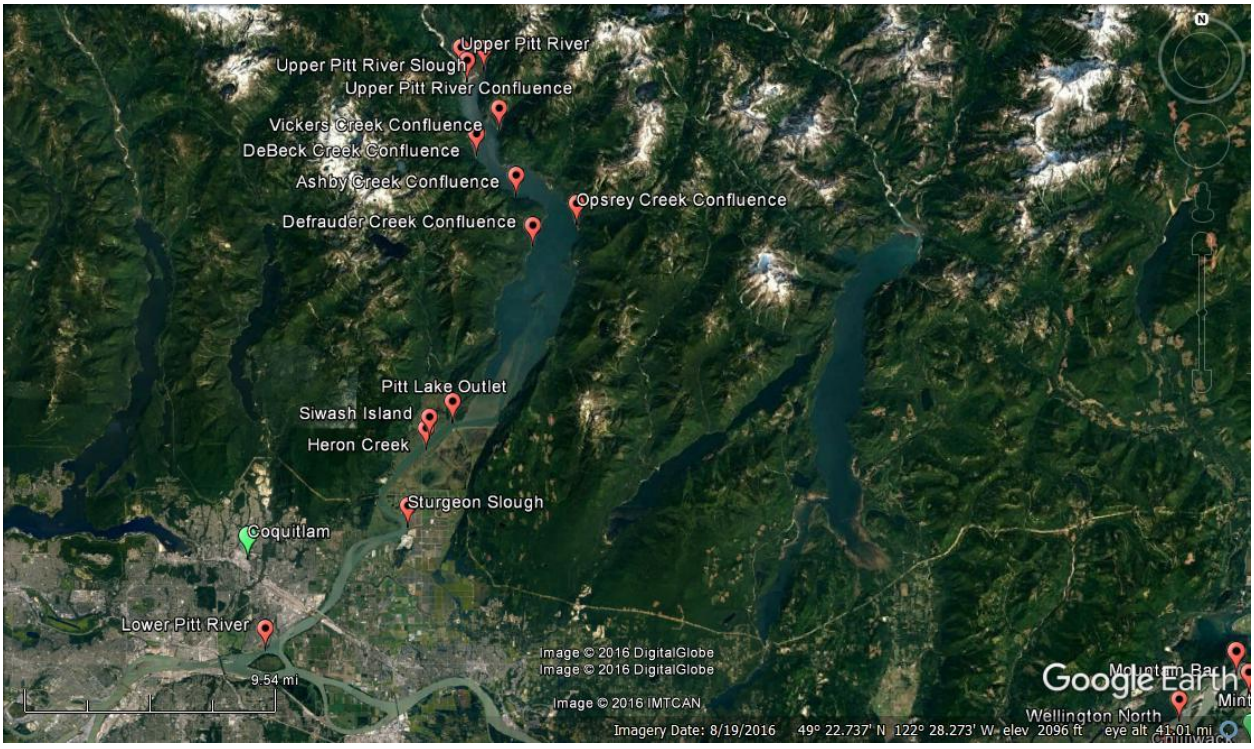
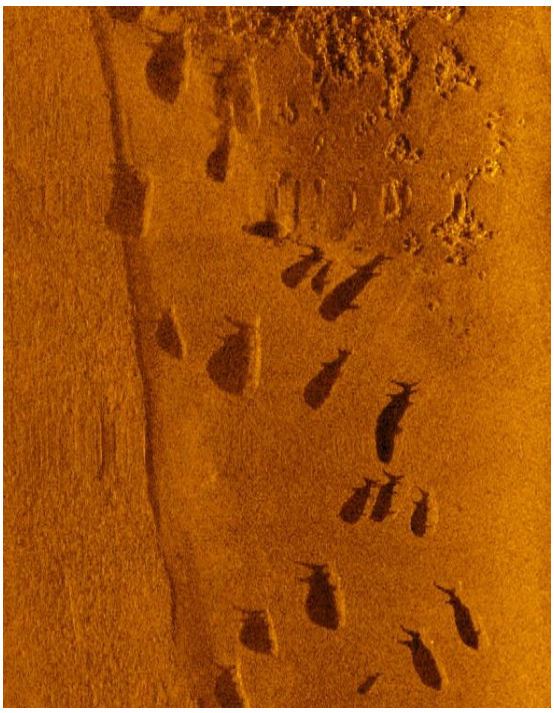
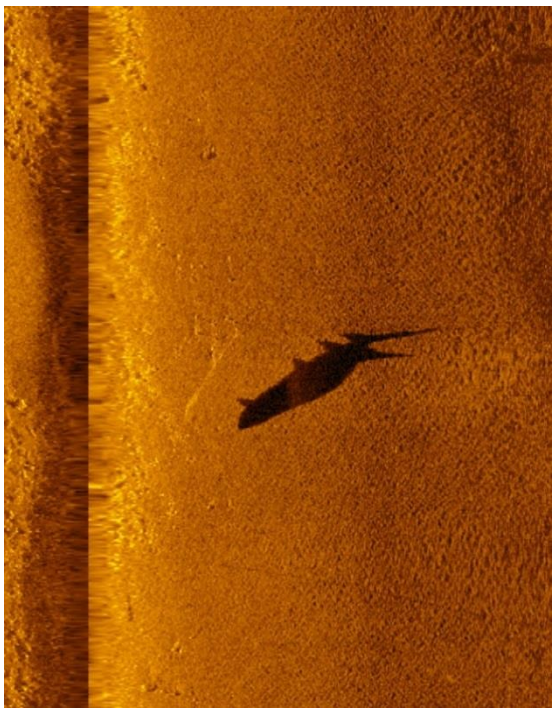


Figure 4. 2016 Pitt River and Pitt Lake side-scan sonar survey locations, near Coquitlam, BC.

