FOX LAKE LONG-RANGE AQUATIC PLANT MANAGEMENT PLAN UPDATE (2018-2022)

PREPARED FOR:

THE FOX LAKE INLAND LAKE PROTECTION AND REHABILITATION DISTRICT AND THE WISCONSIN DEPARTMENT OF NATURAL RESOURCES

DECEMBER 14, 2017

CHAPTER 1 – INTRODUCTION AND GOALS

INTRODUCTION

Fox Lake is a 2,625-acre lake located within the municipal boundaries of the Town of Fox Lake and City of Fox Lake. Fox Lake is a natural glacial drainage lake that was enlarged in 1845 by the construction of a dam on the lake outlet named Mill Creek. Fox Lake has a history of alternating between clear water and turbid water states. In 1995 the Fox Lake Inland Lake Protection and Rehabilitation District (FLILPRD) in partnership with the Wisconsin Department of Natural Resources (WDNR), University of Wisconsin – Extension, and Dodge County Land Conservation Department began a restoration project to stabilize Fox Lake into a clear water state. The management plan included the following elements:

- Shoreline Stabilization
- Watershed Protection
- Aquatic Plant Management
- Fishery Management
- Dam Replacement
- Public Education

In 2007 Fox Lake was in a clear water state and contains abundant macrophyte growth. Evidence suggested the fishery was improving relative to previous years. Both the improved water clarity and condition of the fishery attributed to the abundant macrophyte growth which was causing navigation problems in the lake. To address issues with aquatic plants an aquatic plant management plan was prepared and approved by the FLILPRD and WDNR.

Under NR 107 and NR 109 of the Wisconsin Administrative Code, to be eligible for lake-wide control of nuisance aquatic plants using herbicides or harvesting, a community must have an approved aquatic plant management plan. That plan needs to be updated every five years. At this time the 2007 approved plan needs to be updated to keep the Fox Lake community eligible for any large-scale herbicide or harvesting permits that may be needed.

Recent aquatic plant surveys have shown that the aquatic plant community in Fox Lake is declining. Therefore this plan update will serve two purposes:

1. Identify management options to protect and enhance the aquatic plant community.

2. Identify methods to control nuisance aquatic plants where they interfere with navigation, swimming or fishing on the lake.

PURPOSE STATEMENT

The Fox Lake Long-Range Aquatic Plant Management Plan Update (2018-2022) is a long-term plan which will guide aquatic plant management activities. The purposes of the plan are to promote a healthy and diverse aquatic plant community, facilitate recreational lake use, and educate local residents on the benefits of maintaining a healthy aquatic plant community. This includes the challenges of managing a shallow eutrophic lake and maintaining a clear water macrophyte-dominated state (versus turbid algal- dominated state), maintaining habitat areas for fish, wildlife, and zooplankton, and developing strategies to address the management of Coontail and Eurasian Water Milfoil. Recreational use concerns must address an overabundance of plants in some shallow areas of the lake. The plan update will also address not just the control of nuisance plants, but also enhancement of the plant community in areas where plants have been lost.

GOAL STATEMENT

The purpose of the Fox Lake Long-Range Aquatic Plant Management Plan Update (2018-2022) focuses on balancing the ecological needs of the lake and the recreational uses of the district residents and other lake users. This requires careful maintenance of existing aquatic plants and carefully planned selective aquatic plant management.

The goals of the aquatic plant management plan are:

- Maintain and promote the clear water state
- Protect and promote the existing native aquatic plant community, fish, and wildlife
- Educate district residents about the importance of aquatic plants
- Receive public input and opinions for acceptable plant management options
- Facilitate access to deep water areas and recreational uses.

