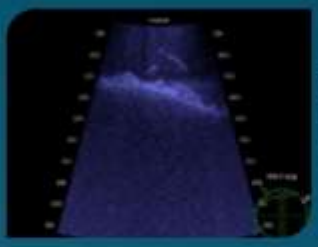
LAKE STURGEON STEWARDSHIP & ENHANCEMENT PROGRAM



Construction of Shoals to Enhance Lake Sturgeon Spawning Habitat in the Winnipeg River at Pointe du Bois: 2011 Monitoring Program

Report 11-05
March 2012

Manitoba Hydro

Lake Sturgeon Stewardship and Enhancement Program

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Construction of Shoals to Enhance Lake Sturgeon Spawning Habitat in the Winnipeg River at Pointe du Bois: 2011 Monitoring Program

Report Prepared for

Manitoba Hydro

March 2012

By

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ACKNOWLEDGMENTS

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1.0 INTRODUCTION

Manitoba Hydro has developed a province wide Lake Sturgeon Stewardship and Enhancement Program with a goal to maintain and enhance Lake Sturgeon populations in areas affected by their developments and operations. The Program sets out several strategies to achieve this goal including researching, developing and evaluating potential recovery actions.

Lake Sturgeon typically spawn in swift turbulent water in rapids or at the base of falls. Hydroelectric developments also typically target these areas to take advantage of the hydraulic head for power generation. Consequently, loss or alteration of spawning habitats is one of the most significant impacts that hydro development can have on Lake Sturgeon populations.

In 2009, a study was initiated by Manitoba Hydro to determine if rock shoals constructed in an existing hydroelectric generating station tailrace would provide suitable spawning habitat for Lake Sturgeon. The study was conducted downstream of the Pointe Du Bois GS on the Winnipeg River (Figure 1) because:

- the presence of a relatively abundant Lake Sturgeon population downstream of the Pointe du Bois GS would maximize chances for immediate evaluation of study success; and
- three years of baseline information on spawning had already been collected at the site as part of the environmental studies for the Pointe du Bois Spillway Replacement Project which would assist in site selection and evaluating study success (McDougall et al. 2008a, McDougall et al. 2008b, McDougall 2009).

The spawning surveys at Pointe du Bois identified several areas downstream of the powerhouse that had suitable depths and velocities for Lake Sturgeon spawning but were not targeted by spawning Lake Sturgeon presumably because of the lack of suitable substrates (i.e., substrates that provides sufficient interstitial spaces for egg deposition and incubation) and/or turbulence. Rock shoals were constructed within these sites to enhance conditions for Lake Sturgeon spawning. A description of the rationale for site selection and construction is provided in North/South Consultants (2011a).

The first Lake Sturgeon spawning shoal in Manitoba was constructed approximately 40 m downstream of Unit 16 of the Pointe du Bois powerhouse in late April 2009 (Figure 2). Subsequent monitoring of the shoal began that spring in conjunction with Lake Sturgeon spawning studies conducted as part of the Pointe du Bois Spillway Replacement Project (Koga and MacDonell 2009). Although Lake Sturgeon were observed moving near the constructed shoal, results indicated that Lake Sturgeon did not spawn over the shoal, but instead selected areas closer to the powerhouse where higher water velocities and more complex flows existed. Based on the monitoring results, three additional spawning shoals were constructed closer to the powerhouse, immediately downstream of units 1, 5 and 13 during April 2010 (Figure 2).

Monitoring in 2010 found evidence of Lake Sturgeon spawning in the powerhouse tailrace area mostly between units 2 and 4, however some egg deposition was observed between units 11 and 12 and between units 5 and 10 (North/South Consultants 2011a). It appeared that sturgeon were attracted to the high flows exiting the turbines, and were keying in on the current edges adjacent to the main flow. Large numbers of eggs were collected in close proximity to the shoals downstream of units 5, 13, and 1 suggesting that spawning occurred near the shoals. A DIDSON (Dual Identification Sonar) acoustic camera (Soundmetrics Corp., Lake Forest Park, Washington, USA) showed large numbers of inactive sturgeon present near the Unit 1 shoal prior to the spawning period. As peak spawning approached, the number of sturgeon present near Unit 13 increased rapidly. The shoal near Unit 5 could not be monitored with the DIDSON camera in 2010 due to turbulent flows. Egg mat results suggested that this

area may have been an important location for spawning within the tailrace. The shoal downstream of Unit 16 attracted few Lake Sturgeon during the monitoring period and egg mats set in the vicinity of the shoal did not capture any eggs.

Monitoring of the constructed shoals at Pointe du Bois GS was continued during the Lake Sturgeon spawning period in spring 2011. This report provides the results of that program.

2.0 POINTE DU BOIS GENERATING STATION

Construction of the Pointe du Bois Generating Station (GS) began in 1909 with the station becoming operational in 1911. Upon completion of the Pointe du Bois GS in 1926, the powerhouse was comprised of 16 horizontal twin reaction Francis turbines with discharge ratings of 33 cms (units 2, 3, 4 and 7), 43 to 44 cms (units 5, 6, 8, 9, 10 and 11), 46 cms (units 12, 13 and 14) and 51 cms (units 15 and 16) plus two small Francis units, each with 5 cms ratings (North/South Consultants 2011b). In 1999, the eastern most Francis unit was replaced with a StrafloTM unit which had an increased capacity of approximately 69 cms. The maximum powerhouse capacity is about 712 cms. Flows in excess of powerhouse capacity are passed through the existing spillway, such that the outer forebay is controlled at or near the target Full Supply Level elevation of 299.1 m.

The station is capable of generating 78 MW when fully operational producing an average annual generation of 599 million kWh. In recent years, several generating units have been inoperable on a rotating basis and, therefore, the station has generally operated below its full capacity.

The Pointe du Bois GS is the most upstream of six hydroelectric stations currently in operation on the Manitoba portion of the Winnipeg River. Along with the Slave Falls GS (located approximately 7.8 km downstream of the Pointe du Bois GS), it operates primarily as a run-of-the-river plant with little storage. Powerhouse and spillway flows are primarily manipulated in response to regulated flows received from Ontario (North/South Consultants 2011b).

3.0 CONSTRUCTED SPAWNING SHOAL MONITORING METHODS

Monitoring of spawning activity in relation to the constructed shoals was conducted concurrently with egg deposition monitoring conducted as part of the Pointe du Bois Spillway Replacement Project (Koga and MacDonell 2012). Lake Sturgeon activity on and around the shoals was monitored with a DIDSON acoustic camera and egg deposition on and adjacent to the shoals was monitored with egg mats.

DIDSON Acoustic Camera

The DIDSON monitoring setup consisted of a camera unit attached to a X^2 pan & tilt rotator (Soundmetrics Corp., Lake Forest Park, Washington, USA) mounted on a swiveling pole mount (constructed by Anything Custom Ltd, Winnipeg, Canada) (Figure 3). A custom built mounting bracket (also constructed by Anything Custom Ltd., Winnipeg, Manitoba) was bolted to the seat of the boat and the pole, rotator, and camera were attached to it. The setup allowed the camera to be lowered approximately 1 m below the water surface for monitoring and raised for travelling.

The boat was moored differently at each of the constructed shoal locations for optimal camera operation. To monitor the constructed shoal downstream of Unit 16, the boat was moored immediately downstream of the shoal and the camera was pointed upstream. At the Unit 13 shoal, the boat was tied directly to the powerhouse and the camera was pointed downstream at the shoal (Figure 4). A large king anchor with 10 to 15 m of line attached to a buoy was deployed at the upstream end of the Unit 5 constructed shoal

to make a more permanent and stable monitoring station. The boat was tied to the king anchor in a location immediately downstream of the constructed shoal (Figure 5). The constructed shoal downstream of Unit 1 was monitored by mooring the boat in the calmer water east of the shoal (Figure 6). To decrease boat sway and enhance the video quality two drift socks were attached to the rear corners of the boat at the Unit 5 and Unit 1 monitoring stations.

Each constructed shoal was monitored throughout the spawning period for approximately 1 to 2 hours each day, and the time of day that each shoal was monitored was changed daily. Digital images were recorded whenever there was evidence of fish use. The digital data were reviewed and summarized at a later date to describe the frequency of Lake Sturgeon observations and spawning behaviour.

Egg Collection Mats

Egg collection mats were placed on and around the constructed shoals to monitor egg deposition. Each egg mat consisted of a 30 x 90 cm portion of furnace filter material wrapped around a 39 x 19 x 9 cm cinder block and held in place with bungee cords (Figure 7). Lake Sturgeon eggs readily adhere to furnace filter material and the presence of eggs on the mats provides an indication that spawning has occurred in close proximity.

The mats were either deployed as transects running parallel to the river flow, with mats located at approximate 20 m intervals, or as individual mats. The majority of transects consisted of four to five egg collection mats, with some transects consisting of only two mats. A large anchor was attached to the upstream end of most transects and a float was attached to the downstream end to facilitate retrieval. The egg collection mats were lifted every two to three days to inspect the filter material for eggs and subsequently replaced. GPS coordinates, depth, and velocity were recorded at each mat location. It should be noted that GPS coordinates for each egg mat were determined at the surface of the water and, while providing a general location, do not necessarily represent the exact location of each mat. Egg mats with GPS locations within 10 m of the constructed shoal were used to assess egg deposition in relation to each shoal.