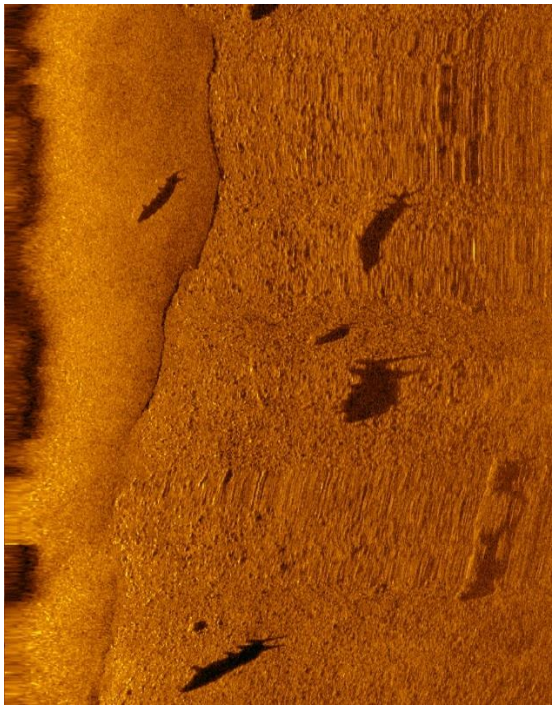


Group of sturgeon at Bristol Island, sand bottom, June 8



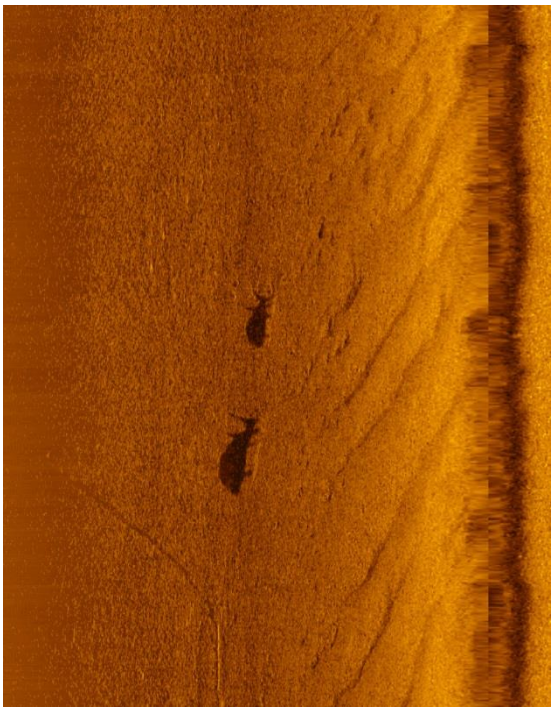
A sturgeon at Coquihalla, sand bottom, June 15

Group of twenty-one sturgeon at Bristol Island, sand bottom, June 15

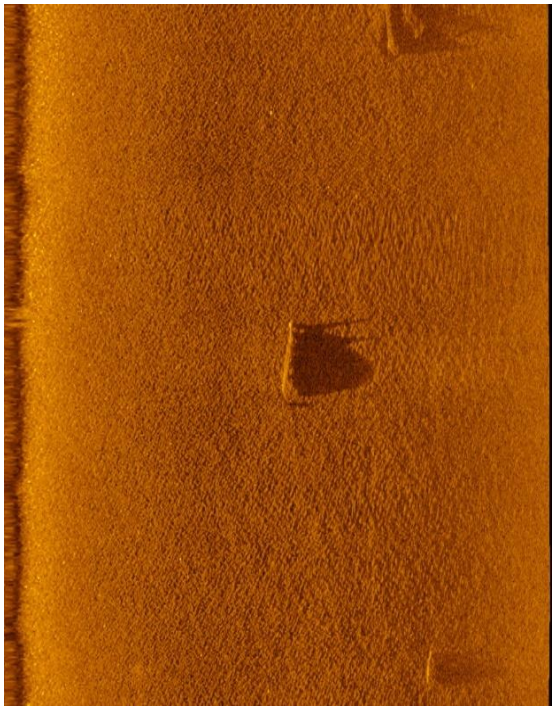


A few sturgeon at Landstrom Bar, gravel bottom, June 1

Figure 5. Side-scan sonar images of sturgeon detected at Bristol Island, Coquihalla, and Landstrom Bar in the lower Fraser River in June 2016.

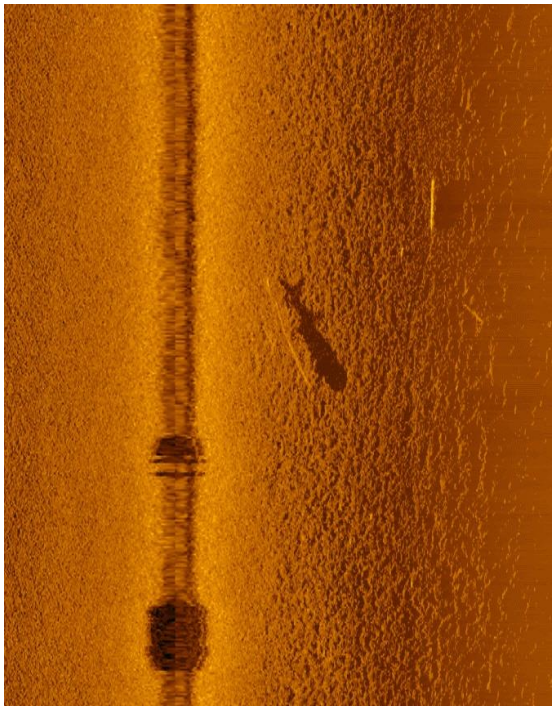


Two sturgeon at Landstrom Bar, sand bottom, June 15



2.8 metre sturgeon at Mountain Bar, sand bottom, June 14

Group of sturgeon at Bristol Island, sand bottom, June 15



4.5 metre sturgeon at Herrling, sand bottom, June 9

Figure 6. Side-scan sonar images of sturgeon detected at Landstrom Bar, Mountain Bar, Bristol Island, and Herrling in the lower Fraser River in June 2016.

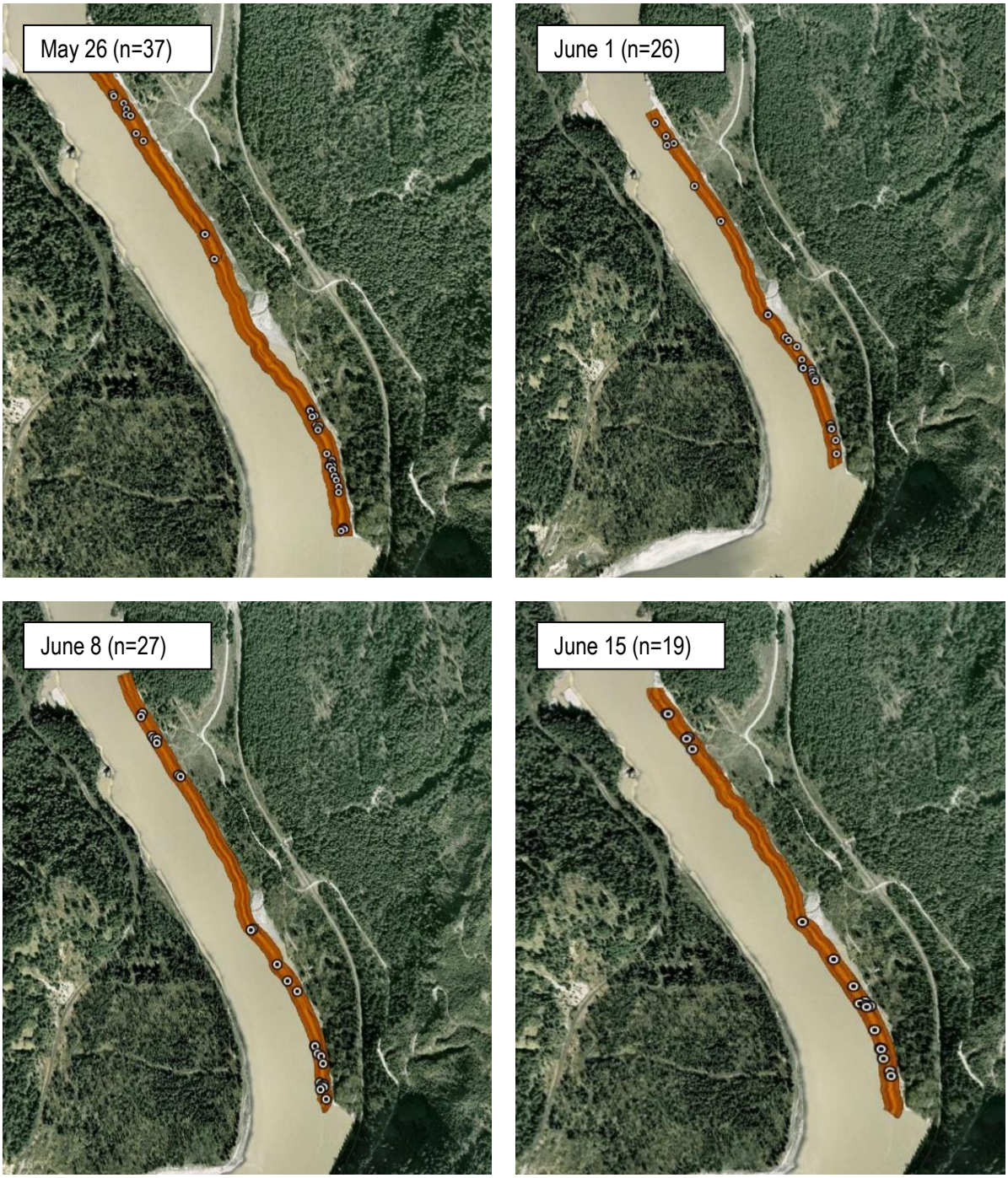


Figure 7. Distribution of mature size (>160 cm) White Sturgeon detected near 289 Bar in 2016.

