

11-PA-11090700-044

Assessment and Management of Eurasian Watermilfoil on Crooked Lake and Duck Lake

Review of Project Description

Duck Lake

Duck Lake is a prized economic and ecological resource to the local area. Since 2006, this highly valued fishery has been stocked by the Michigan Department of Natural Resources with over 15,000 walleye fry (<http://www.michigandnr.com/fishstock/>). Based on a detailed aquatic plant assessment by the Army Corp of Engineers ERDC (will be referred to as ERDC), Duck Lake has a large diversity of aquatic plants and the highest floristic quality rating of the selected lakes surveyed within the Watersmeet Township (Skogerboe, 2003). Meaning the vegetation of Duck Lake is characteristic of a pristine and undisturbed water body. Lakeguard (also referred to as the ISCCW) education data shows that Duck Lake attracts many boaters and anglers that use multiple bodies of water, increasing the risk of spreading EWM to surrounding lakes, many of which are located within the Ottawa National Forest. A pioneering population of EWM was discovered in a southwest bay of Duck Lake in 2005. Since its discovery, EWM has spread to numerous locations throughout Duck Lake, extending from the south near the Duck Creek outlet to the far northern edge. In 2010 approximated 60 distinct locations of EWM were documented in multiple locations around the entire perimeter of the lake. The presence of EWM continues to threatens the economic and ecological integrity of this highly valued water body. In addition, Duck Lake poses a potential source population to the spread of EWM to surrounding lakes.



Educational signage at Duck Lake boat launch

Crooked Lake



Two elderly gentlemen showing off their solar panel adapted fishing rig

Eurasian watermilfoil continues to pose a significant risk to the ecological health of this pristine wilderness lake. In 2002, five individual plants of EWM were found near the Crooked Lake access site (Skogerboe, 2003). Since then, small colonies and individual plants have been located and removed primarily by hand pulling from various locations around the entire perimeter of the first bay. Recent

monitoring efforts by the ISCCW and the USFS Ottawa National Forest have found numerous new location of EWM in higher densities. Currently these monitoring efforts are limited to only the first bay where the access site is located. Since 2007, it is not known if a full lake survey looking for EWM has been conducted. The spread of EWM from the first bay of Crooked Lake, which is on the perimeter of the Sylvania Wilderness Area, into areas of Crooked Lake that are within the Sylvania Wilderness Area, can pose significant management challenges. Finding any existing small pioneering populations of EWM and removing these populations will minimize the spread of EWM and reduce future management costs.

Review of Project Goals and Objectives

- (1) Identify, map and control Eurasian watermilfoil (EWM); thereby improving fish habitat, restore water quality and augment the reestablishment of native aquatic species.
- (2) Improve and maintain recreational opportunities on Duck and Crooked Lake.
- (3) Provide educational opportunities for citizens and visitors to learn about the ecological and social impacts of EWM.

Identifying and mapping EWM in both systems allow for a rapid response to smaller populations that could be managed in 2011, in addition any larger areas of EWM identified that would require additional management, specifically MDEQ permits, would be and incorporated into 2012 management plans. Identifying the location of EWM in a system is key in abating the proliferation of EWM. This type of early detection, reduces long term management costs and maintains if not improves long term recreational opportunities, fish habitat and water quality.

Survey Methods

To fulfill the project goals, detailed plant surveys were conducted Duck Lake and Crooked Lake during the summer of 2011. The Duck Lake survey was completed between the 21st-26th of August and the Crooked Lake survey was completed between the 12th-16th of September. These plant surveys provide information on (1) the location and abundance of EWM in both systems, (2) location information of other invasive species (3) identification of susceptible habitat characteristics for the establishment of EWM (4) native aquatic species information and (5) basic water quality parameters.

Specifically this survey followed the state of Wisconsin's Aquatic Plant monitoring and point intercept surveying protocol (<http://www.uwsp.edu/cnr/uwexplakes/ecology/APM/PI-Protocol-2010.pdf>). Crooked Lake had a total of 839 sampling points with a resolution of 55 meters, whereas Duck Lake had a total of 588 sampling points with a resolution of 65 meters (Figures: 1 & 2). On Duck Lake a Crestliner 1860 modified "v" hull boat was used equipped a Lowerance depth finder, Garmin 78CSx handheld GPS, a surveying throw rake on a 30 foot rope and a 15 foot surveying rod. On Crooked Lake a Sylvan 1436 Jon boat was used with a Motorguide

trolling motor equipped with a Hummingbird portable depth finder, Garmin 78CSx handheld GPS as well and the two surveying rakes.

The GPS was used to navigate the boat to each sampling site, once the site was reached the depth was recorded. The depth determined whether the site was shallower or deeper than the maximum rooting depth of aquatic vegetation for that particular lake. If it was shallower than the maximum rooting depth, a rake was dropped to collect a aquatic plant sample and determine the sediment type. The aquatic plant sample was given a overall relative abundance rating and each species on the rake was identified and given an individual abundance rating. This procedure was repeated for each sampling point. In addition to systematically sampling at each point, additional efforts were made in between sampling points scanning and searching for EWM and other aquatic invasive species. On Duck Lake, emphasis was also placed on visually checking each EWM buoy placed in the water. On Crooked Lake additional visual observations were made around previous EWM locations, treatment areas and the channel from the first bay to the second bay. Because of this extended searching, efforts were made to time the surveys during calmer periods of wind and no precipitation.

Figure 1: Duck Lake sampling grid

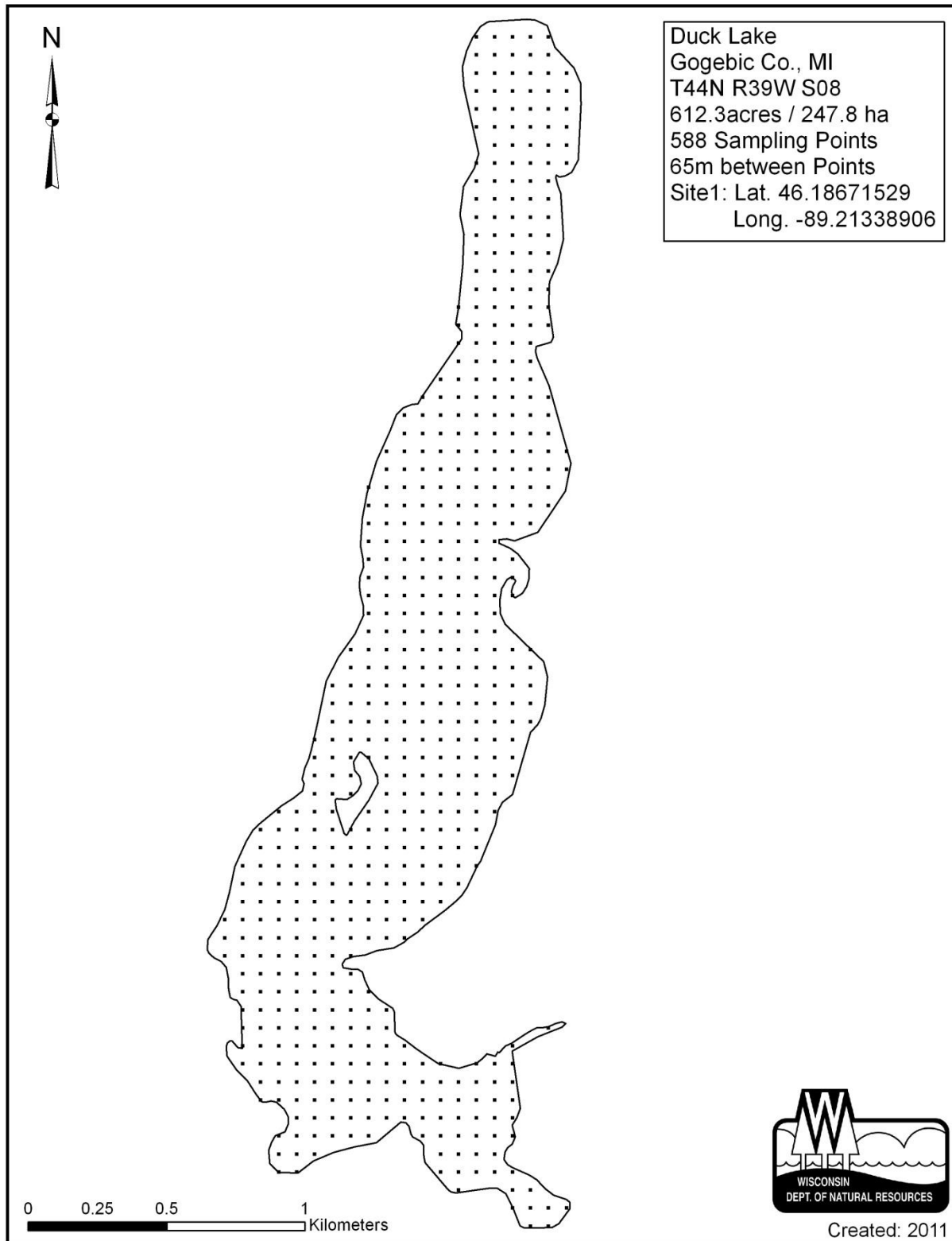
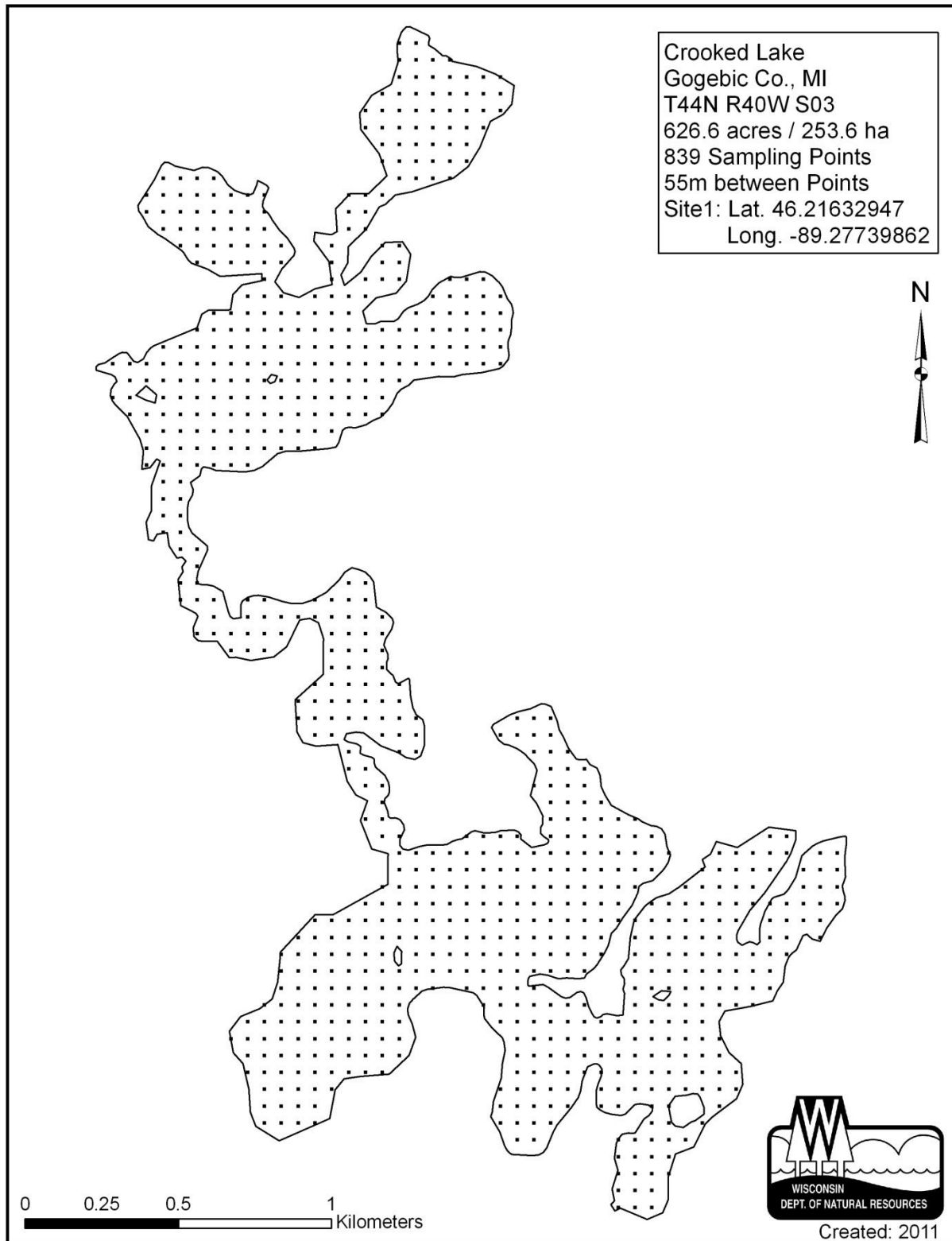