4.0 RESULTS

4.1 2011 Discharge and Unit Operation

Winnipeg River discharge was relatively high during spring 2011 and a spill occurred throughout the Lake Sturgeon spawning period. Nine of the 16 powerhouse generating units were operational during this time including units 1-4 (easternmost units), 6-9 and 12 (western-most unit). Mean daily discharge from the powerhouse ranged from 267-382 cms from May 19 to June 14. Spillway discharge was 1202 cms on May 26 and remained between 1115-1317 cms through mid-June. Although there was no discharge from Unit 5, discharges from units 4 and 6 remained strong creating substantial turbulence and velocities over the Unit 5 shoal. Velocities recorded near eggs mats located below Unit 5 ranged from 0.57 to 0.64 m/sec and ranged from 0.57 to 0.88 m/sec below Unit 4. Velocities directly in front of units 4 and 6 ranged from 0.58-1.1 m/sec.

4.2 2011 Spawning Period and Locations

The Pointe du Bois Spillway Replacement Project egg mat monitoring program results (Koga and MacDonell 2012) suggested that Lake Sturgeon spawning commenced just prior to 24 May in 2011. Peak egg collections occurred from 27 to 30 May and eggs continued to be detected in large numbers

until 4 June (Figure 8). A secondary spawning event was detected on 13 June when eggs were collected on several mats in the powerhouse tailrace. Egg mat data indicated that spawning occurred both below the powerhouse tailrace and spillway areas; however, the majority of eggs were collected from the powerhouse tailrace.

4.3 DIDSON Acoustic Camera Monitoring Results

Monitoring with the DIDSON acoustic camera was conducted from 24 May to 7 June. Water temperature at the onset of monitoring was 8^{o}C and increased to 11^{o}C by the end of the monitoring program (Figure 8).

Few Lake Sturgeon were observed on or near the constructed shoals at the start of the monitoring period (24 May) (Figure 9). Several Lake Sturgeon were observed staging downstream of the unit 1 and 13 shoals on 26 May. Lake Sturgeon observations on or near the shoals peaked from 29-31May, particularly below Unit 5 where the number of Lake Sturgeon present during these dates were too numerous to effectively count. Sturgeon were also abundant near Unit 13 during this period The number of Lake Sturgeon observations decreased steadily in early June; however, some individuals were observed up until the end of the monitoring period on 7 June.

Unit 1 Shoal

Monitoring at the Unit 1 shoal occurred from 24 May to 4 June and then again on 7 June (Figure 9). Overall fewer Lake Sturgeon were observed on or near the Unit 1 shoal in 2011 than in 2010 (North/South Consultants Inc. 2011). Lake Sturgeon were first observed on the shoal on 26 May and the highest number of Lake Sturgeon observed on and near the shoal occurred on May 27 (n=15) (Figure 9). As the number of Lake Sturgeon increased at the unit 5 and 13 shoals the number decreased at Unit 1 similar to what was observed in 2010. The DIDSON camera did not detect any behaviour or activity by Lake Sturgeon that would suggest that spawning occurred on the Unit 1 shoal in 2011.

Unit 5 Shoal

Due to mooring difficulties DIDSON monitoring of the Unit 5 shoal did not commence until 30 May. Monitoring continued for three consecutive days and then again on 4 and 6 June. At the onset of monitoring, Lake Sturgeon were present in relatively large numbers both on and adjacent to the Unit 5 shoal (Figure 9). Groups of sturgeon were observed moving up and down in the water column and for several seconds just above the substrate. Attempts were made to "zoom in" on the sturgeon congregations but turbulent surface water conditions prevented capturing a clearer image. Groups of Lake Sturgeon were observed for several minutes and then would move out of detection range for a short period of time before returning the shoal area. The number of Lake Sturgeon observed on the Unit 5 shoal on 4 June and 6 June was significantly lower than during the peak period. However, Lake Sturgeon remained more abundant into June at the Unit 5 shoal than at the other three shoals (Figure 9). Screen captures for some of the footage recorded at the Unit 5 shoal are presented in figures 10 and 11.

Unit 13 Shoal

Monitoring at the Unit 13 shoal occurred daily from 24 May to 3 June and then again on 6 June (Figure 9). Lake Sturgeon were first observed on the shoal on 25 May and the highest number of Lake Sturgeon observed on and near the shoal occurred on May 31 (n=15) (Figure 9). Initially, numbers of Lake Sturgeon near the Unit 13 shoal were lower than at the Unit 1 shoal. However, as water temperature increased, Lake Sturgeon numbers and activity levels increased near Unit 13. Lake Sturgeon observations on the shoal peaked from May 29 to June 3. Lake Sturgeon were frequently observed

utilizing the boulders at upstream end of the shoal (Figure 12, lower panel), entering the non-operable unit openings, and near bedrock outcrops west of the shoal. Although large congregations of actively swimming Lake Sturgeon were observed on the shoal, no distinct spawning behavior was observed. Several other fish species (non-Lake Sturgeon) also were observed orienting to this shoal (Figure 12, upper panel).

Unit 16 Shoal

Monitoring at the Unit 16 shoal occurred daily from 26 May to 1 June (Figure 9). Similar to 2010, the Unit 16 shoal had the lowest frequency of Lake Sturgeon observations of all constructed shoals. Only three Lake Sturgeon were detected on or near the shoal throughout the monitoring period. No evidence of spawning activity was observed on or near the shoal.

4.4 Egg Mat Monitoring Results

A total of 87 egg mat sets were conducted within 10 m of the five constructed shoals at Pointe du Bois during the 2011 Lake Sturgeon spawning period: 19 near the Unit 1 shoal; 22 near the Unit 5 shoal; 37 near the Unit 13 shoal; and nine near the Unit 16 shoal (Table 1).

Large numbers of Lake Sturgeon eggs (n=1863) were found immediately on and/or downstream of the Unit 5 shoal indicating that spawning occurred in this area in 2011 (Figure 13). No eggs were found on mats set in close proximity to the shoal near Unit 13 and only one egg was found near Unit 16 shoal suggesting that spawning (n=112) did not occur in proximity to these shoals in 2011. Eggs found downstream of the Unit 1 shoal may be indicative of spawning that occurred further upstream, but may have originated in the vicinity of units 2-6.

4.5 Egg Deposition – Prior to and Following Shoal Construction

Egg deposition on egg mats located within 10 m of shoal locations for years prior to (2008) and following shoal construction (2009-2011) are provided in figures 13 to 16. Spawning occurred adjacent to the Unit 5 shoal in front of Unit 4 in all four years of study, both in years when the unit was on (2009 and 2011) and in years when the unit was off (2008, 2010). In years when Unit 4 was on, there was one year when an adjacent unit was off (i.e., Unit 5 in 2011) and one year when both adjacent units were on (i.e., 2009). These data suggest that spawning Lake Sturgeon below the Pointe du Bois Powerhouse were not keying in on specific micro-hydraulic features as these would have differed in front of Unit 4 in all four years of study. Alternatively, substrates in the vicinity of Unit 4 are more diverse (higher density of boulders) than elsewhere across the face of the powerhouse and it may be that this substrate in combination with the high flows associated with Unit 1 makes this area desirable for spawning sturgeon. Although egg deposition data from 2010 suggested that the Unit 5 shoal did not attract additional spawning activity, the data from 2011 suggest that sturgeon shifted some spawning activity in a more westerly direction in front of Unit 5, which had not been observed in previous years.

Spawning has not occurred in the area of the Unit 13 shoal in any of the four years of study from 2008-2011. However, there has been little in the way of attraction flow near the Unit 13 shoal since it was constructed. Unit 13 was not in operation in 2010 or 2011 and in 2011 all units west of Unit 10, with the exception of Unit 12, were off. The shoal did attract a number of sturgeon staging prior to spawning in 2011 (see Section 3.3), but all spawning occurred to the east of Unit 12 where flows were concentrated.

Egg mats have yielded few Lake Sturgeon eggs immediately downstream of Unit 1 or on the Unit 1 shoal over the four years of study. This may be partially attributable to the high water velocities affecting sampling efficiencies in this area. However, the data that have been collected suggest that

sturgeon are selecting turbulent areas adjacent to the high water velocities emanating from Unit 1 rather than the jet of high velocity water passing directly over the Unit 1 shoal (water velocity of ~1.3 m/sec).

No spawning activity has been observed or detected in the vicinity of the Unit 16 shoal over the four years of study. It is surmised that spawning Lake Sturgeon are attracted to the origin of flow at the Powerhouse and, therefore, not attracted to the Unit 16 shoal which is located more than 50 m downstream.