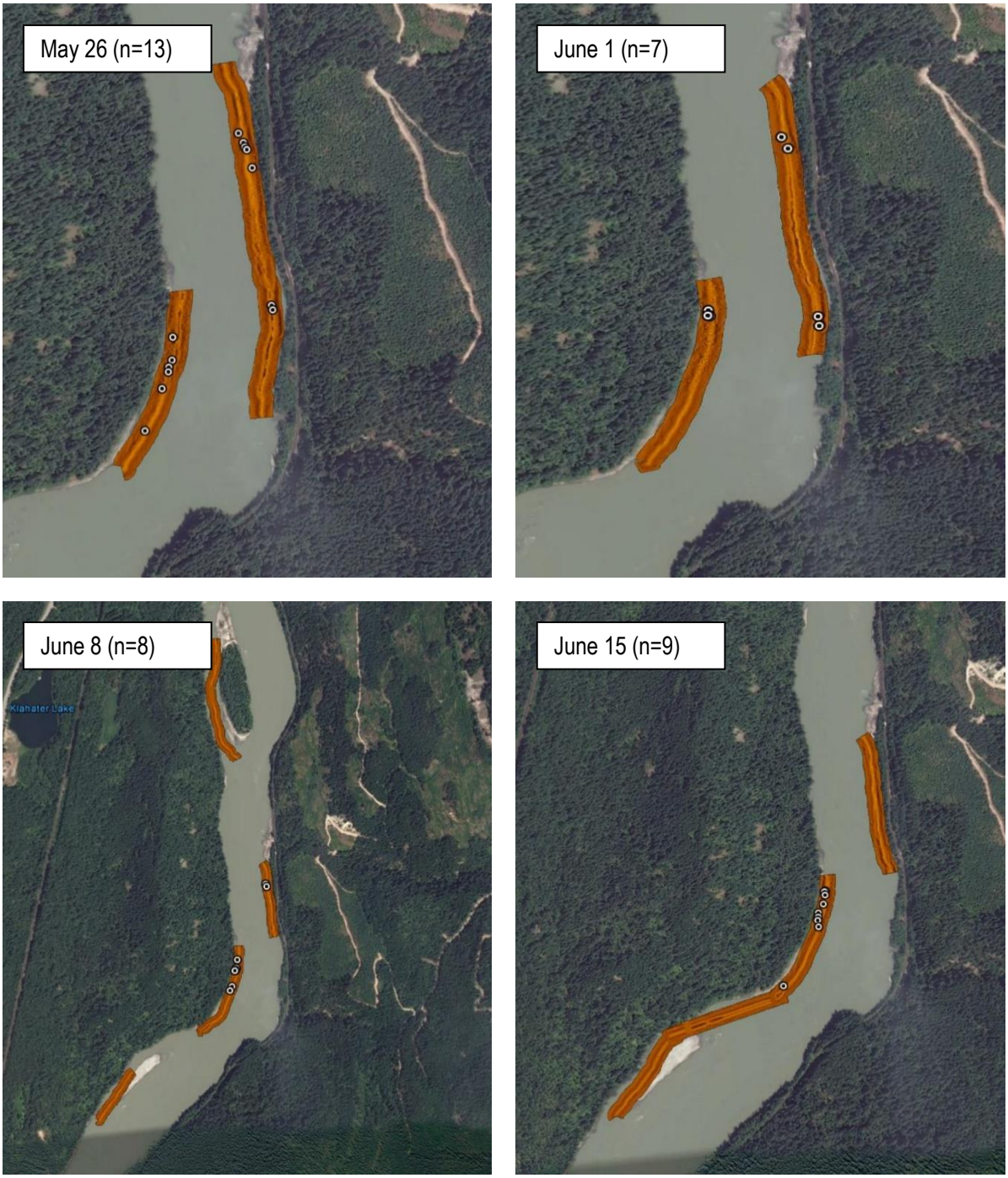


Figure 8. Distribution of mature size (>160 cm) White Sturgeon detected near 302 Bar in 2016.