Figure 2: Crooked Lake sampling grid



Duck Lake

Duck Lake is located in eastern Gogebic County, Southwest of Watersmeet, MI (Figure: 3). Most of the property surrounding Duck Lake is privately owned, however the lots are large and much of the riparian zone is in a natural state. The surface area of Duck Lake is 612 acres (Digital Water Atlas of Michigan, Michigan Department of Natural Resources, Fisheries Division, IFR). Duck Creek flows out of Duck Lake at the south eastern end of the lake. A Michigan Department of Natural Resources owned boat ramp and parking area is located on the east side of Duck Lake.

Figure 3: Location of Duck Lake



A total of 571 points were sampled on Duck Lake. Of these sampling points, 181 points had vegetation (Table: 1). No EWM was found on the sampling rake and only one visual observation of EWM was made near sampling point 50 (Figure: 4).

Table 1: Survey Summary

Total number of sites visited	571
Total number of sites with vegetation	181
Total number of sites shallower than maximum depth of plants	353
Frequency of occurrence at sites shallower than maximum depth of plants	51.27
Simpson Diversity Index	0.88
Maximum depth of plants (ft)	18.00
Number of sites sampled using rake on Rope (R)	20
Number of sites sampled using rake on Pole (P)	300
Average number of all species per site (shallower than max depth)	0.98
Average number of all species per site (veg. sites only)	1.91
Average number of native species per site (shallower than max depth)	0.98
Average number of native species per site (veg. sites only)	1.91
Species Richness	26
Species Richness (including visuals)	33

The maximum rooting depth of vegetation during the survey was 18 feet, which is approximately 63% of the surface area of Duck Lake (Figures: 5 & 6). Of the sites sampled, 59% had a muck substrate, 15% a rock substrate and 26% a sand substrate (Figure: 7). The average depth of Duck Lake based on the survey is 14 feet with a maximum depth of 29 feet. The three most abundance plant species found in Duck Lake are *Potamogeton robbinsii*, *Vallisneria americana* and *Potamogeton amplifolius* at 26.70%, 15.34% and 14.49% respectfully (Figure: 8). Three species with a Coefficient of Conservatism of 10 were documented (Figures: 9, 10 & 11). Of these species *Potamogeton vaseyi* is considered threatened in the State of Michigan (<http://web4.msue.msu.edu/mnfi/data/specialplants.cfm>). The average Coefficient of Conservatism for Duck Lake is 7.37 with a Floristic Quality Index of 36.12.