5.0 SUMMARY

In 2011, Lake Sturgeon spawning occurred in both the powerhouse tailrace and spillway areas, with the highest concentration of egg deposition occurring between units 2 and 6 below the powerhouse (Figure 17). Additional egg deposition was observed between units 11 and 12 and to a lesser extent between units 7 and 10 (Figure 18). Large numbers of sturgeon observed on and adjacent to the Unit 5 shoal during the peak spawning period and large numbers of Lake Sturgeon eggs located near the shoal during this period suggest that sturgeon spawned on the Unit 5 shoal in 2011. The absence of observed spawning behavior and the small number of eggs collected in association with the Unit 1 shoal suggest that spawning did not occur on this shoal in 2011. Although the DIDSON camera showed sturgeon to be congregating near the Unit 13 shoal, egg mat results suggest that spawning did not occur in this location in 2011. It is likely that water velocities on the Unit 13 shoal (downstream of a unit that was not operating) were suboptimal compared to velocities further east along the powerhouse. The data suggest that sturgeon may have been congregating in areas of lower velocity east of Unit 1 and downstream of inoperable units (e.g., Unit 13) during the pre-spawning period. During the spawning period activity increased in proximity to the spawning locations (between Units 2-6, and units 11 and 12) where Lake Sturgeon may have been attracted to the flows exiting turbines (1-4, 6-9 and 12). Egg deposition in front of Unit 4 and adjacent to the Unit 5 shoal during different hydraulic conditions in each of the four years of study suggest that spawning Lake Sturgeon may be selecting more for macro-habitat features (e.g., adjacent to maximum flow, turbulence) rather than specific micro-habitat features (e.g., water velocity).

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Table 1. Summary of the number of egg mats and eggs located on or within 10 meters of the constructed shoals located downstream of the Pointe du Bois GS, spring 2011.

Constructed Shoal Area	Number of Egg Mats Present	Number of Eggs Collected Within Area
on Unit 1 SS	0	0
on Unit 5 SS	0	0
on Unit 13 SS	5	0
on Unit 16 SS	0	0
within 5 m of Unit 1 SS	3	0
within 5 m of Unit 5 SS	7	600
within 5 m of Unit 13 SS	11	0
within 5 m of Unit 16 SS	3	0
within 10 m of Unit 1 SS	16	112
within 10 m of Unit 5 SS	15	1263
within 10 m of Unit 13 SS	21	0
within 10 m of Unit 16 SS	6	1
Grand Total	**58**	**1376**

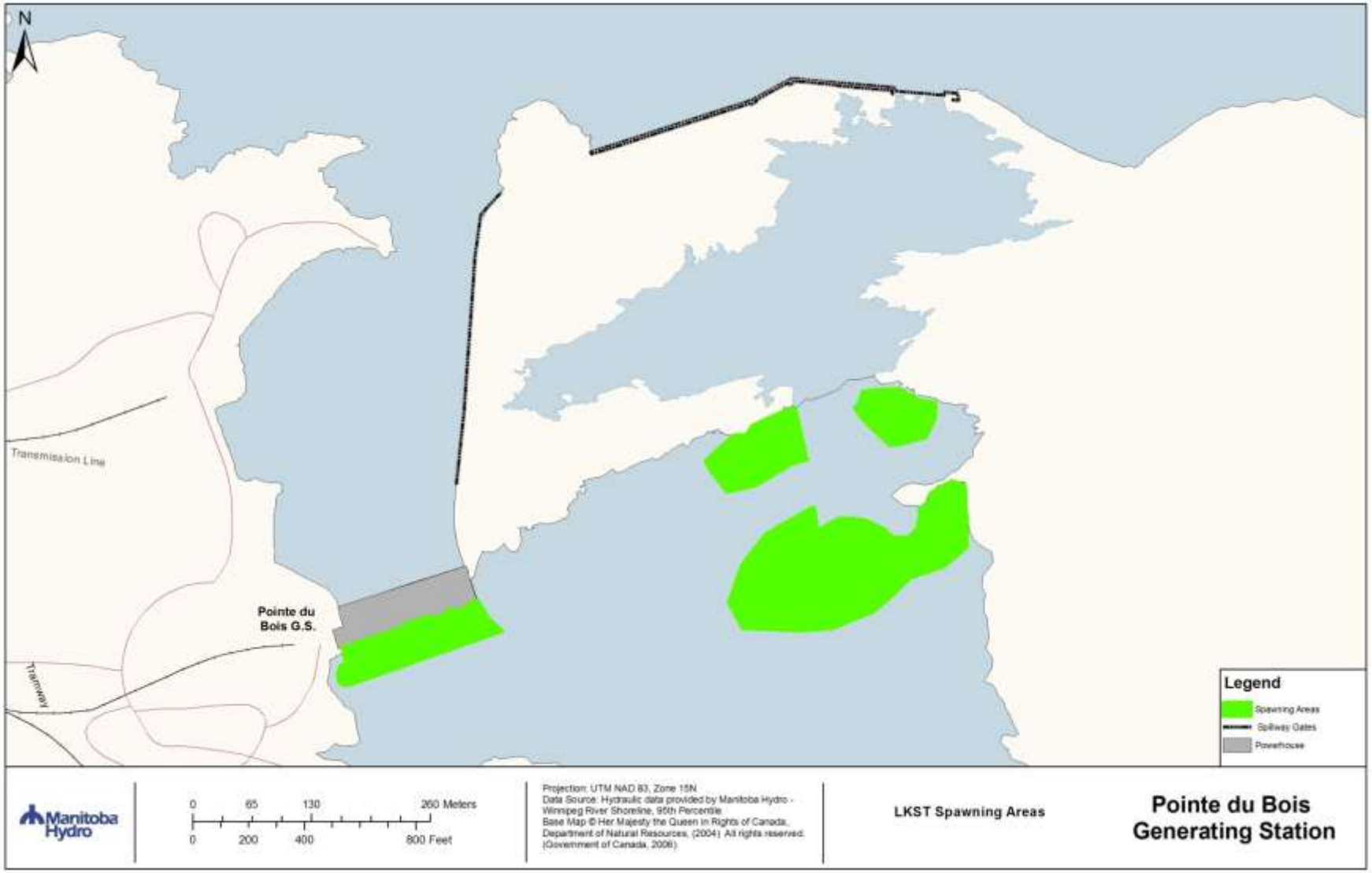

Figure 1. Lake Sturgeon spawning areas identified below the Pointe du Bois generating station and spillway.

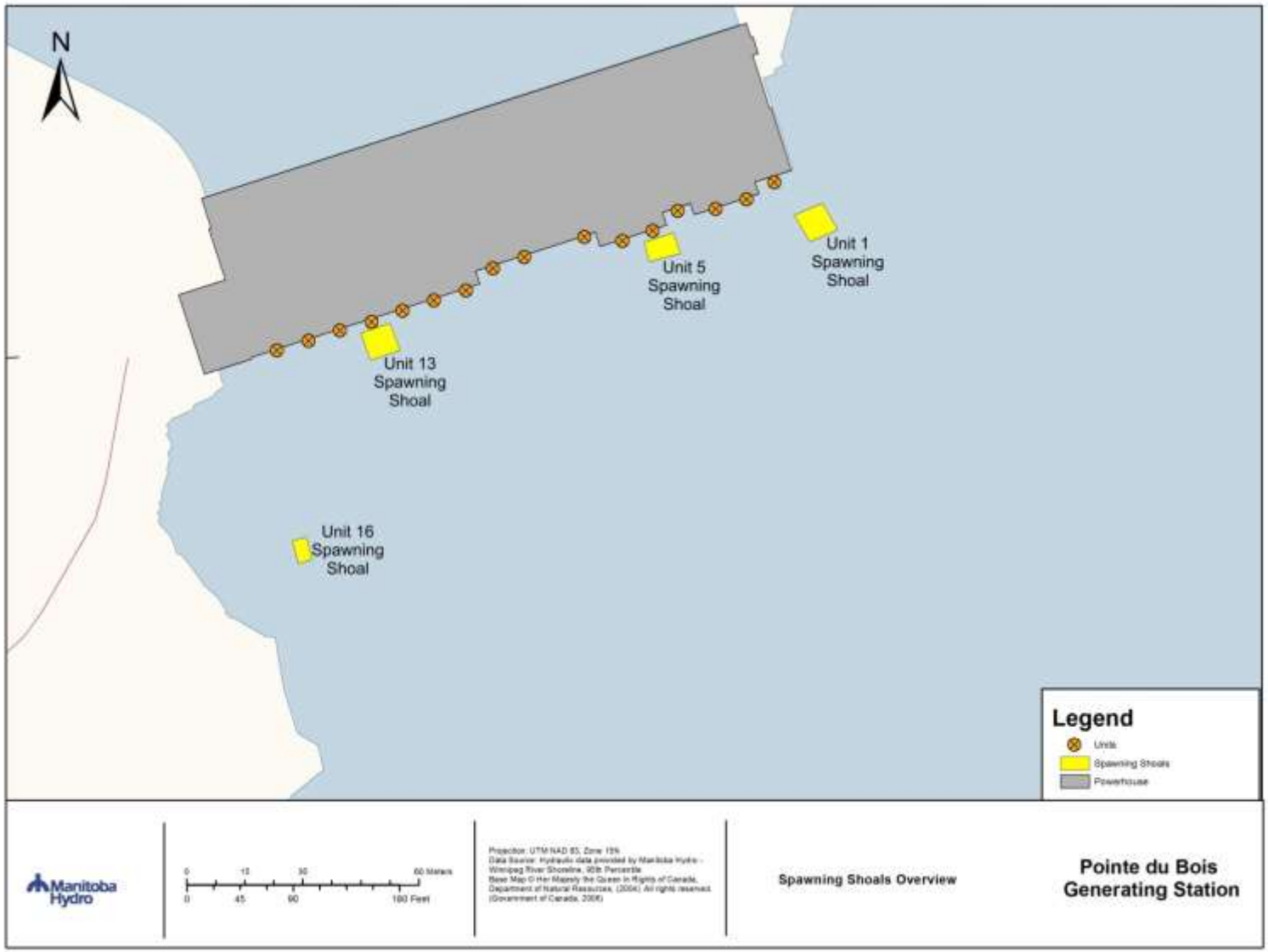

Figure 2. Location of shoals constructed in 2009 (Unit 16) and 2010 (units 1, 5, and 13) downstream of the Pointe du Bois GS.