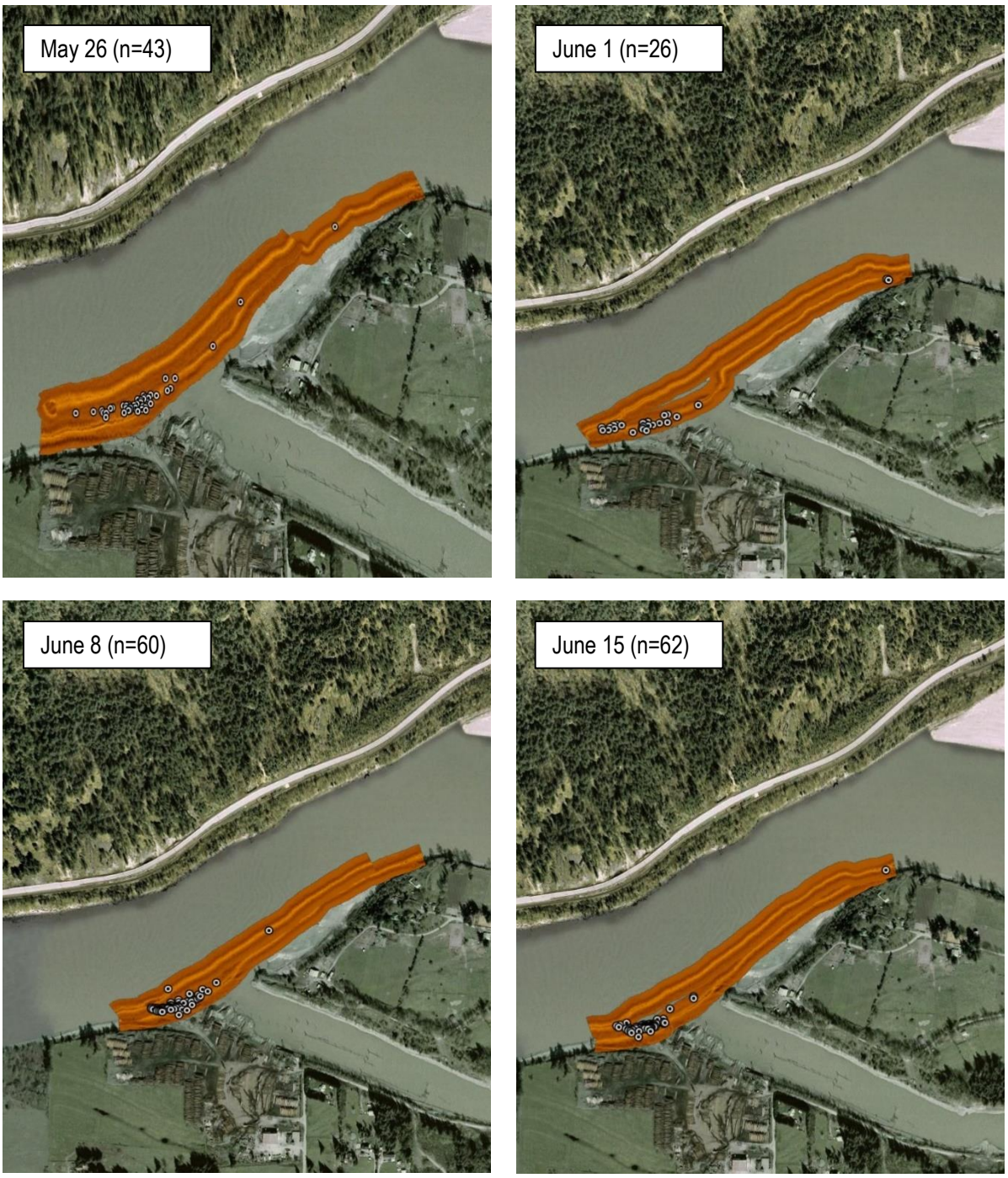


Figure 9. Distribution of mature size (>160 cm) White Sturgeon detected near Bristol Island in 2016.

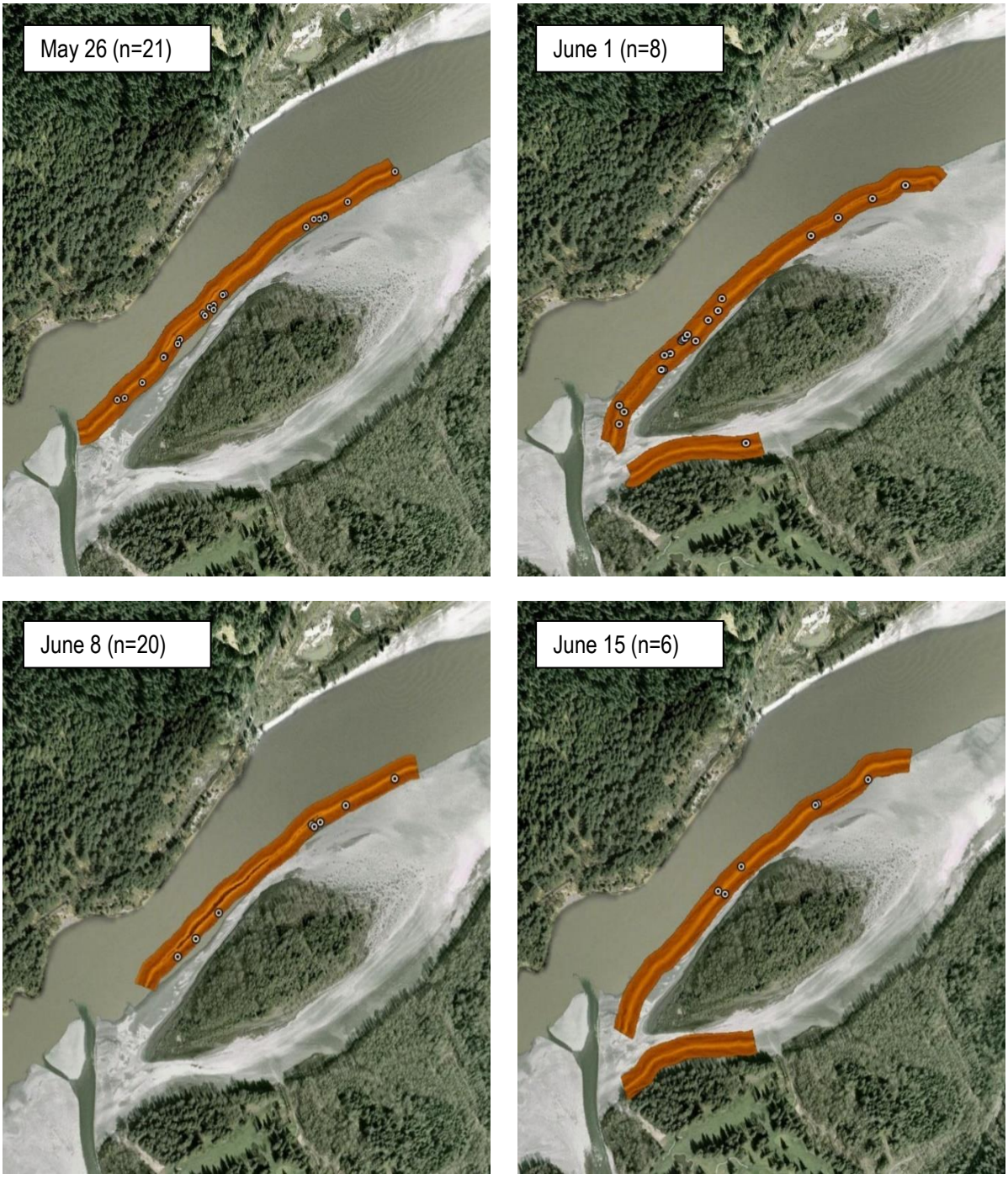


Figure 10. Distribution of mature size (>160 cm) White Sturgeon detected near Coquihalla in 2016.

Figure 11. Distribution of mature size (>160 cm) White Sturgeon detected near Herrling in 2016.