Figure 4: EWM observed, Duck Lake 2001

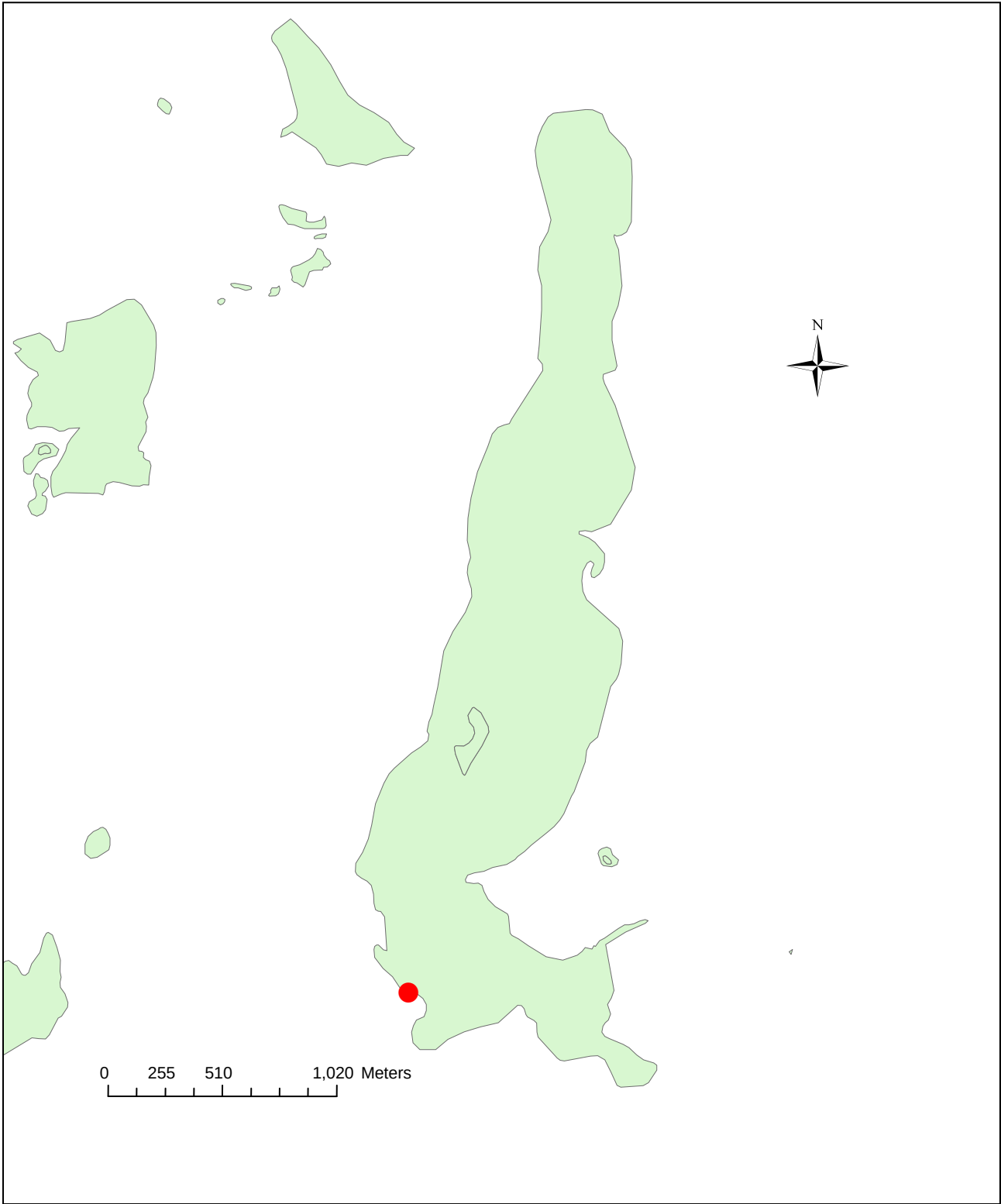


Figure 5: Maximum depth of plant colonization, Duck Lake 2011

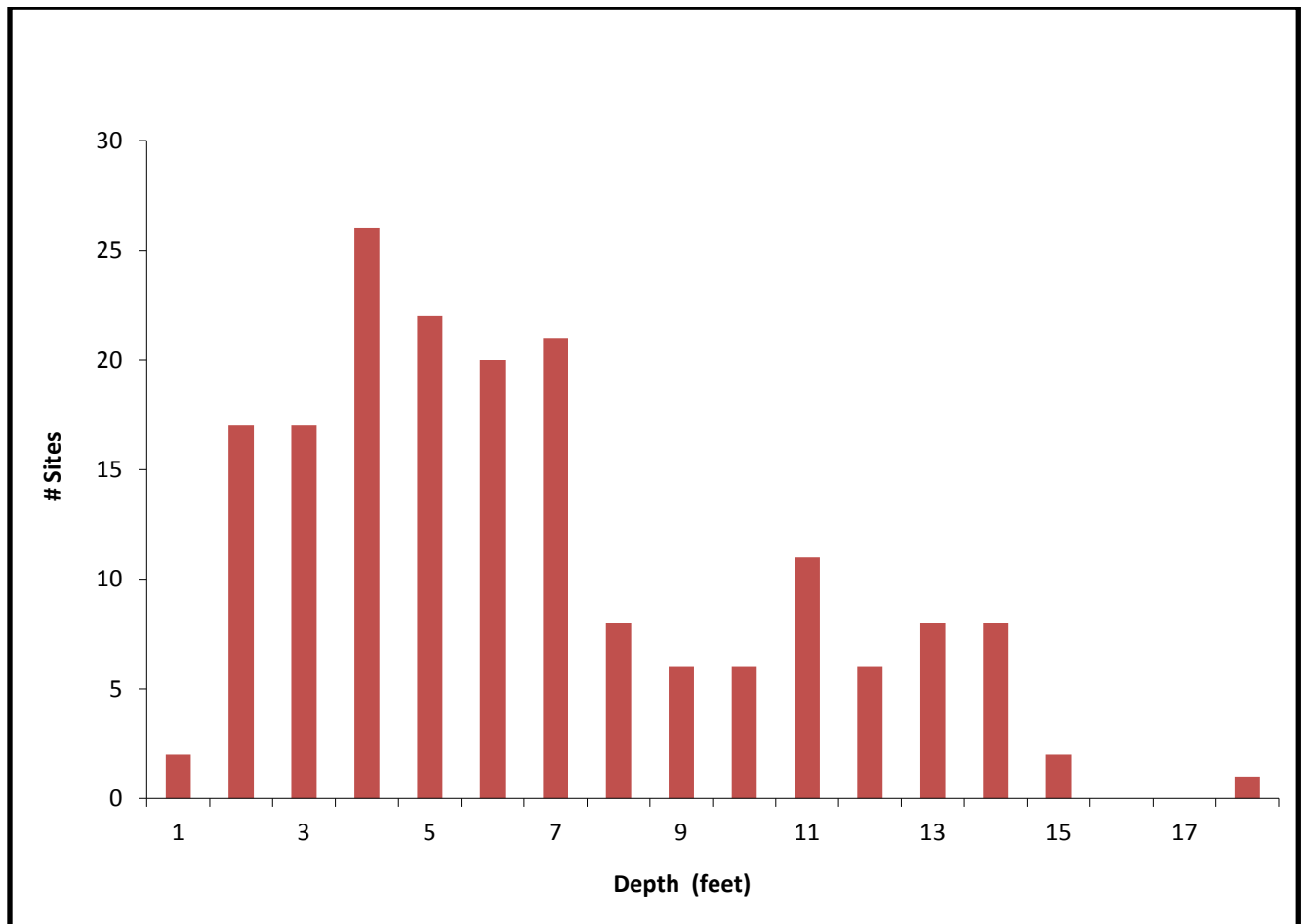


Figure 6: Maximum depth of plant colonization, Duck Lake 2011

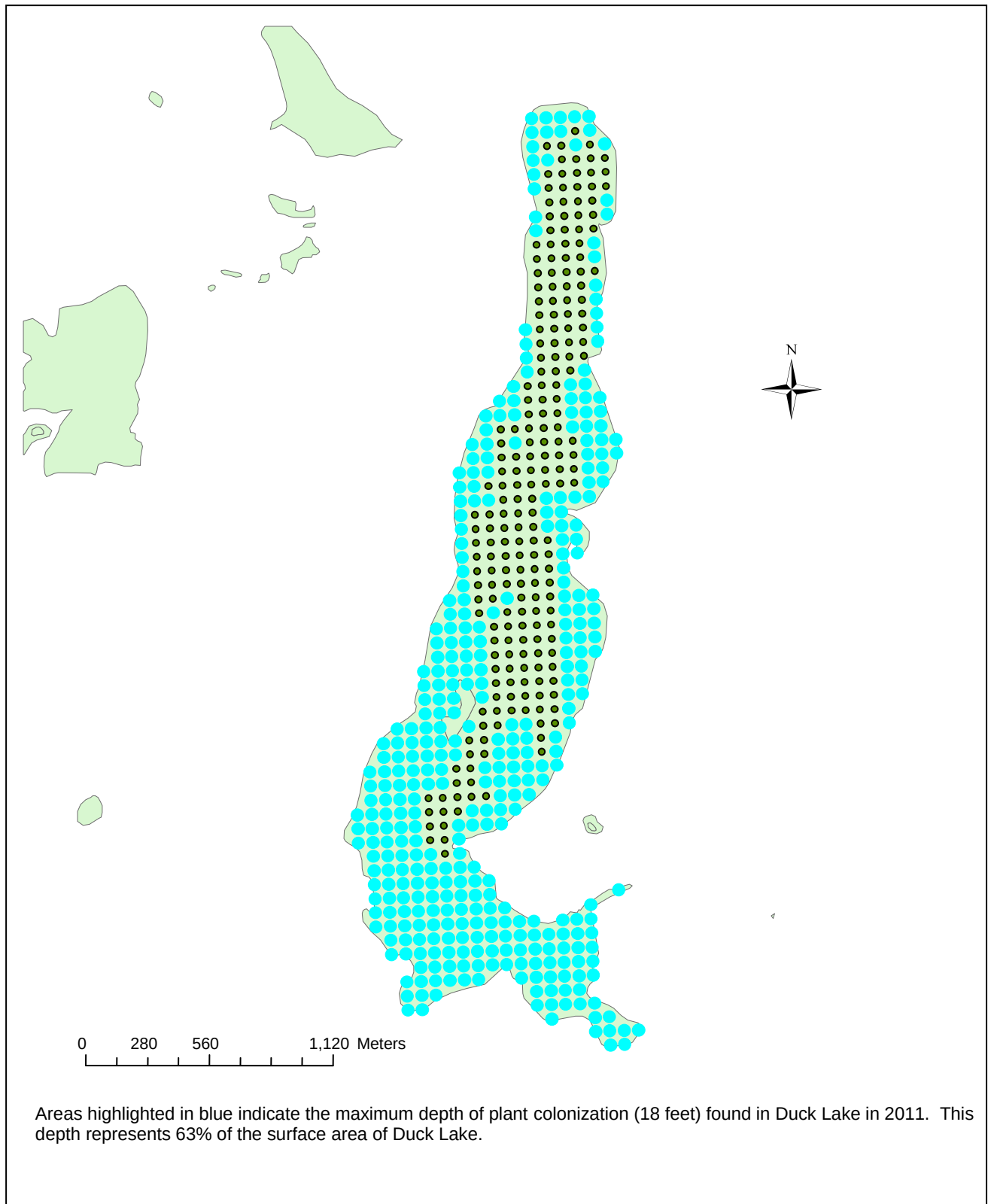


Figure 7: Sediment type, Duck Lake 2011

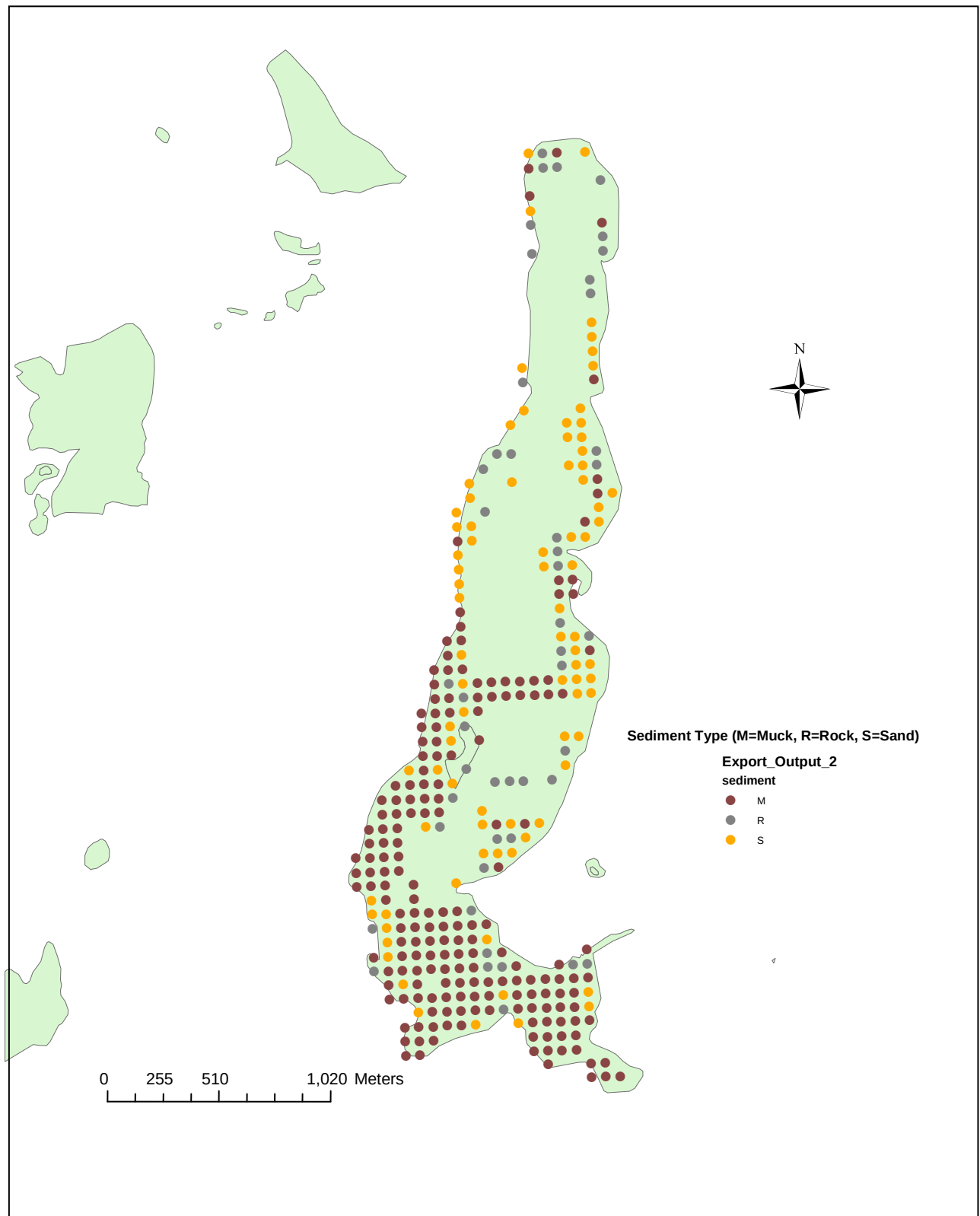
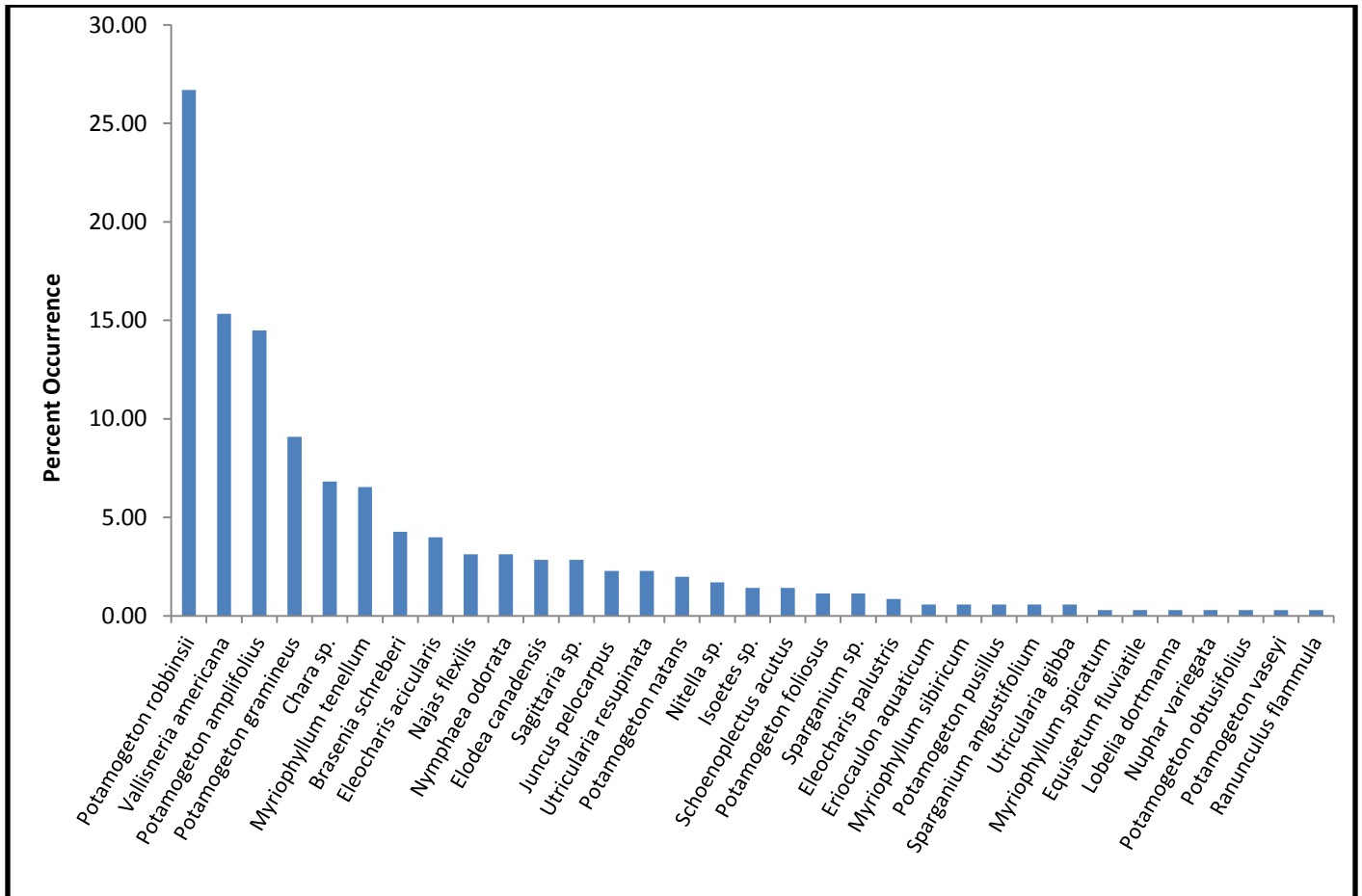


Figure 8: Frequency of occurrence of plant species found in Duck Lake, 2011



The map displays the British Isles, including Great Britain and Ireland. Sampling locations are indicated by green dots. The dots are distributed across the islands, with a higher concentration in the central and southern regions of Great Britain. A scale bar at the bottom left shows distances of 0, 255, 510, and 1,020 meters. A north arrow is positioned at the top right of the map.