Figure 3. DIDSON acoustic camera and pole mount used to monitor the constructed shoals.

Figure 4. Location of the Unit 13 shoal DIDSON monitoring station.

Figure 5. Location of the Unit 5 shoal DIDSON monitoring station.

Figure 6. Location of the Unit 1 shoal DIDSON monitoring station.

Figure 7. Egg collection mat used to monitor spawning on and near the constructed shoals.

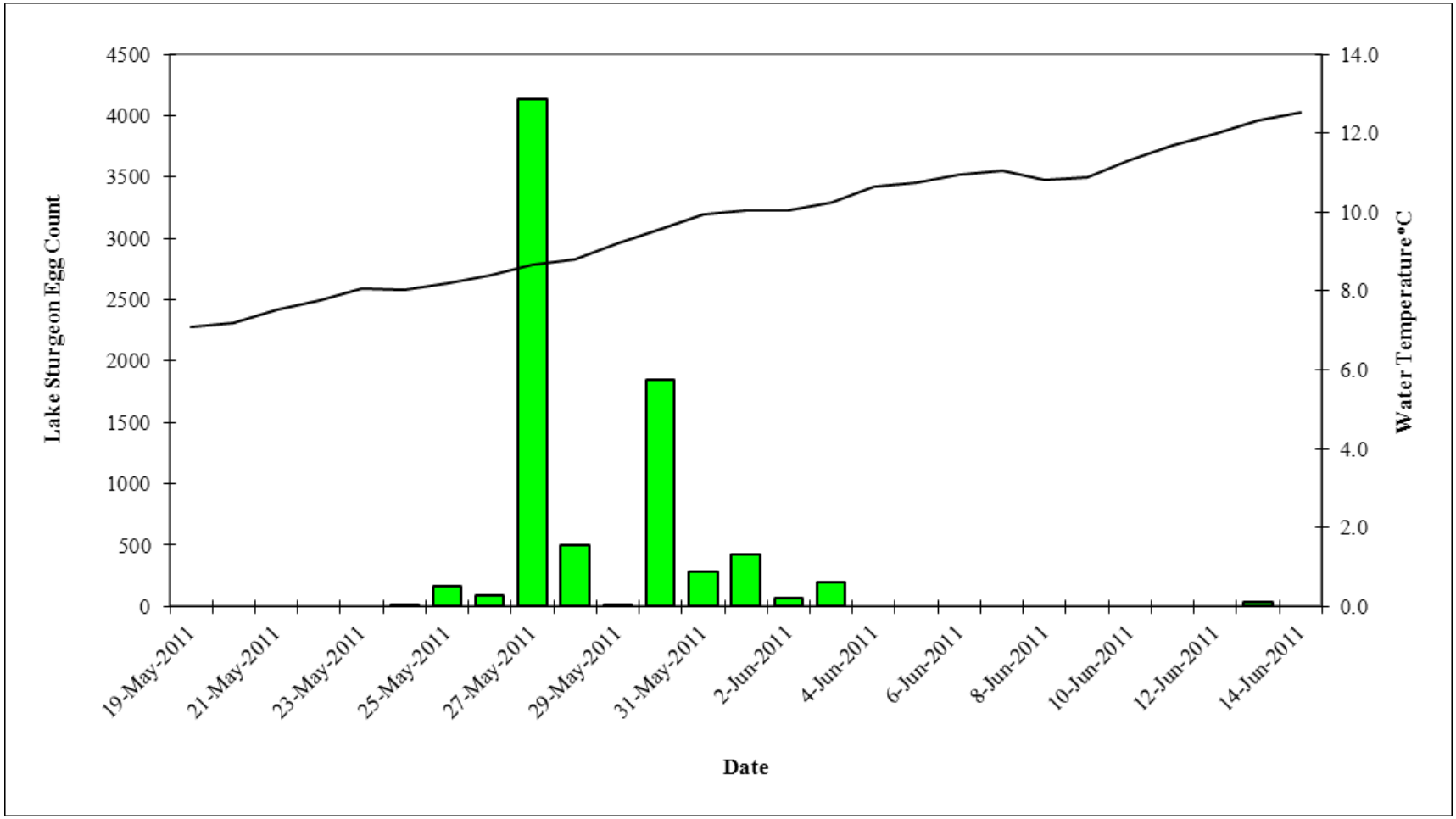

Figure 8. Summary of Lake Sturgeon egg collection mat results from below Pointe du Bois for spring 2011 with daily water temperature indicated.

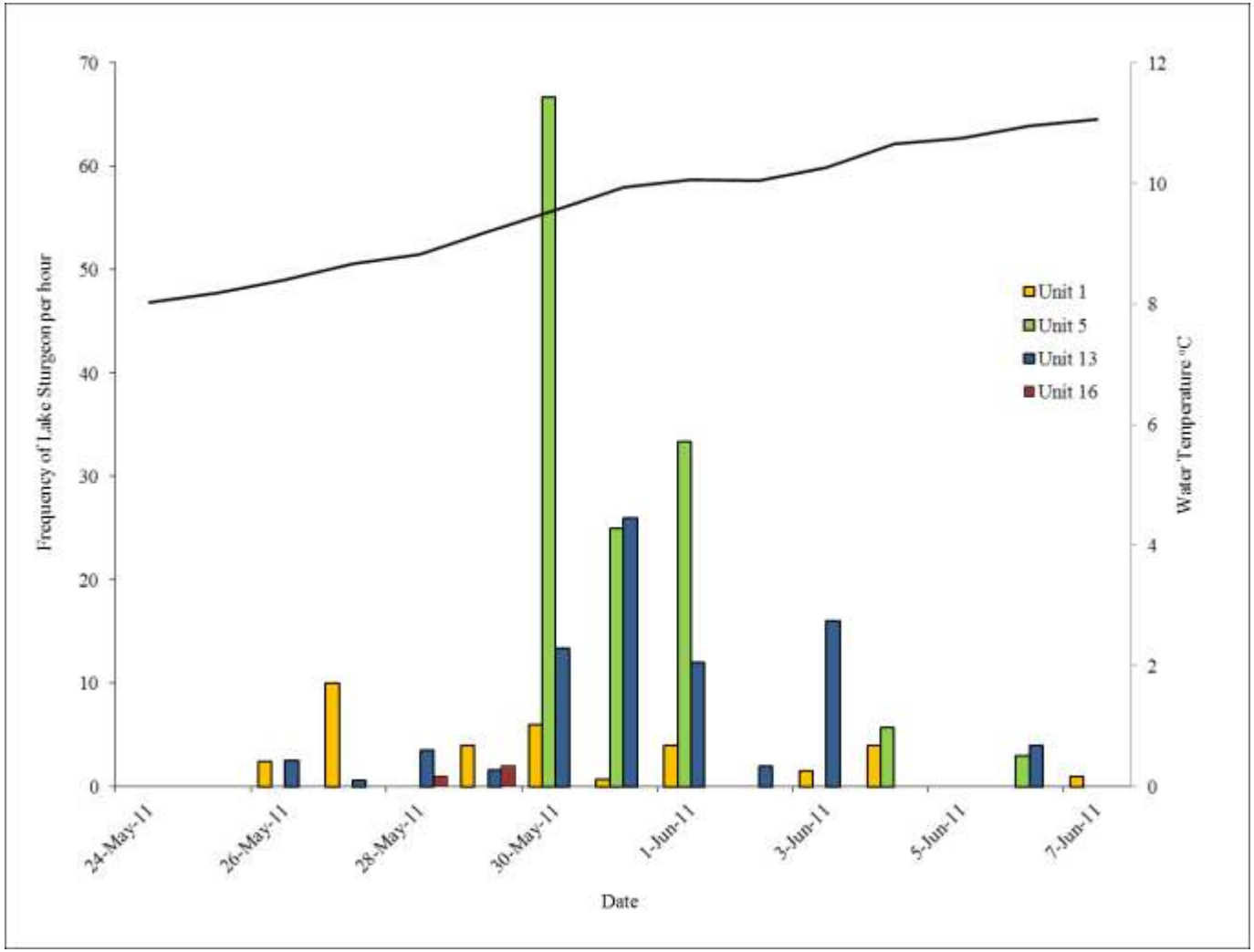

Figure 9. Frequency of Lake Sturgeon observed within the monitoring areas for each constructed shoals. Water temperature during the monitoring period is indicated on the secondary vertical axis. Note: Monitoring of the Unit 5 shoal was conducted from May 30 to June 1, June 4 and June 6.