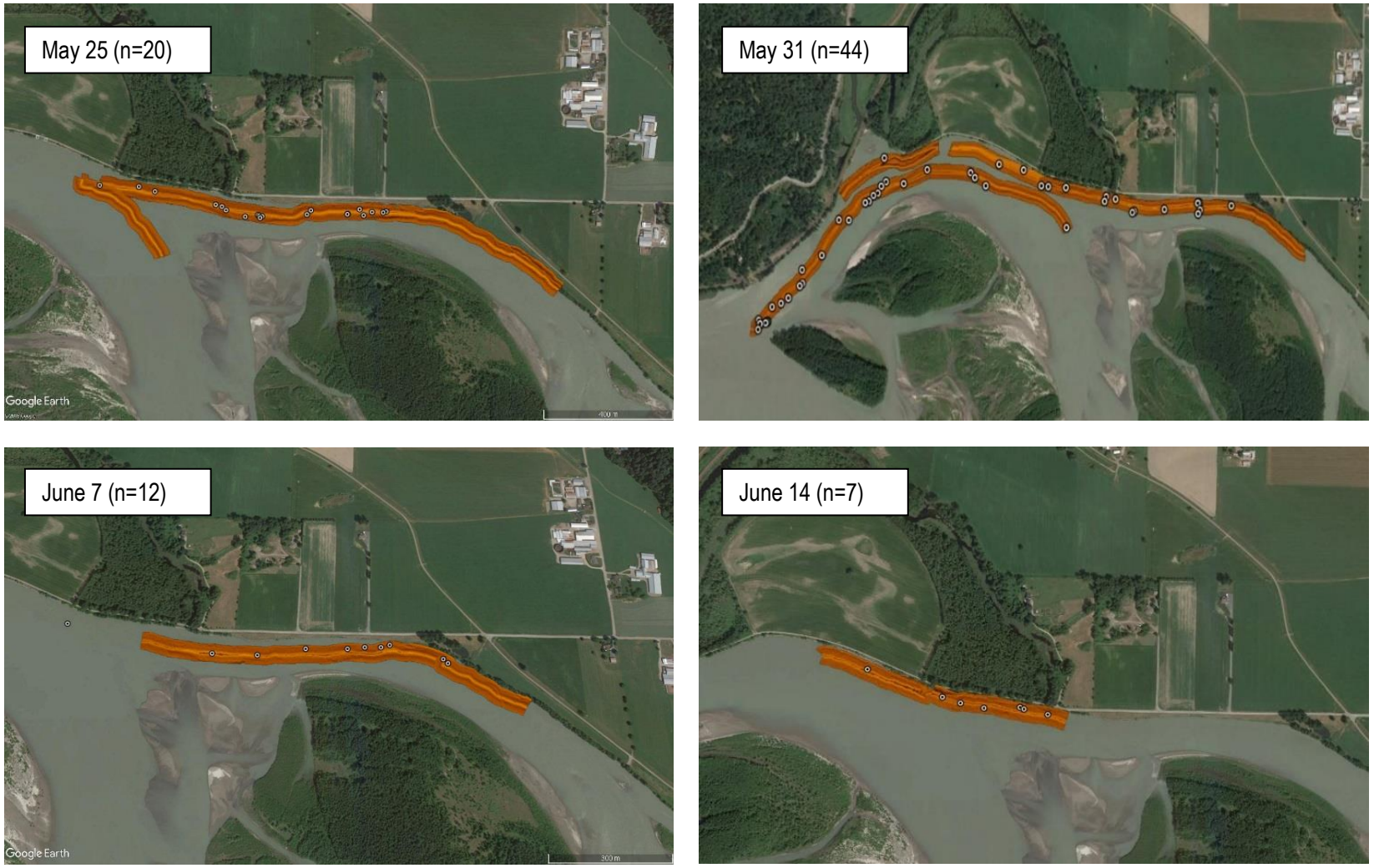


Figure 12. Distribution of mature size (>160 cm) White Sturgeon detected near Hamilton Bar in 2016.

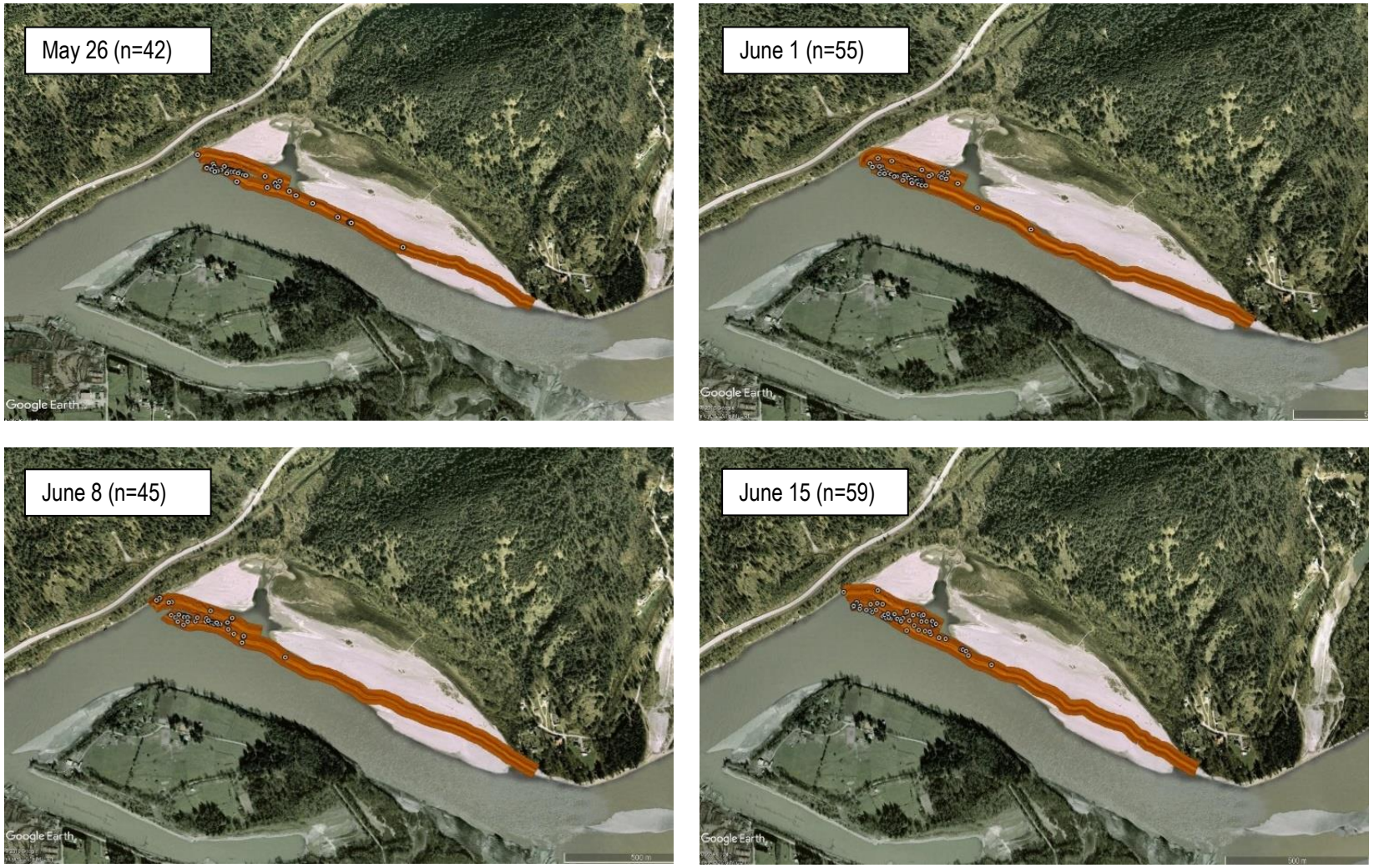


Figure 13. Distribution of mature size (>160 cm) White Sturgeon detected near Landstrom Bar in 2016.