Figure 10: Location of water lobelia, Duck Lake 2011

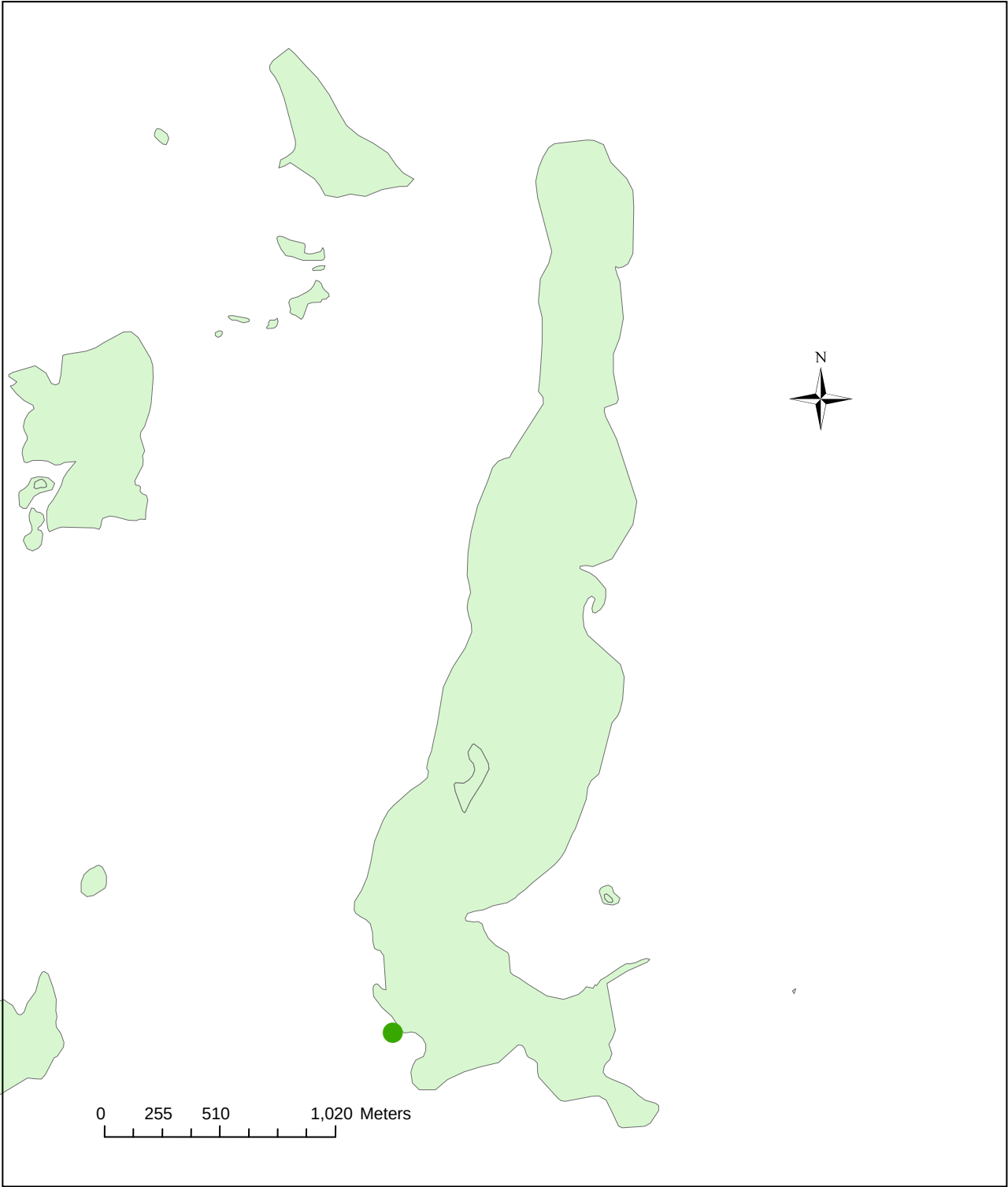
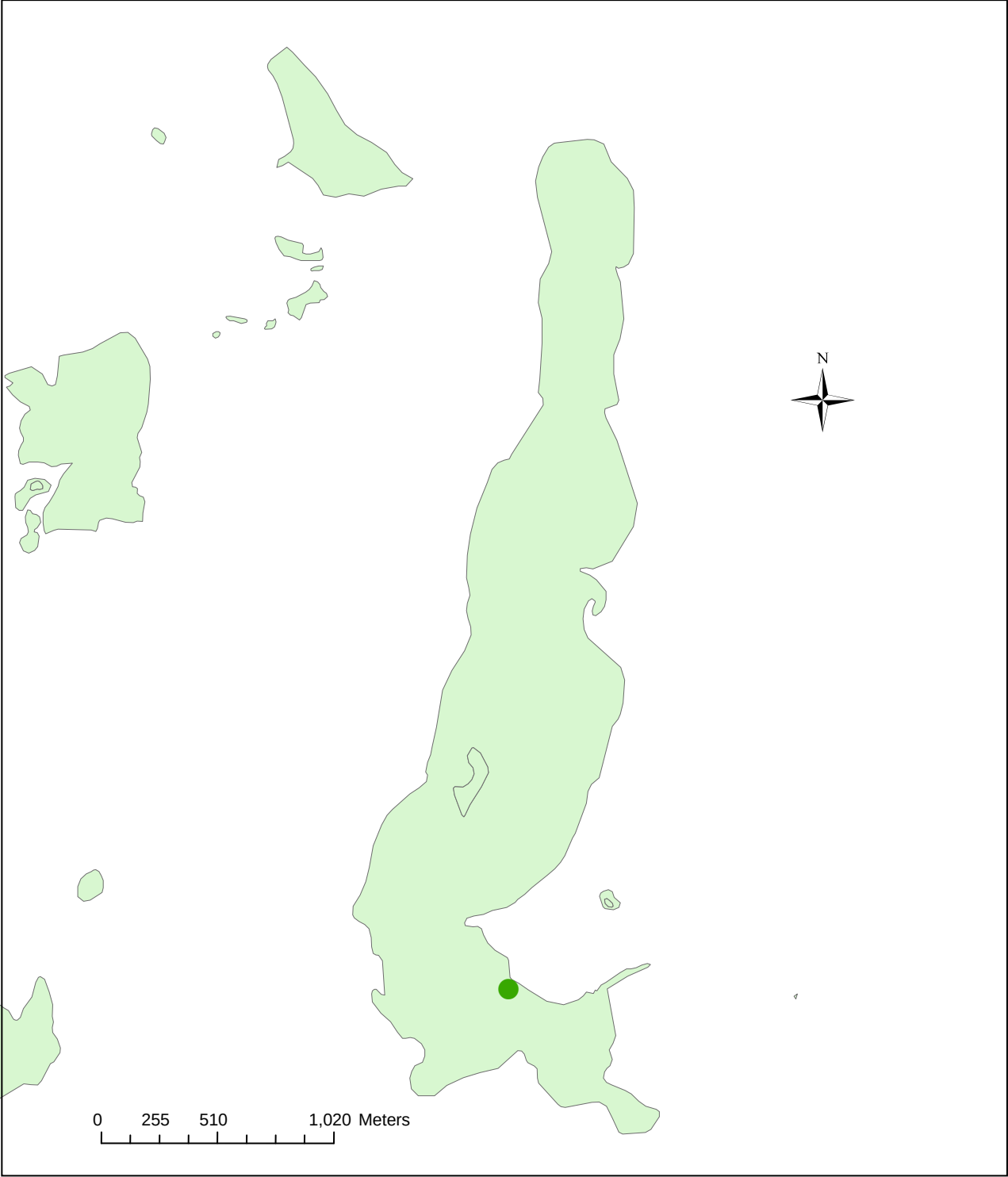


Figure 11: Location of Vasey’s pondweed, Duck Lake 2011



On September 11th 2011, a dissolved oxygen/temperature profile was created for Duck Lake (Table: 2). It was taken near sampling point 477. The average secchi reading for that day was 12 feet 3 inches.

Table 2: D.O.-Temperature profile of Duck Lake, 2011

Depth (m)	D.O.	Temp. (C)	% Sat
Surface	9.5	22.6	109.8
0.5	9.46	22.6	109.2
1	9.45	22.6	108.7
1.5	9.39	22.6	108.5
2	9.37	22.6	108.2
2.5	9.38	22.5	108.1
3	9.37	22	107.5
3.5	9.32	20.8	104.2
4	9.4	20.6	104.8
4.5	9.18	20	102.1
5	7.04	19.2	76.5
5.5	6.06	19.2	65.6
6	5.87	19.1	63.3
6.5	5.54	19.1	59.9
7	4.53	19.1	48.8
7.5	0.18	19	1.7
8	0.13	19	1.4
8.5	0.12	19	1.3

Plants of Concern

In 2002 the ERDC conducted a vegetation assessment on Duck Lake. The only potentially aggressive plant species that was recorded at that time was *Phragmites australis*. *Phragmites* was not sampled during the 2011 survey, however it was recorded near several sampling points (Figure: 12). This plant has the potential to become an aggressive shoreline colonizer, displacing native vegetation by creating monotypic stands. In addition to *Phragmites*, reed canary grass was also observed during the survey (Figure: 13). This plant was not recorded during the 2002 ERDC survey. As with *Phragmites*, reed canary grass can potentially displace native vegetation.