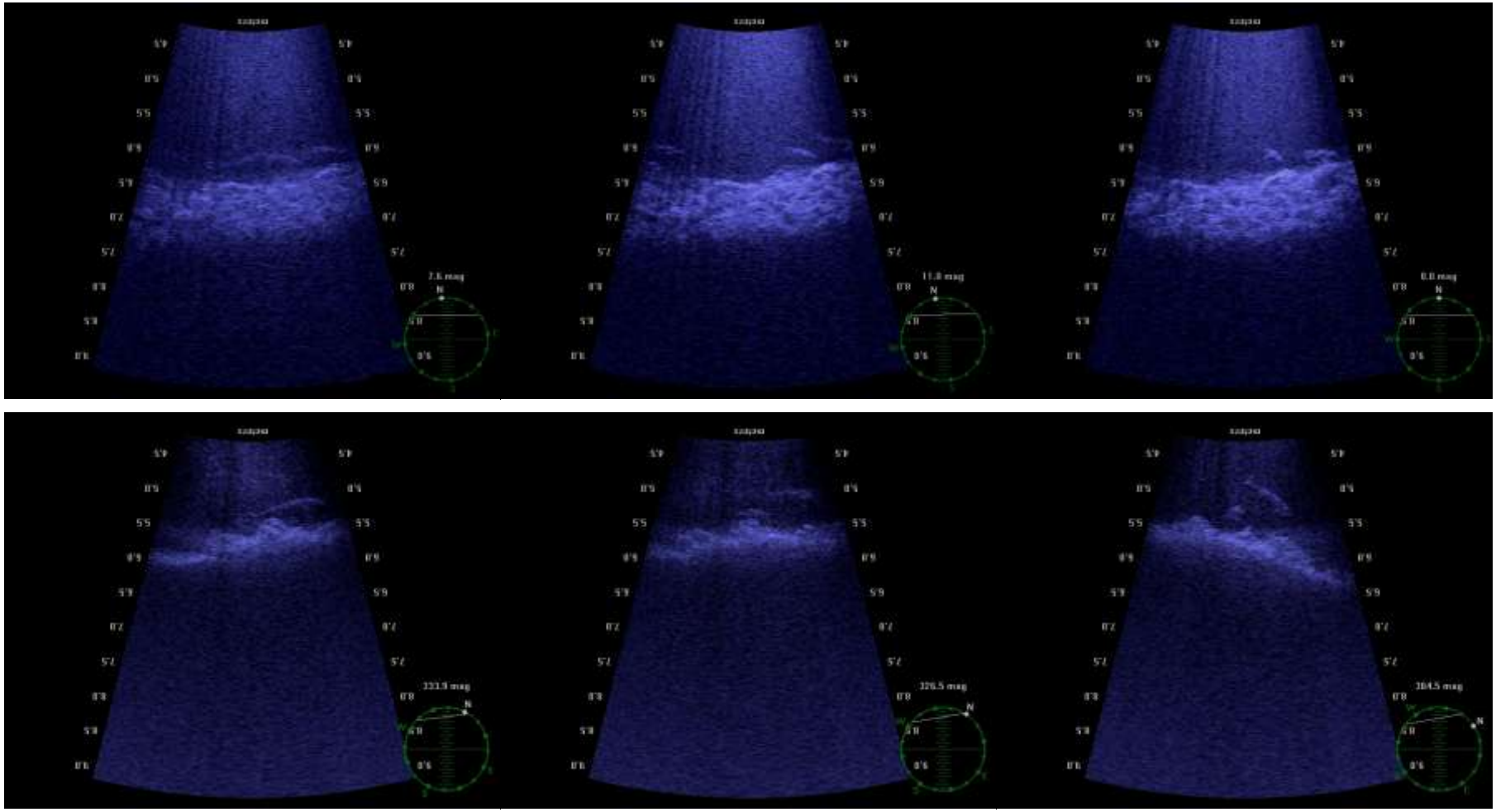

Figure 10. Screen captures from DIDSON camera footage for the Unit 5 shoal. Both upper and lower panel show multiple large Lake Sturgeon swimming onto shoal substrate in close proximity to each other during peak spawning period (30 May).

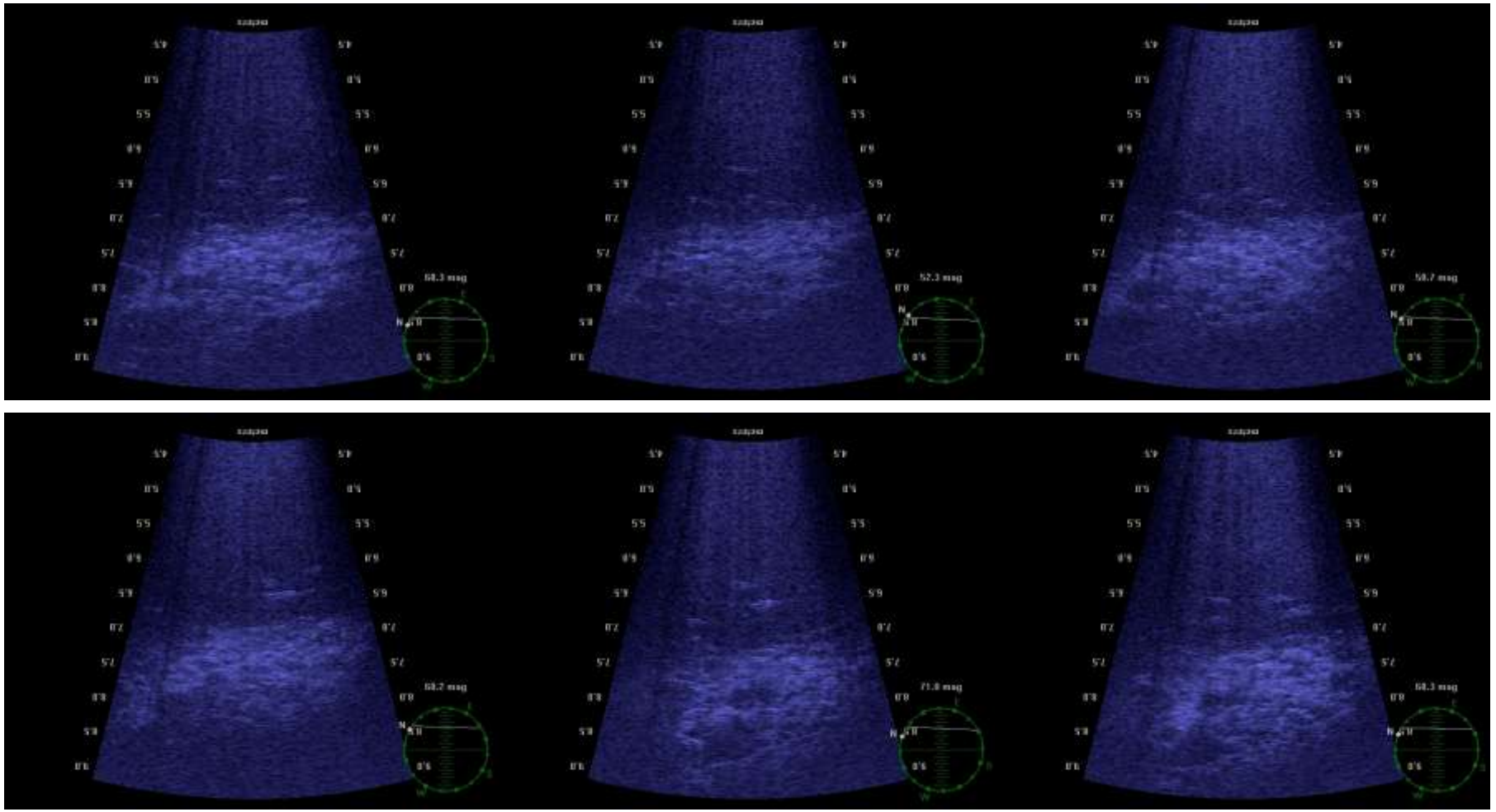

Figure 11. Screen captures from DIDSON camera footage for the Unit 5 shoal. Upper and lower panel are sequential scenes from multiple large Lake Sturgeon moving together on the shoal during peak spawning period (31 May).