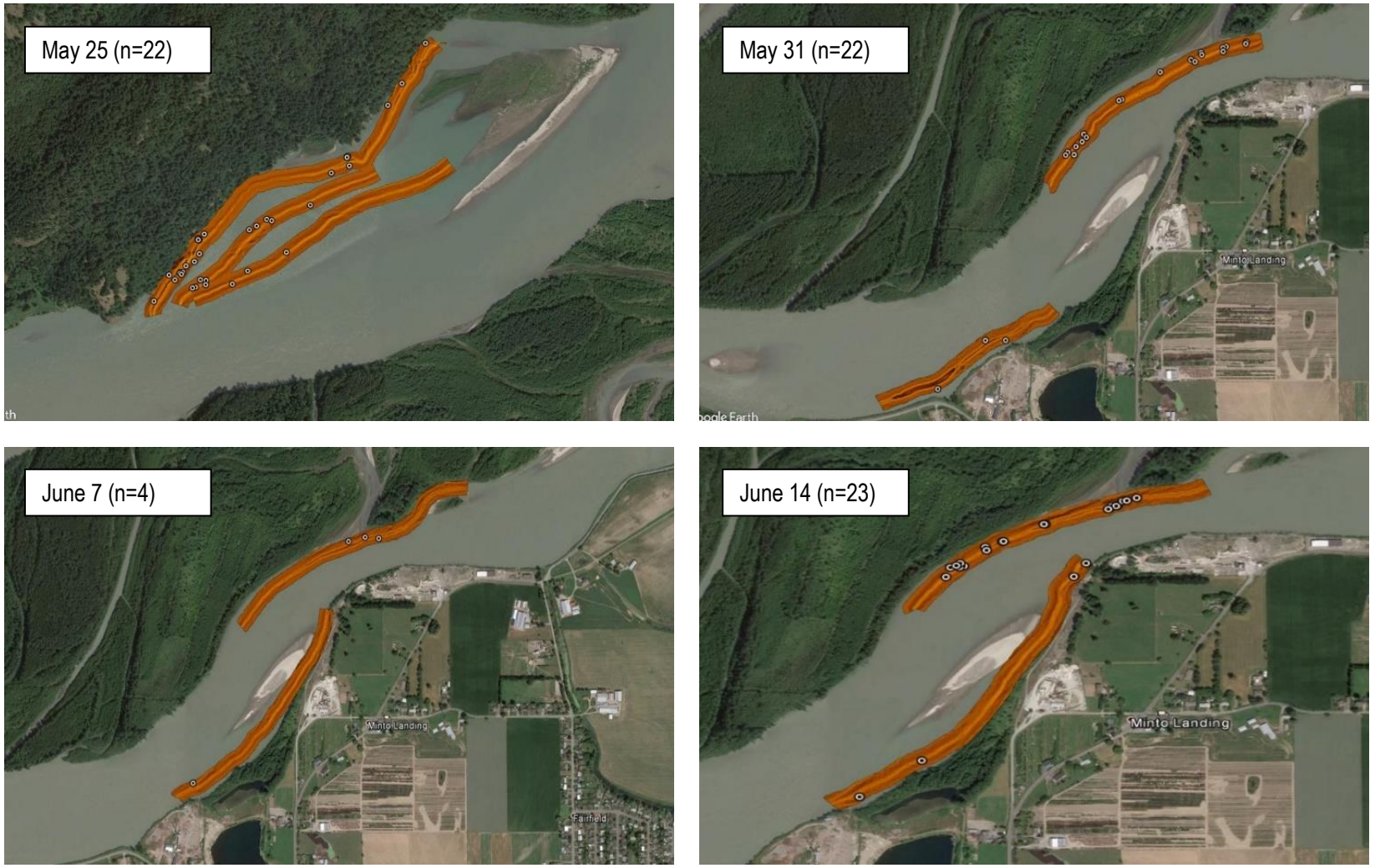


Figure 14. Distribution of mature size (>160 cm) White Sturgeon detected near Minto in 2016.

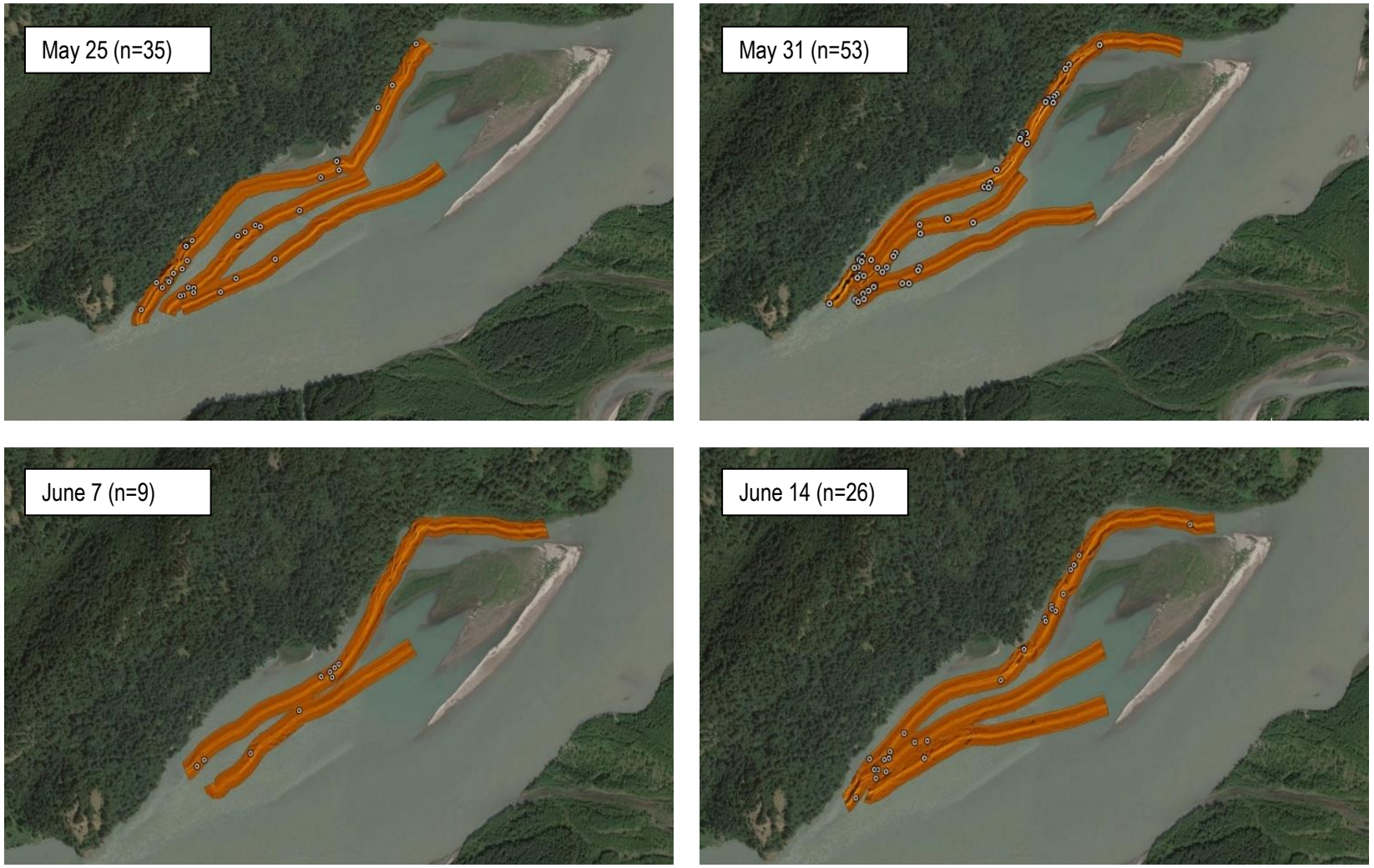


Figure 15. Distribution of mature size (>160 cm) White Sturgeon detected near Mountain Bar in 2016.