Phragmites in Duck Lake



Phragmites near the boat launch, Duck Lake

Figure 12: Location of *Phragmites*, Duck Lake 2011

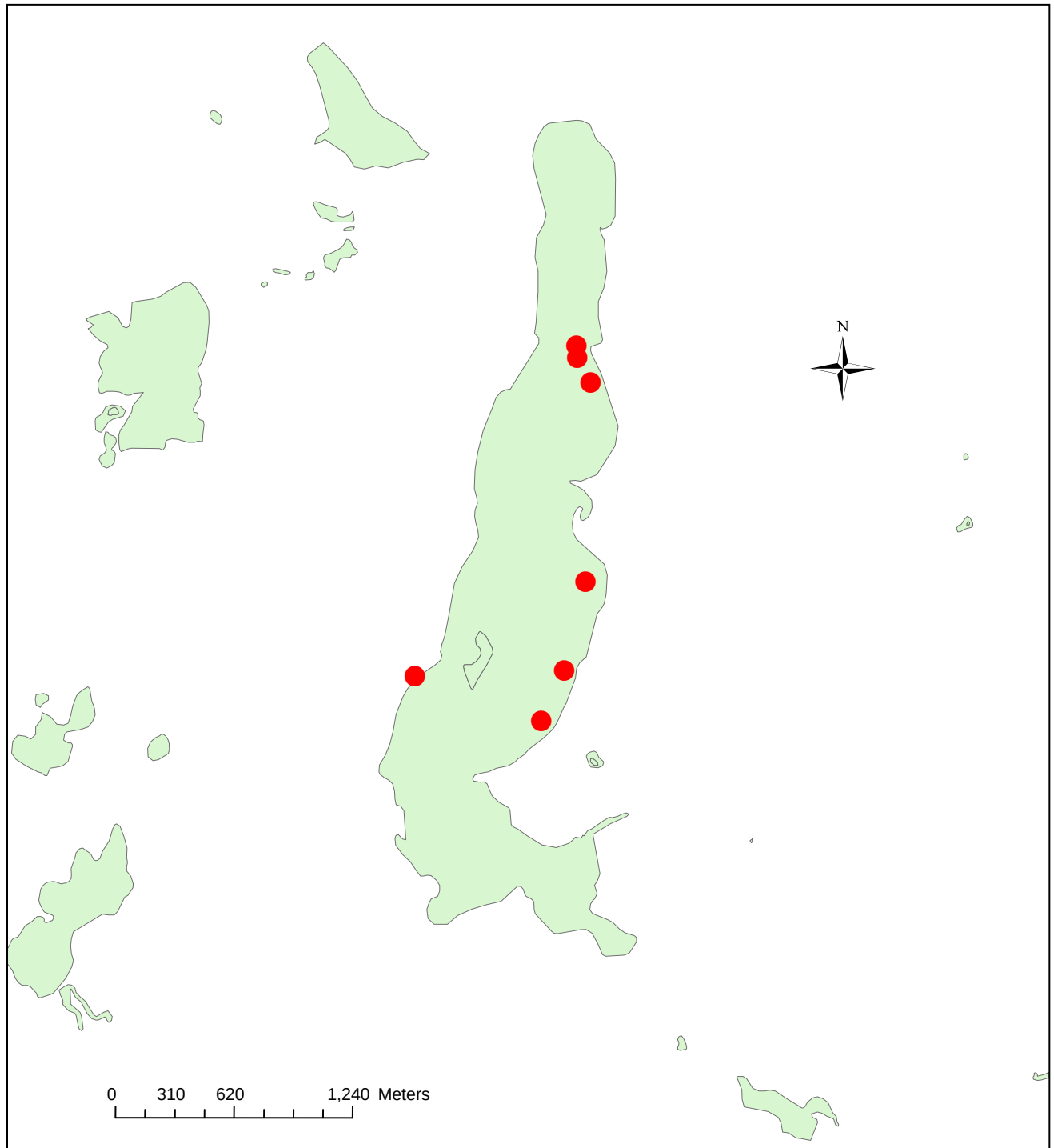
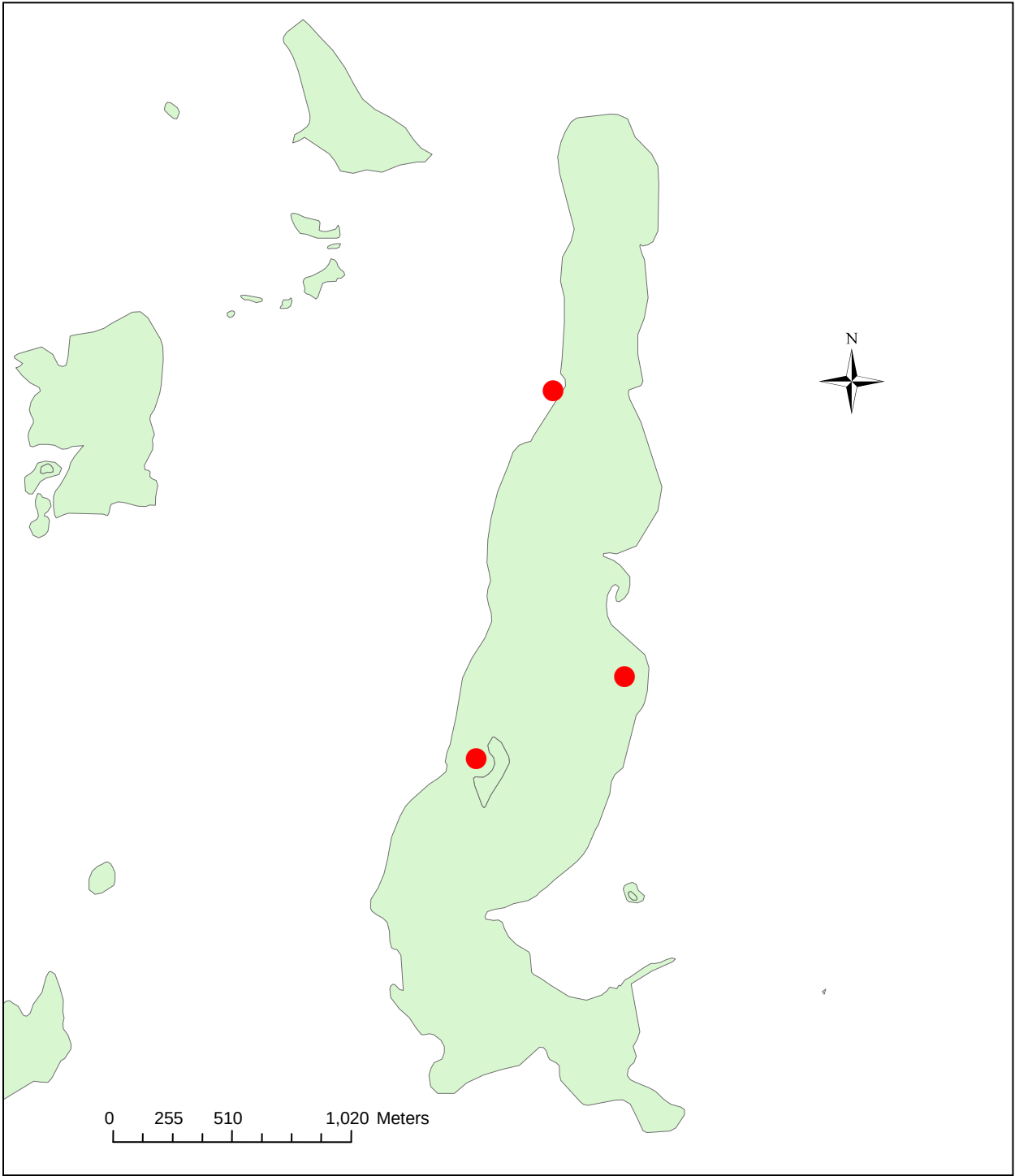


Figure 13: Location of reed canary grass, Duck Lake 2011



EWM in Duck Lake

In 2005 the first infestation of EWM was discovered in the southwest bay of Duck Lake. Since then, EWM has spread to many areas throughout the lake at varying densities. The Duck Lake Homeowners Association has worked vigilantly since 2005 to keep EWM at low densities and reduce the probability of spread internally but also externally to other lakes. The two primary management tools used are seasonal herbicide treatments and a ongoing seasonal hand pulling/diving program. In 2011 alone approximately 380 hours of volunteer time was dedicated to EWM management.



Educational marker at the boat launch

The Duck Lake riparian owners are very active in the management of EWM. The shoreline is split up into segments and each segment is assigned to a riparian owner. The owner who is assigned that segment is then tasked with the job of patrolling their segment in search of EWM. If EWM is found during a patrol, a GPS waypoint is marked and a yellow foam buoy with a piece of blue ribbon on top is placed in the water near the plant. Once a few locations of EWM have been identified, a scuba diving crew is assembled and a modified pontoon boat specifically made for hand pulling EWM is taken out for the divers to hand pull the plants. As the divers hand pull the plants, there are people on the boat using pool skimming nets to collect any fragments that were not captured by the divers. Once the plant or plants have been pulled, the immediate area is scoured for additional plants not visible from the water's surface and the piece of ribbon is pulled off the top of the buoy signaling that the site has been pulled. The area will be periodically checked to make sure no new EWM arises.



Initial EWM found in 2005

During the time of this survey, the Duck Lake EWM dive team had been actively searching and hand pulling EWM. The majority of these locations were in shallow water, where the bottom is readily visible under ideal weather conditions. In addition a contracted biologist from the ISCCW conducted a whole lake meander type survey looking for EWM. Most of these survey techniques are designed for shallow water (less than 10-12 feet deep) so it is very crucial to occasionally inspect areas of the lake where vegetation can still grow.

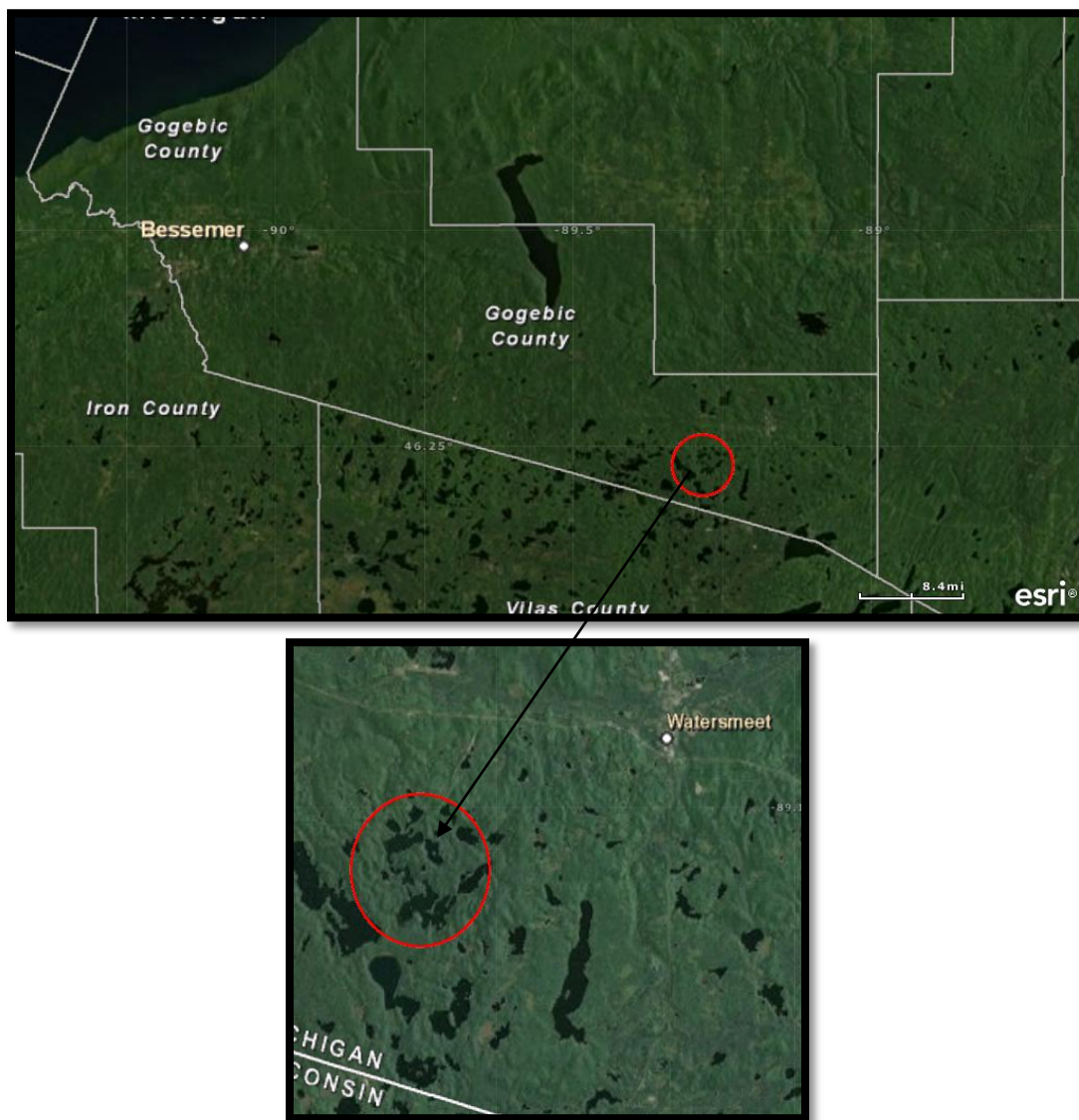
Based on the maximum rooted depth of vegetation recorded during the survey, 63% of Duck Lake has the potential to sustain aquatic plant life, including EWM. Given that the majority of this region is at the southern end and southwest side of the lake, extra attentions needs to continue within these particular regions. Periodic checks of deeper water adjacent to EWM already identified with an underwater camera and or sampling grid as done in this survey is also recommended.