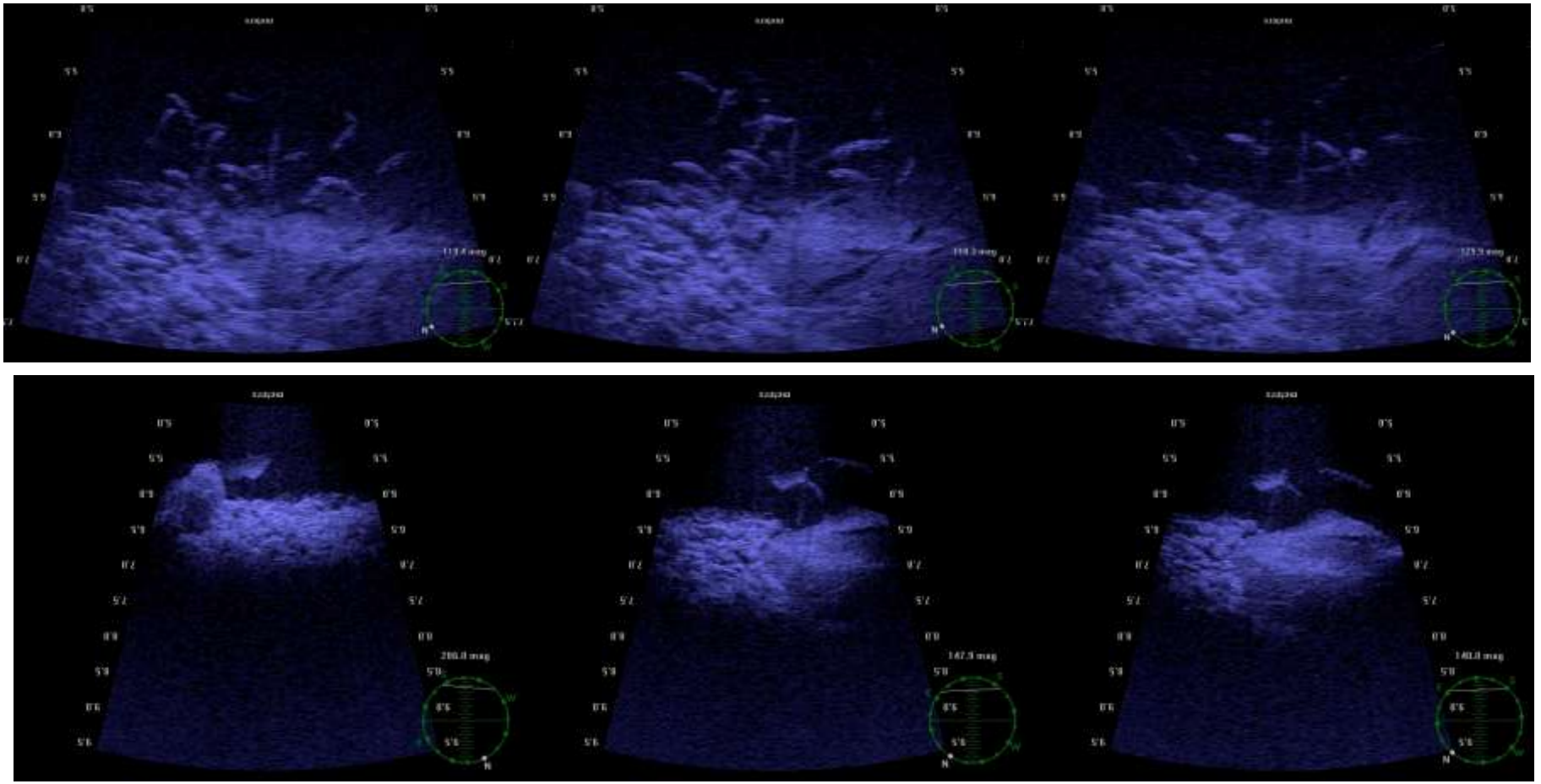

Figure 12. Screen captures from DIDSON camera footage for the Unit 13 shoal. Upper panel shows a large number of non-Lake Sturgeon moving together adjacent to the shoal around a king anchor on 29 May. Lower panel shows large boulders at front of shoal and a large Lake Sturgeon swimming over them on 31 May.

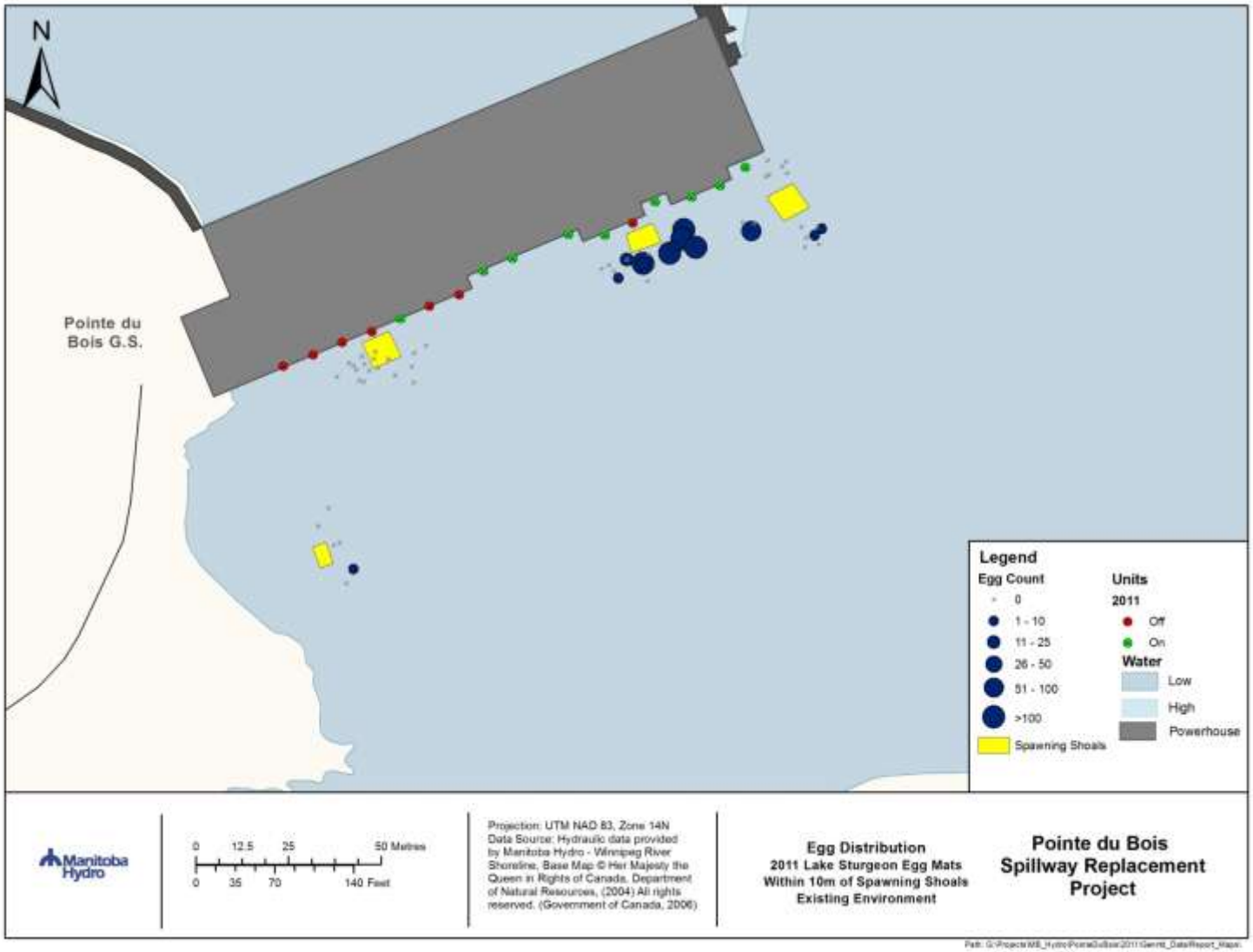

Figure 13. Lake Sturgeon egg mats in 2011 located within 10 metres of the constructed shoals indicating presence, absence, and abundance of eggs along with unit operation status (on/off) during peak spawning.