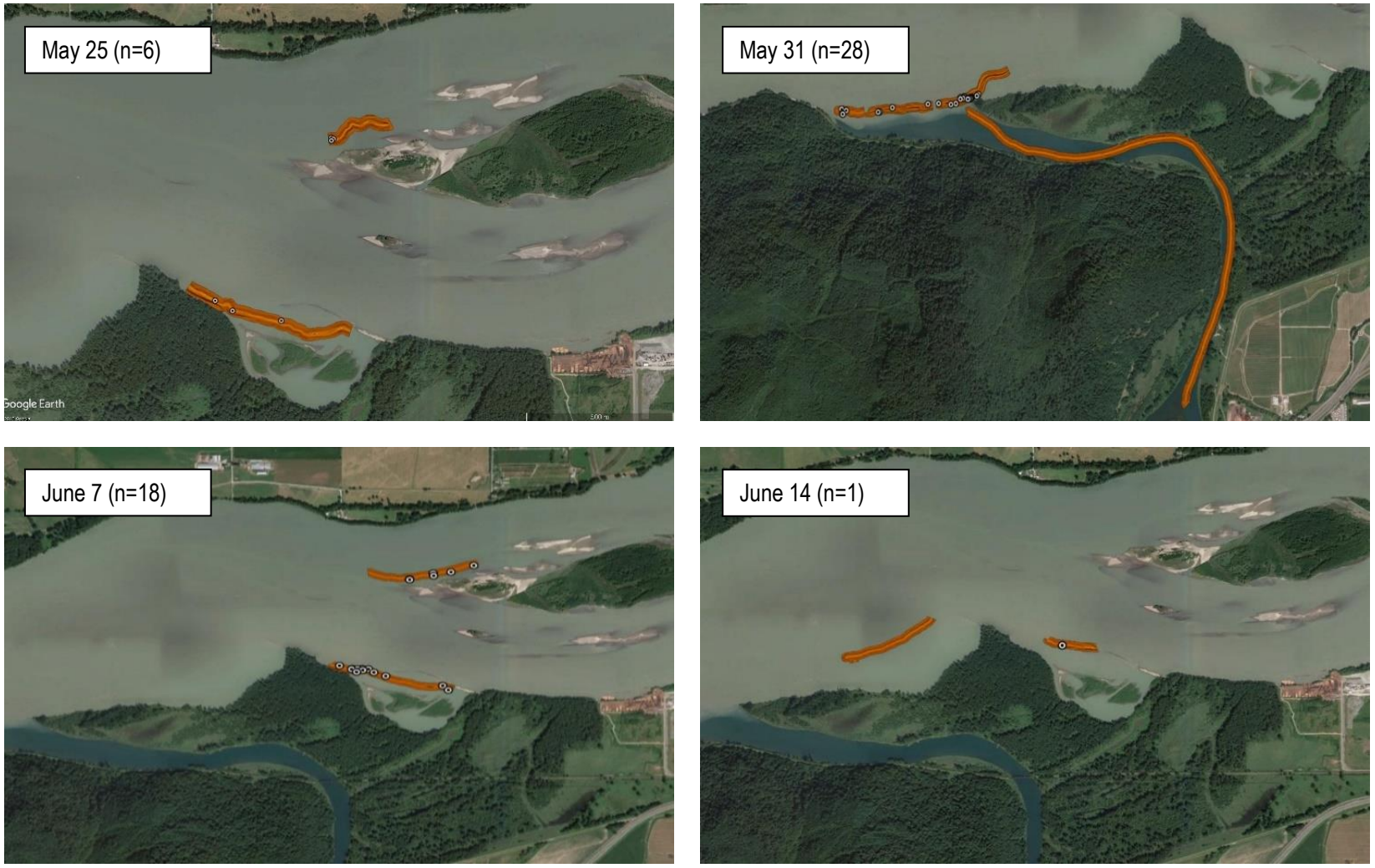


Figure 16. Distribution of mature size (>160 cm) White Sturgeon detected near Vedder River in 2016.

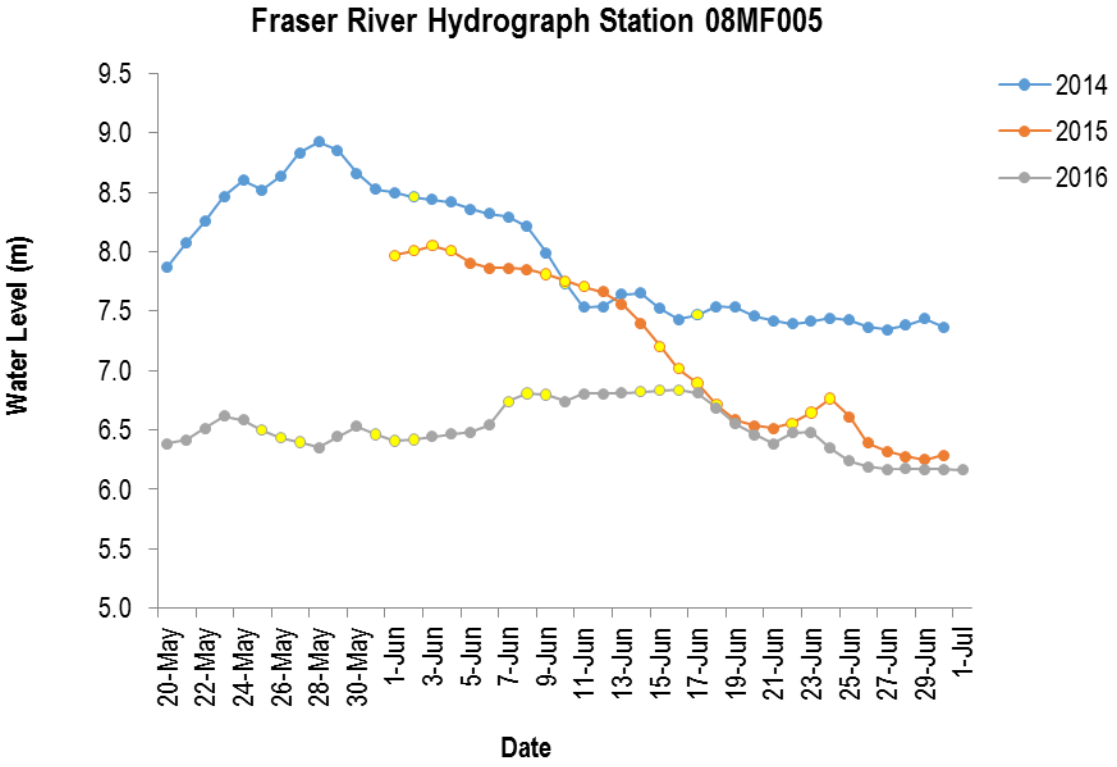


Figure 17. Average daily June water level on the Fraser River at Hope, BC, for 2014 to 2016. Yellow circles indicate sonar survey days. Environment Canada data source: https://wateroffice.ec.gc.ca.