A goal of this survey was to augment the current Duck Lake and ISCCW efforts by combining known EWM information on Duck Lake underpinned with systematic surveying procedures. The combined efforts of the Duck Lake riparian's and the ISCCW has kept the management of EWM at sensible levels. Lessening the efforts that these organizations have put forth can potentially lead to larger scale unmanageable situation. A undetectable bed of EWM left unchecked may create a circumstance where the boundaries of what volunteer's are capable of handling may be exceeded and where fiscal resources become inadequate.

Crooked Lake

Crooked Lake is located west of Watersmeet, MI and is a boundary water lake to the Sylvania Wilderness Area (Figure: 14). This lake is popular with local and visiting fishermen and silent sport enthusiasts. The surface area of Crooked Lake is 626 acres (Digital Water Atlas of Michigan, Michigan Department of Natural Resources, Fisheries Division, IFR). Crooked Lake is the headwaters to the Middle Branch of the Ontonagon River. The majority of Crooked Lake is owned by the USFS Ottawa National Forest, including the access site. Only a few private riparian's reside along the far northern end of the lake.

Figure 14: Location of Crooked Lake



A total of 575 points were sampled on Crooked Lake. Of these sampling points, 192 points had vegetation (Table: 4). Twenty one species were documented during the survey including visual observations. Taking into account additional boat survey information 25 species in total were documented. These additional species include: *Typha latifolia* (broad leaved cattail), *Calla palustris* (wild or marsh calla), *Phalaris arundinaceae* (reed canary grass) and *Potamogeton epihydrus* (ribbon leaf pondweed). No EWM was found on the sampling rake nor were any visual observations of EWM rooted or floating fragments found.

Table 4: Survey Summary

Total number of sites visited	575
Total number of sites with vegetation	192
Total number of sites shallower than maximum depth of plants	378
Frequency of occurrence at sites shallower than maximum depth of plants	50.79
Simpson Diversity Index	0.82
Maximum depth of plants (ft)	17.00
Number of sites sampled using rake on Rope (R)	61
Number of sites sampled using rake on Pole (P)	339
Average number of all species per site (shallower than max depth)	0.94
Average number of all species per site (veg. sites only)	1.86
Average number of native species per site (shallower than max depth)	0.94
Average number of native species per site (veg. sites only)	1.86
Species Richness	20
Species Richness (including visuals)	21

The maximum rooting depth of vegetation during the survey was 17 feet, which is approximately 57% of the surface area of Crooked Lake (Figure: 15 & 16). Of the sites sampled, 75% have a muck substrate, 18% a rock substrate and 8% a sand substrate (Figure: 17). The three most abundance plant species found in Crooked Lake are *Potamogeton robbinsii*, *Potamogeton zosteriformis* and *Elodea canadensis* at 31.22%, 15.61% and 14.02% respectfully (Figure: 17). The average Coefficient of Conservatism of Crooked Lake is 6.36 with a Floristic Quality Index of 27.76.

Zizania palustris was found at 12.17% of the sample sites, however this percentage is an underestimate of the total spatial distribution of *Z. palustris*. Some sites were inaccessible due to dense plant growth including *Z. palustris*. Figure 19 represents the total observed visual distribution of *Z. palustris* based on the sampling grid.