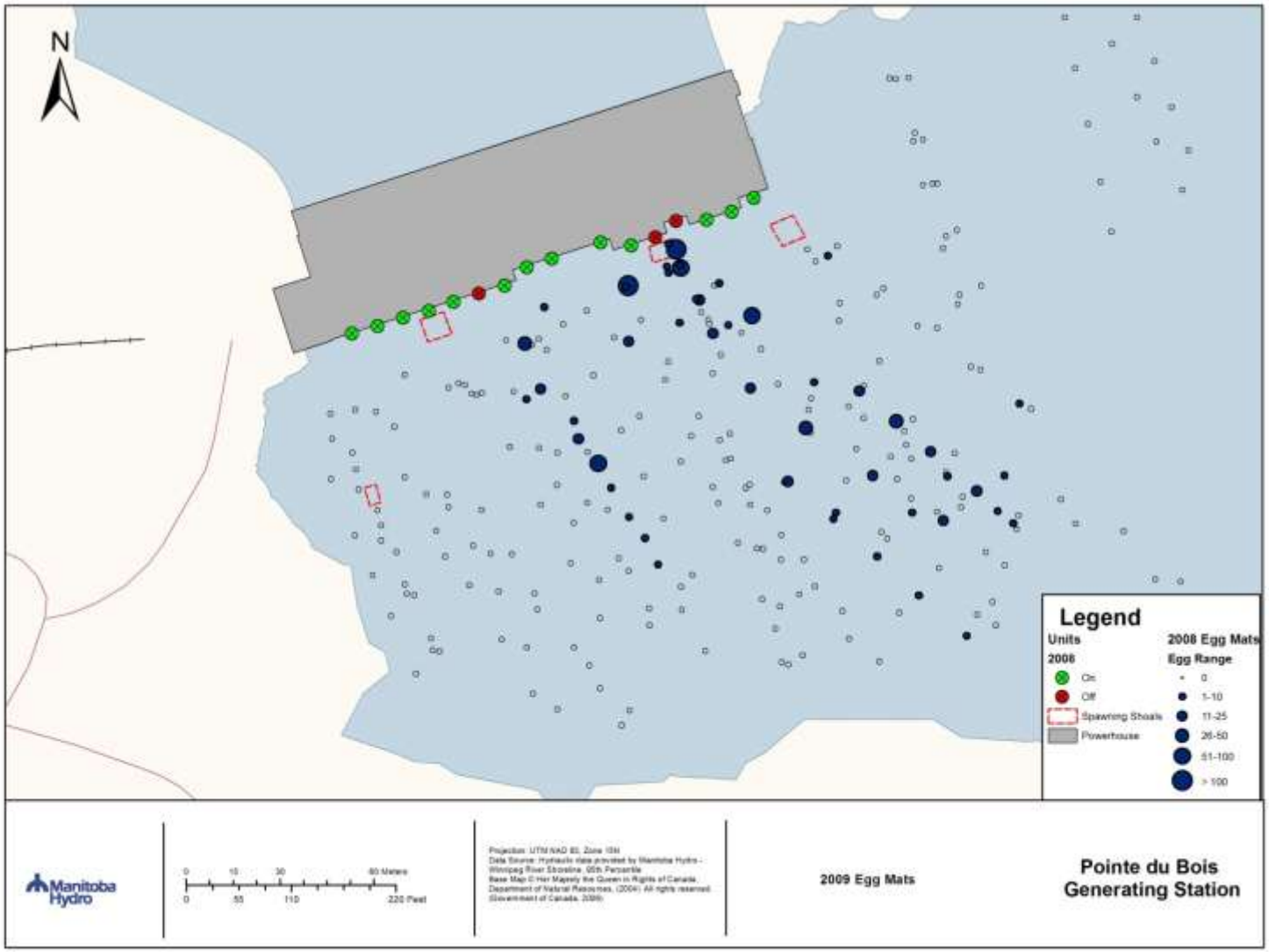

Figure 14. Lake Sturgeon egg mats from 2008 (prior to shoal construction) showing presence, absence, and abundance of eggs along with unit operation status (on/off) during peak spawning.

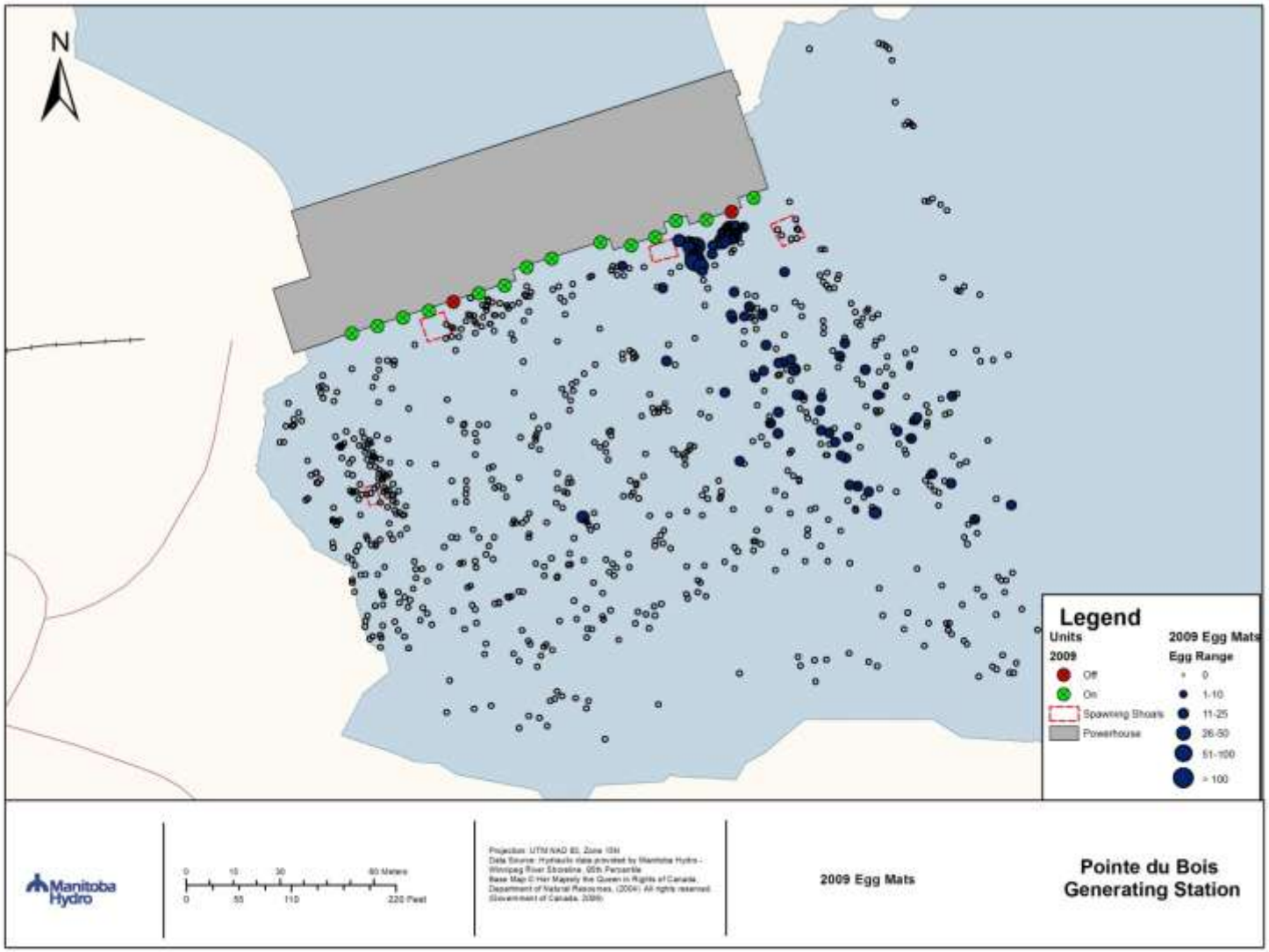

Figure 15. Lake Sturgeon egg mats from 2009 showing presence, absence, and abundance of eggs along with unit operation status (on/off) during peak spawning. Note: Unit 16 shoal constructed in 2009.

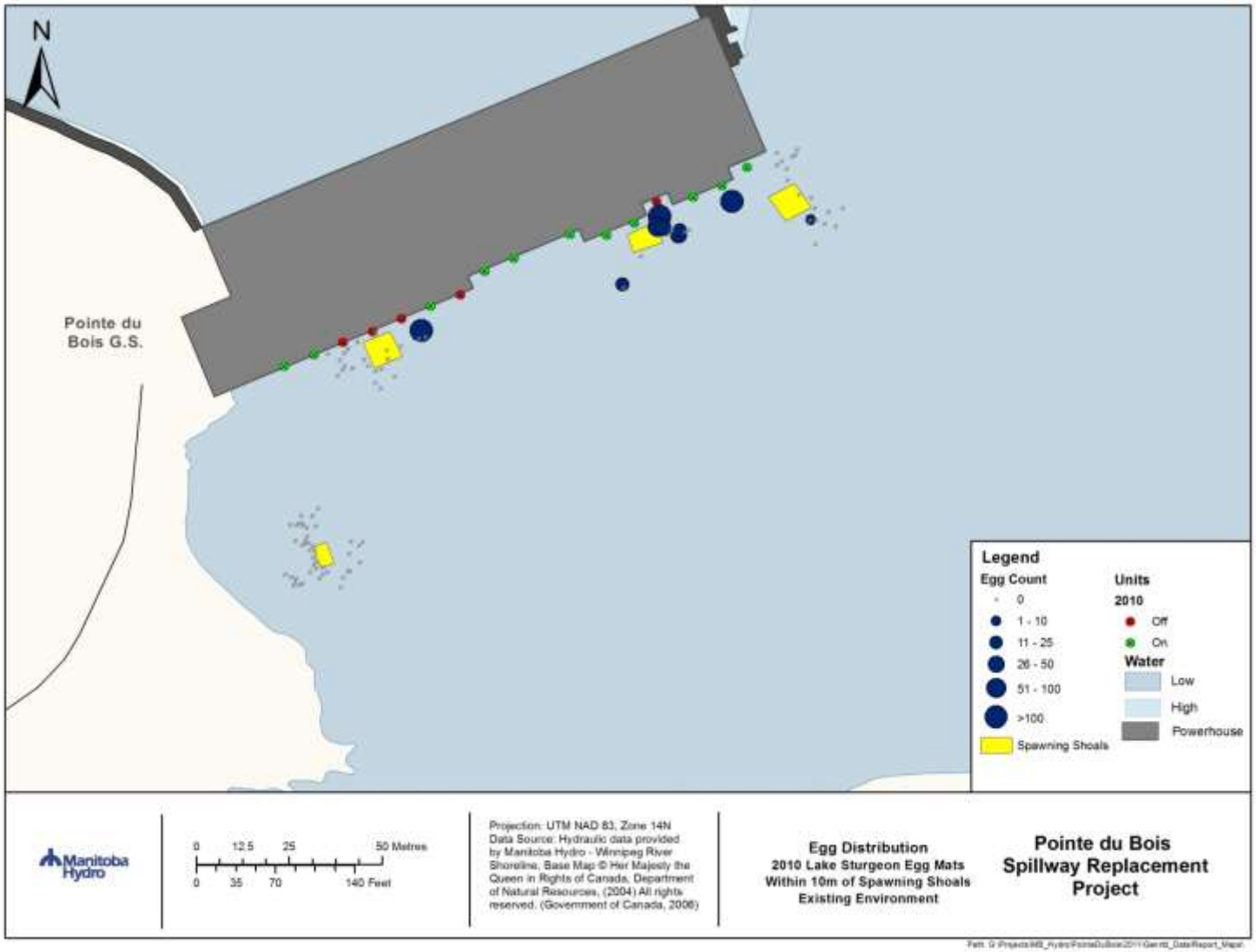

Figure 16. Lake Sturgeon egg mats located within 10 metres of the constructed shoal sites in 2010 showing presence, absence, and abundance of eggs along with unit operation status (on/off) during peak spawning.