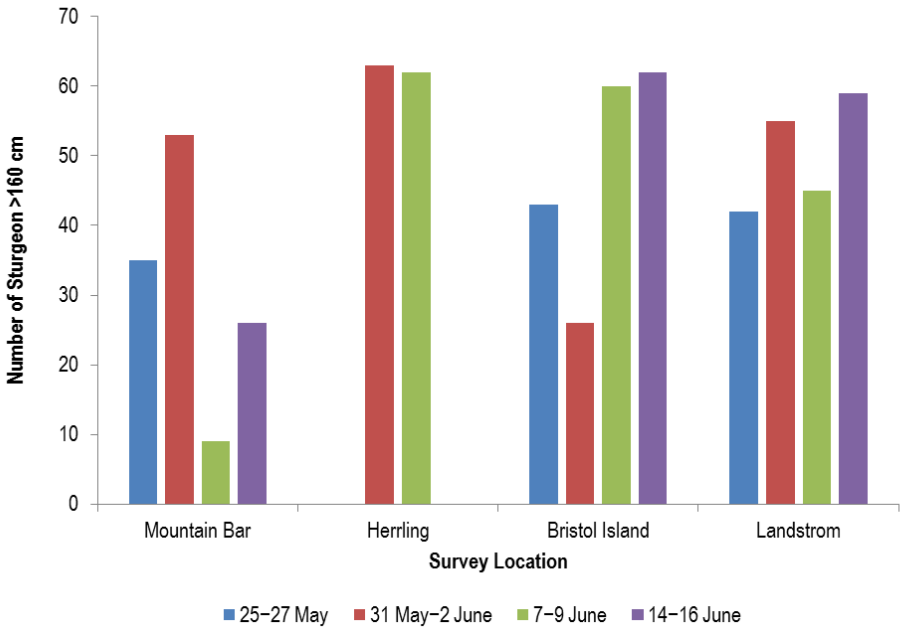


Figure 18. Trends in abundance of mature-sized (>160 cm) White Sturgeon at Mountain Bar, Herrling, Bristol Island, and Landstrom Bar between 25 May and 24 June. Peak abundance occurred in early June at most sites.

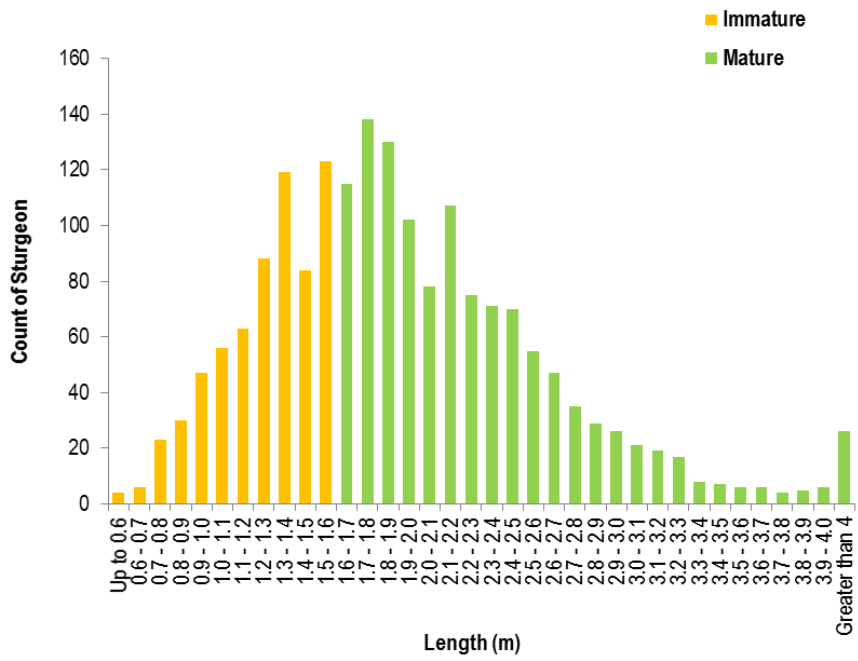


Figure 19. Length-frequency histogram for White Sturgeon observed in 2016. Over half (65%) of observed fish were mature sized (>160 cm).

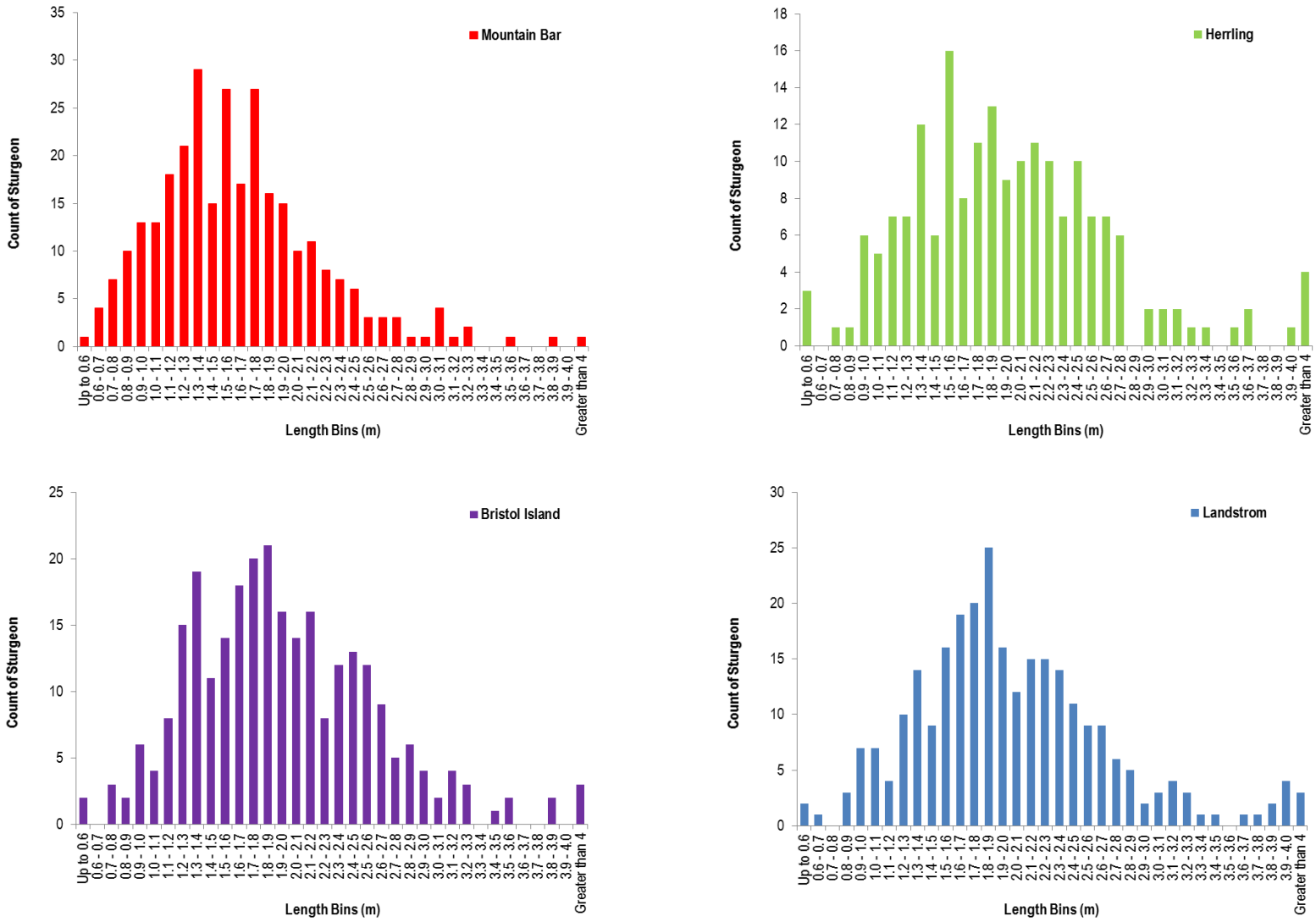


Figure 20. Size distributions for White Sturgeon observed in the four sites with the highest abundances in 2016: Mountain Bar, Bristol Island, Herrling Side Channel, and Landstrom Bar.