Figure 15: Maximum depth of plant colonization, Crooked Lake 2011

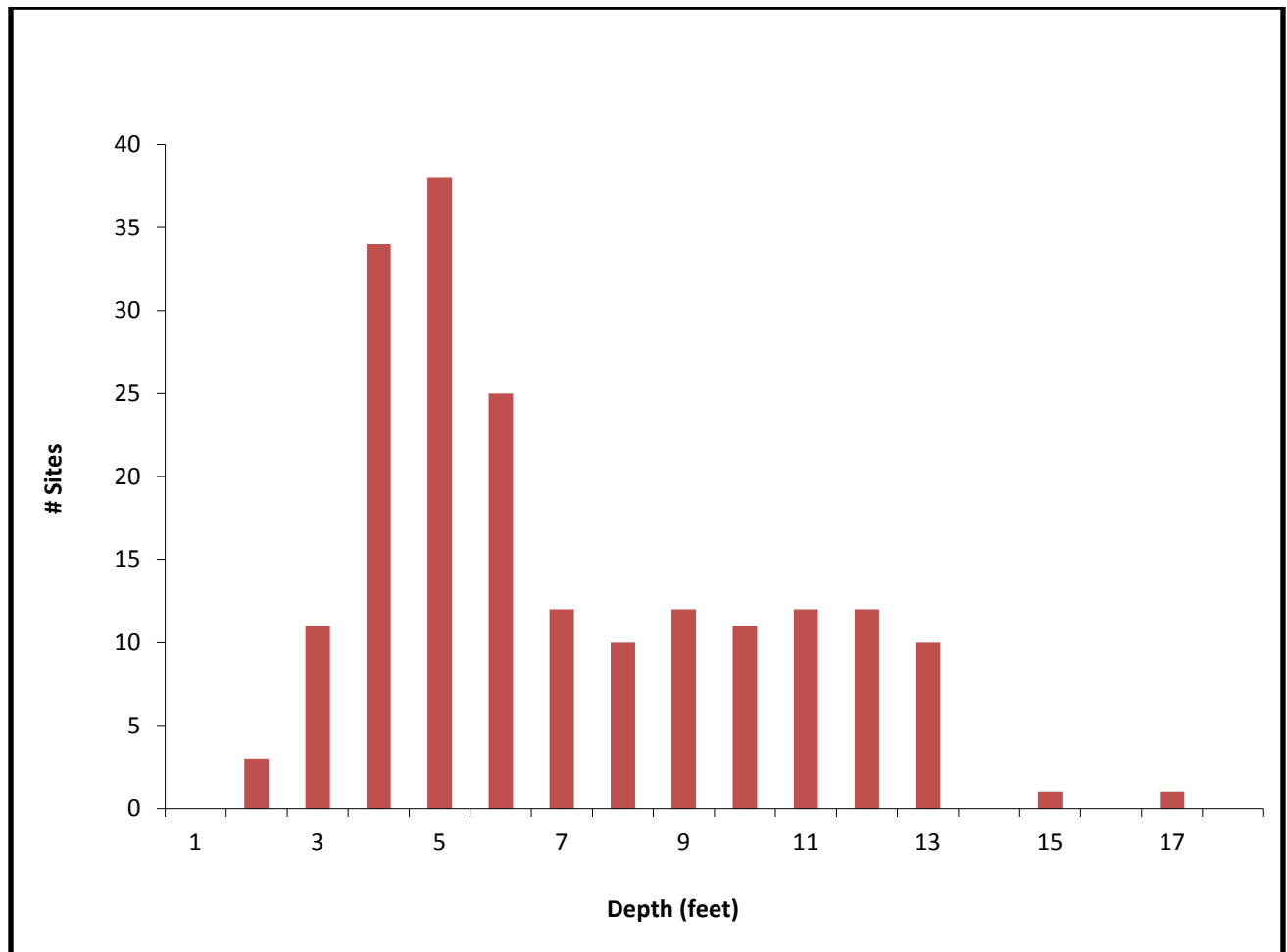


Figure 16: Maximum rooting depth of vegetation, Crooked Lake 2011

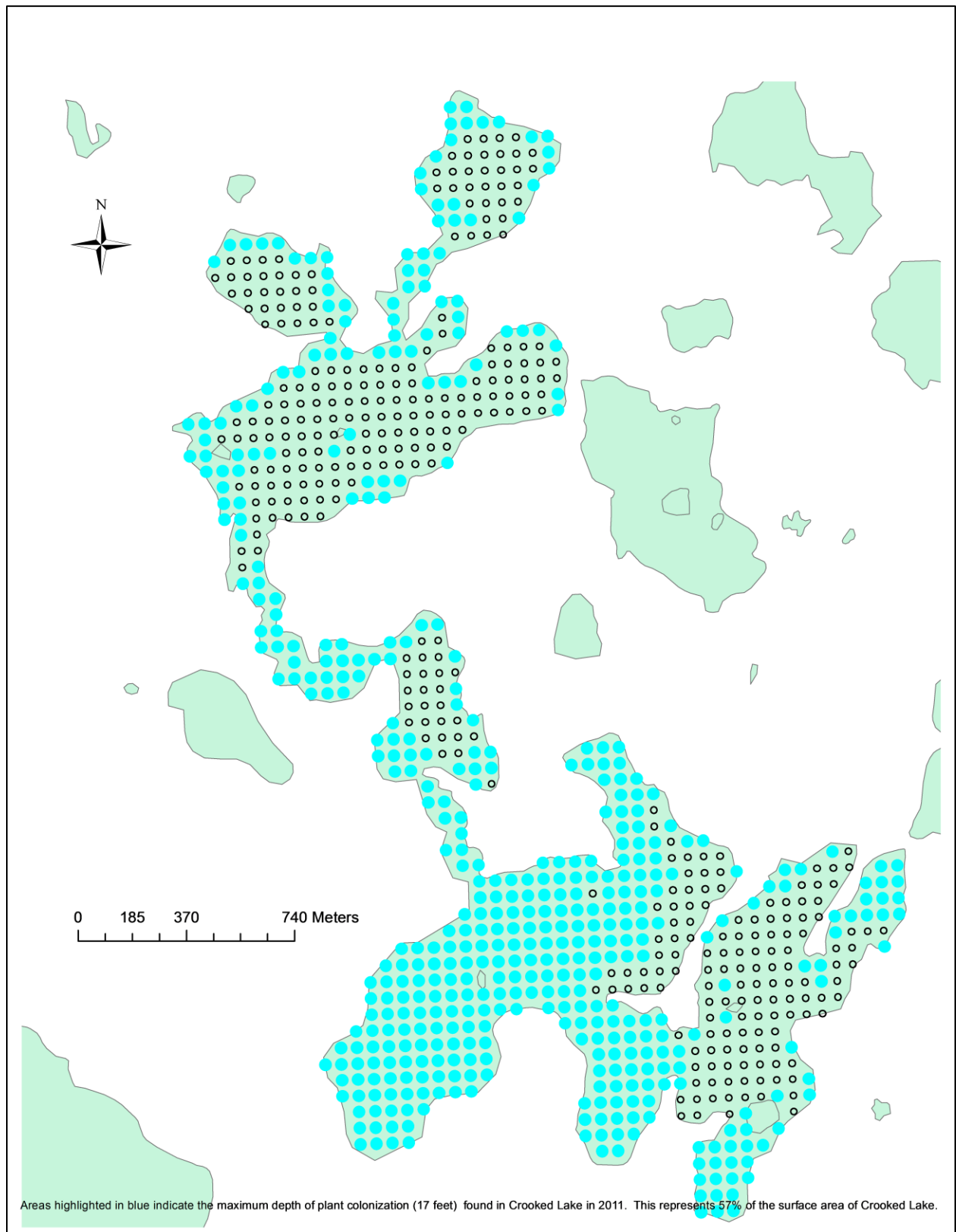


Figure 17: Sediment type, Crooked Lake 2011

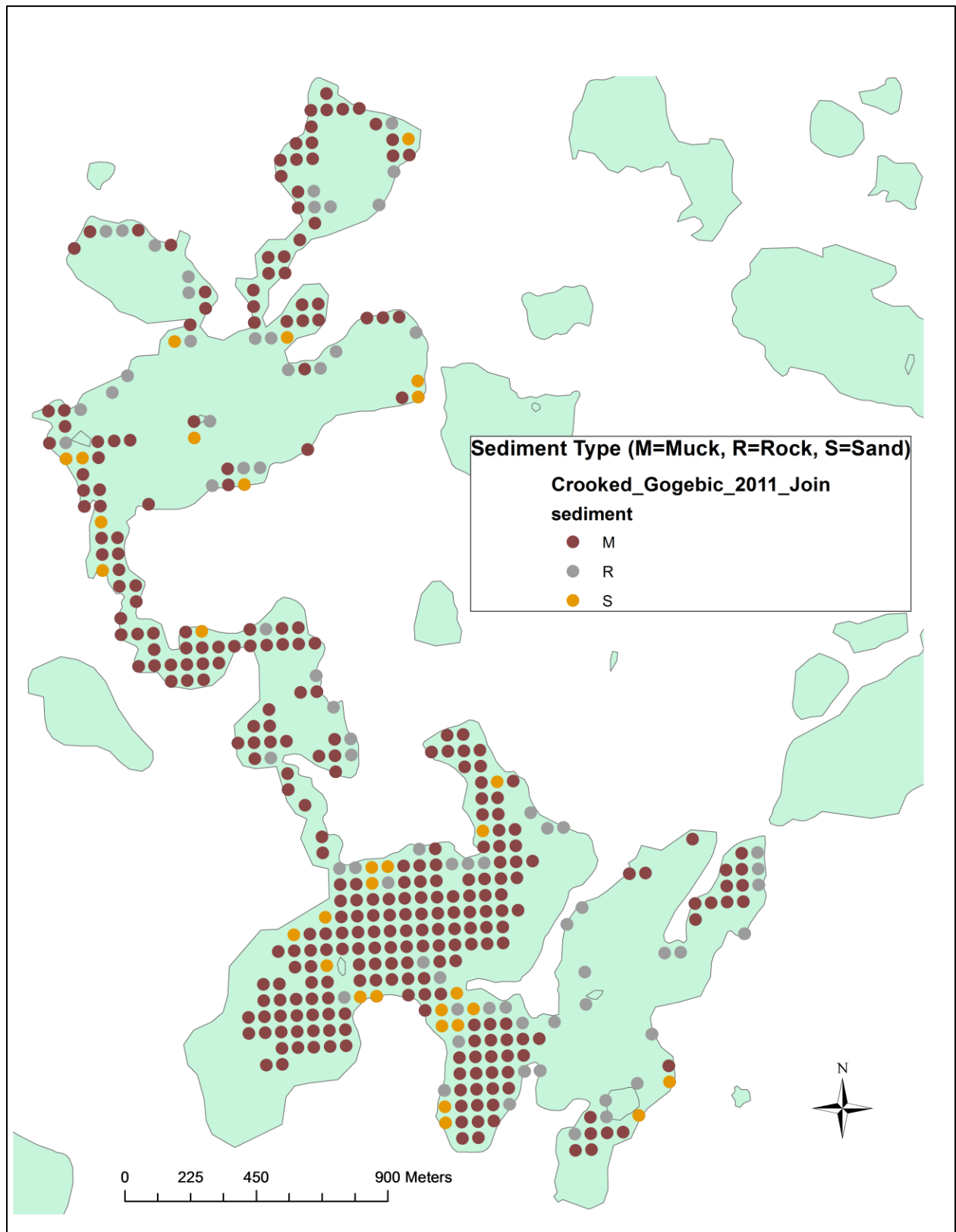


Figure 18: Frequency of occurrence of plant species found in Crooked Lake, 2011

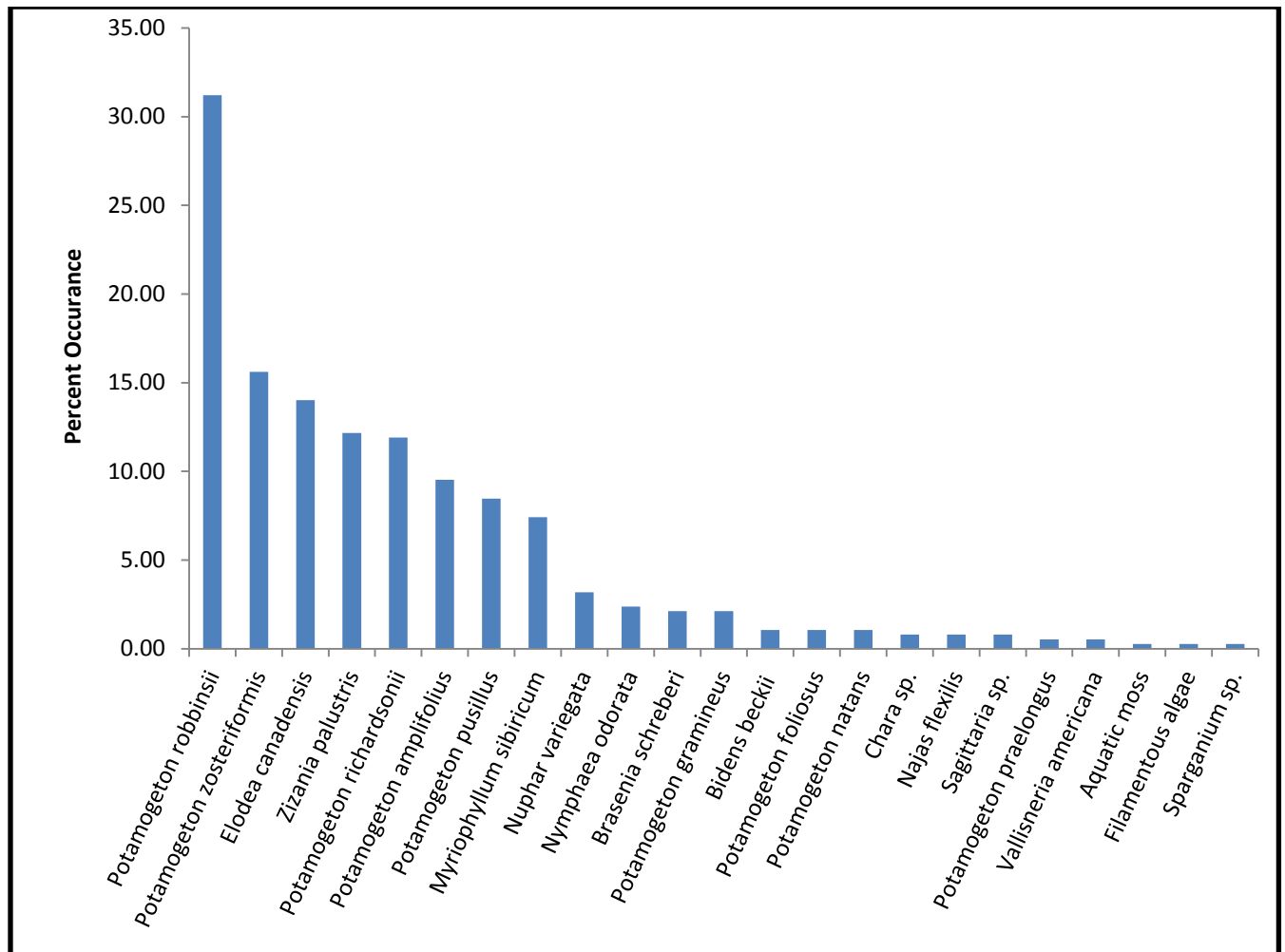
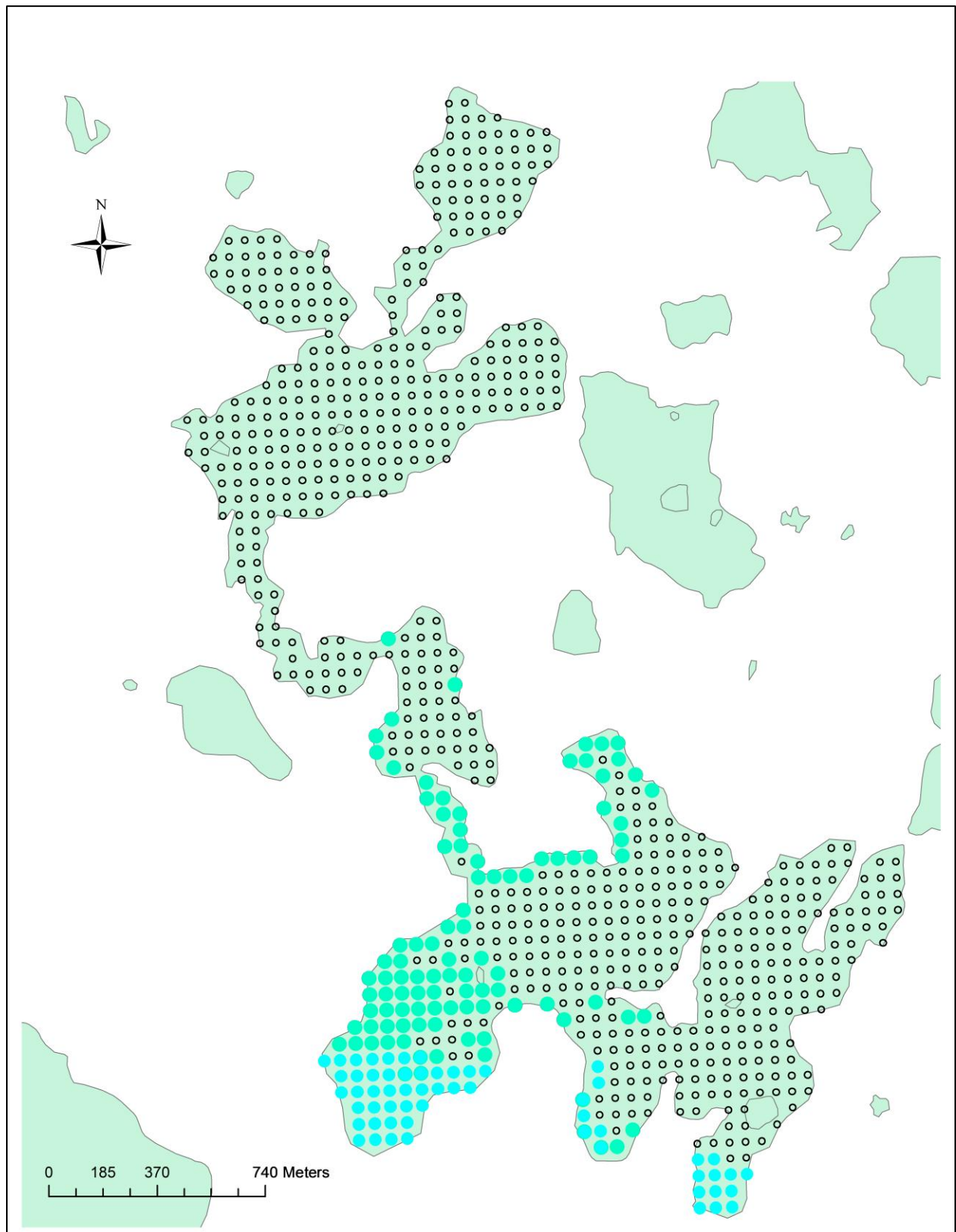


Figure 19: Location of wild rice, Crooked Lake 2011



On September 15th, 2011, a dissolved oxygen/temperature profile was created for Crooked Lake. It was taken near sampling point 815 located in the first bay of Crooked Lake.