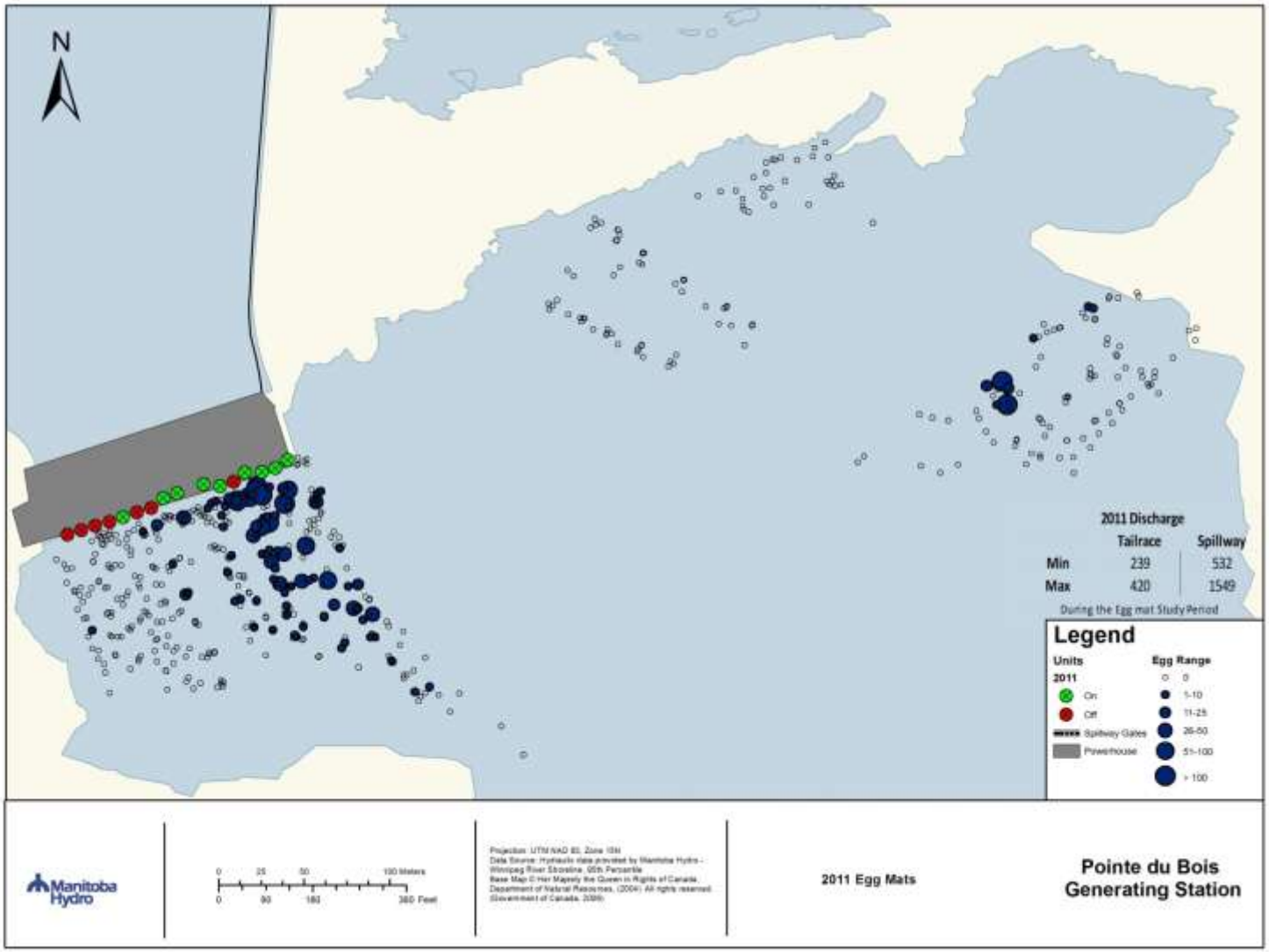

Figure 17. Lake Sturgeon egg mat locations from 2011 indicating presence, absence, and abundance of eggs along with unit operation status (on/off) during peak spawning.

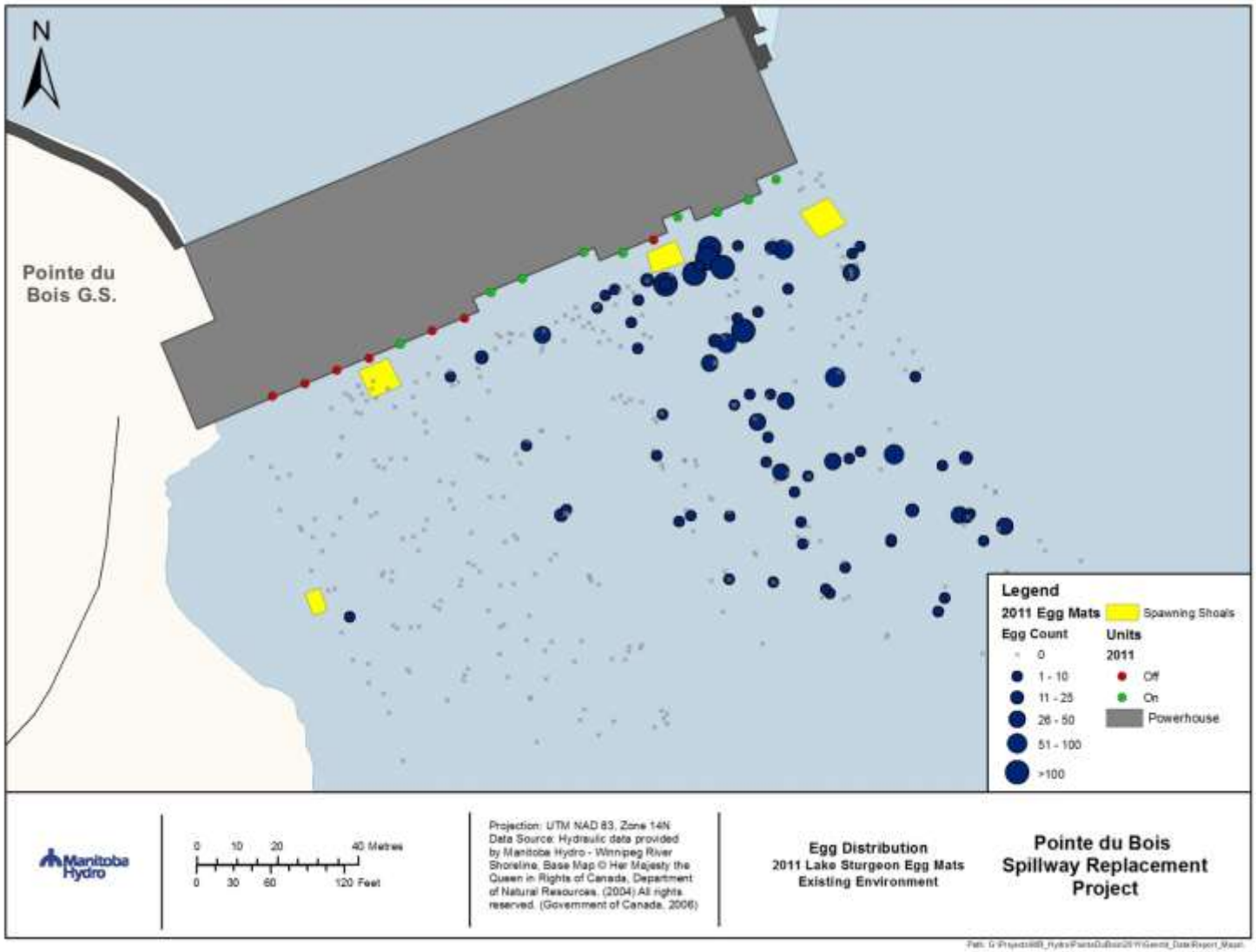

Figure 18. Location of Lake Sturgeon egg mats and constructed spawning shoals within the Pointe du Bois powerhouse tailrace area for 2011.