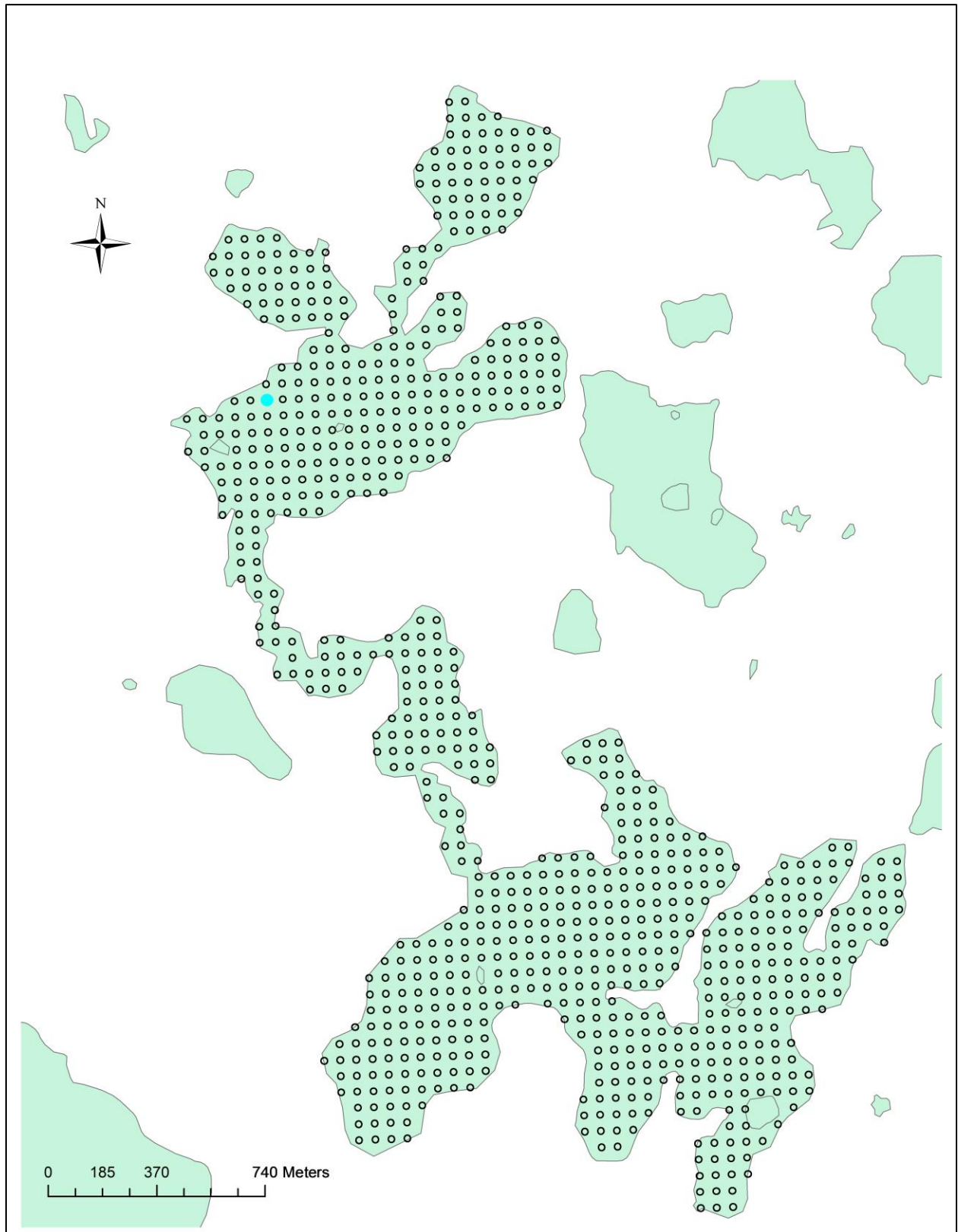
Table 5: D.O.-Temperature profile of Crooked Lake

Depth (m)	D.O.	Temp (C)	D.O. % Saturation
Surface	10.53	14.4	102.2
0.5	10.3	14.4	101.1
1	10.23	14.3	99.7
1.5	10.27	14.2	100.3
2	10.27	14.2	100.4
2.5	10.22	13.9	98.4
3	10.18	13.6	97.6
3.5	10.13	13.5	97
4	10.04	13.4	96.3
4.5	9.99	13.3	95.4
5	9.83	13.3	93.7
5.5	9.64	13.1	91.3
6	9.43	14.9	88.8
6.5	7.55	11.7	69.1
7	0.61	9.6	5.1
7.5	0.53	9.2	3.7
8	0.12	7.7	1
8.5	0.11	6.6	0.9
9	0.11	6.5	0.9
9.5	0.11	6.1	0.9
10	0.12	5.9	0.9

Plants of Concern

In 2002 the ERDC conducted a vegetation assessment on Crooked Lake. The only invasive plant that was recorded at this time was EWM. Reed canary grass, a potentially aggressive plant species was recorded during the 2011 survey (Figure: 20). This plant has the potential to become an aggressive shoreline colonizer, displacing native vegetation creating monotypic stands.

Figure 20: Location of reed canary grass, Crooked Lake 2011

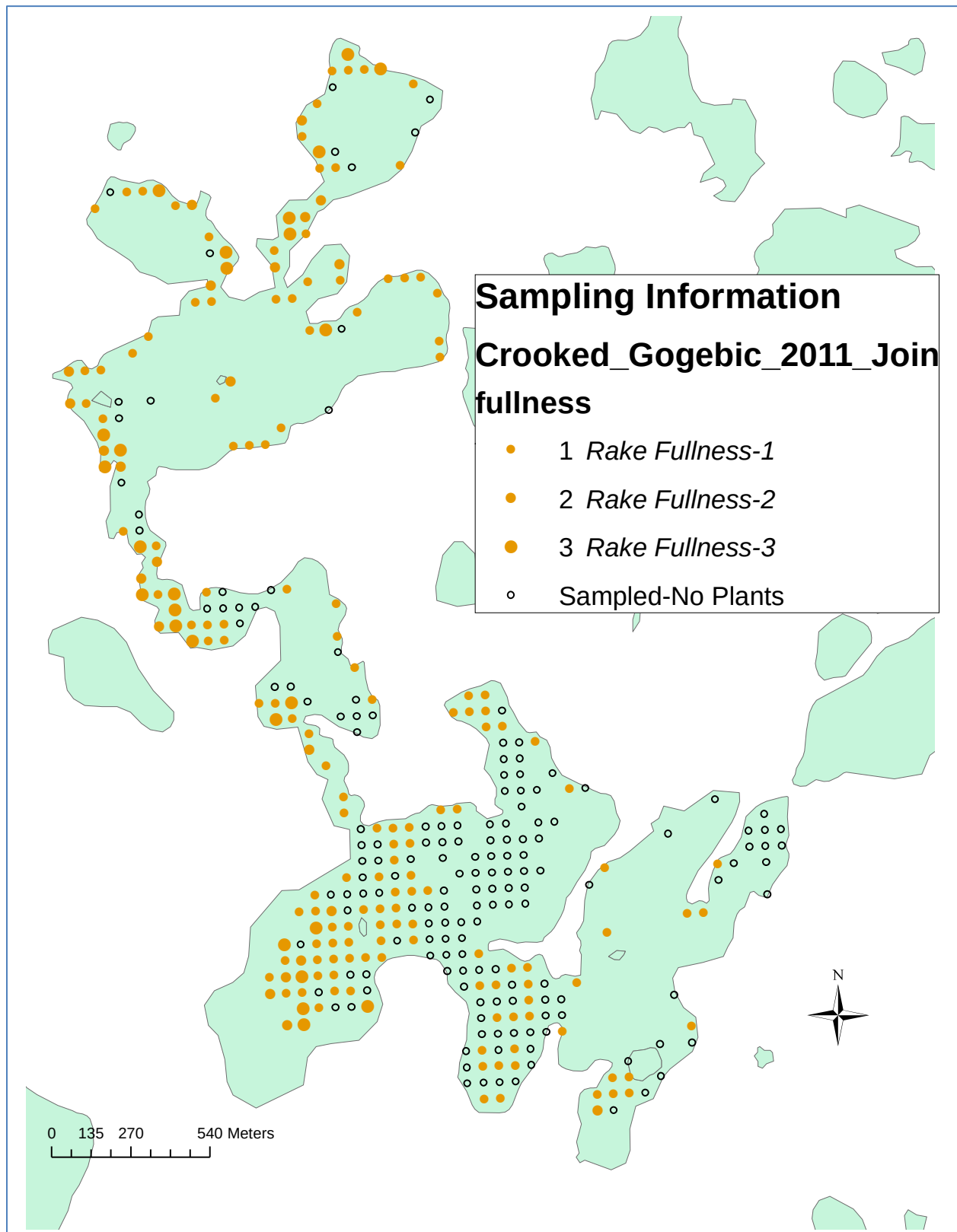


EWM in Crooked Lake

Crooked Lake is a unique system with expansive bays connected by narrow channels. To this date, the first bay (bay farthest to the north) is the only area on the lake to have an infestation of EWM. This year two areas of the first bay of Crooked Lake had a herbicide treatment using granular 2,4-D. The ISCCW contract biologist who has visited the first bay of Crooked Lake annually since 2005 conducted a meaner survey in 2011 and did not find any EWM plants within the treatments area nor any other areas within the first bay. In addition to the work completed by the ISCCW, Ottawa National Forest personnel frequents the first bay of Crooked Lake annually either searching for EWM plants or diving for known EWM plants. Their post treatment survey also revealed no EWM present within the treatment areas.

The primary means of internal spread of EWM past the first bay of Crooked Lake would have to either occur by human transport or EWM fragments from established plants moving through the channel from the first bay to the second. It is plausible that if there is the first internal spread of EWM outside of the first bay, it could begin along the channel between the first and second bay. Based on the information collected during the survey, this area is shallow, supports aquatic vegetation and has a organic substrate, making it a likely colonization candidate for EWM (Figure: 21). An additional area of concern is the fourth bay of Crooked Lake where the majority of the current wild rice beds exists. This area is relatively shallower than the maximum depth of colonization and has a organic substrate. Based on the vegetative survey, even though a great portion of this bay is at and shallower than the maximum rooting depth, there is currently large portions of this bay void of vegetation. This open canvass holds prime conditions for the potential establishment of EWM. Future monitoring work should include an extensive search of the channel between the first and second bay, the shallow regions reaching into second bay adjacent to the channel and periodical checks of the fourth bay.

Figure 21: Location of aquatic plants sampled, Crooked Lake, 2011



During both surveys a variety of interested groups and individual citizens were contacted about the project. A email detailing the project scope was sent to 77 individuals on Duck Lake. Fifteen additional lake users on Duck Lake inquired and learned about the project. On Crooked Lake, several riparian owners were aware of the project, in addition the 20 individual lake users where contacted on Crooked Lake.

Skogerboe, J.G., A.G. Poovey, K.D. Getsinger, G. Kudray. 2003. Invasion of Eurasian Watermilfoil in Lakes of the Western Upper Peninsula, Michigan. ERDC/EL TR-03-10, U. S. Army Engineer Research and Development Center, Vicksburg, MS.
<http://el.erdcl.usace.army.mil/elpubs/pdf/trel03-10.pdf>