ADVISORY COMMITTEE

The following management plan update was prepared with the assistance of a technical and citizen advisory committee. Members of the committee included:

- Cheryl Witkowski – Fox Lake Inland Lake Protection and Rehabilitation District
- Dennis Buren – Lake Resident
- Bob Cerniglia - Lake Resident
- Louis Leizinger – Fox Lake Anglers
- Chuck Orsay - Lake Resident
- Dennis Pufahl - Lake Resident
- Dale Winkelman - Lake Resident
- Ann Tepp - Lake Resident
- Wendy Crary - Lake Resident
- Kathy Rydquist – Coordinator - Fox Lake Inland Lake Protection and Rehabilitation District
- Susan Graham – Regional Lake Coordinator, Wisconsin Department of Natural Resources
- Laura Stremick Thompson – Area Fishery Manager - Wisconsin Department of Natural Resources

Facilitation of the committee was conducted by **Neal O'Reilly, Ph.D.** of the firm Ecological Research Partners, LLC.

CHAPTER 2 – BACKGROUND

MANAGEMENT HISTORY

Fox Lake has a long management history of fish stocking, rough fish removal, various in-lake and watershed surveys, water quality monitoring, aquatic plant management, dredging, and sediment sampling. Much of the history of the lake has been documented in local newspapers by comments made by local residents. Examples of the management history and lake conditions are documented below:

- Fish stocking 1949-2006 including bluegill, walleye, Northern pike, bass, and muskellunge
- Aquatic plants killed with copper sulfate in 150-foot wide band around lake in 1961
- Fisherman's Club requests survey of lake by State Conversation Department due to soil erosion, weed conditions, lake level, pollution, and game feeding
- Rainbow trout caught near Drew Creek inlet
- Fisherman's Club posts signs around lake to deter refuse dumping; water levels causing navigation problems; considering buying a weed cutter
- Bluegill fishkill in winter 1959; bullheads die in spring 1959
- Conservation Department encourages lake residents to shovel ice to prevent fishkill in winter 1962
- Abundant fish reported by Conservation Department in 1962
- Dredging considered by City of Fox Lake in 1962 on Cambra Creek
- In 1963 residents reported weed spraying ruined fishing
- In 1964 local paper reported the lake reeks of pollution smell and lake was a "haven" for algae
- Quarterly water quality monitoring by Wisconsin Department of Natural Resources (WDNR) Bureau of Research in the 1970s.
- One-year water quality monitoring by Aqua-Tech in 1982-83.
- Fox Lake: Water Quality and Management Study, by the Water Resource Management Workshop, University of Wisconsin - Madison (1984).
- WDNR Long-Term Trend Program monitoring from 1986 to the present.
- Aquatic Macrophyte Surveys by WDNR and others in 1954, 1986, 1994, 1998, 2004, 2005, 2006, 2007, 2008, 2013, and 2014.
- Various fishery surveys by WDNR most recently in 2003-2005, including a carp capture and recovery survey.
- Carp exclusion study in 1993 and 1994.
- A priority watershed inventory of barnyard runoff and upland, streambank and lake shoreline erosion sources as part of the Beaver Dam Lakes Priority Watershed Project, 1992 through 1994.

- Water quality appraisal report for the priority watershed project.
- Bottom sediment core sampling by WDNR Bureau of Research.
- Expanded Self-Help Monitoring by the Fox Lake Protection and Rehabilitation District 1990-2014.
- Lake and watershed monitoring 2004-2010.

LAKE CHARACTERISTICS

Fox Lake is a 2,625-acre lake located within the municipal boundaries of the Town of Fox Lake and City of Fox Lake T13N, R13 S13-16, 21-23, 26, and 27 in Dodge County, WI. Table 2-1 summarizes the lake's physical characteristics. Appendix A contains a 1:24,000 USGS topographic map, aerial orthophotographs, a lake bathymetric map, a map of lake sediment characteristics, locations of historic aquatic plant survey transects, and the comprehensive survey site locations.

Table 2-1
Physical Characteristics of Fox Lake, Fox Lake, Wisconsin

Parameter	Size
Surface Area (open water)	2,525 acres
Surface Area (with fringe wetlands)	4,690 acres
Maximum Depth	19 feet
Mean Depth	5 feet
Volume	19,307 acre-feet
Shoreline Length	17.9 miles

Source: WDNR

AQUATIC PLANT COMMUNITY

Historically, the plant community on Fox Lake was surveyed using a transect-based technique (Figure 1 Left). Beginning in 2006 a new comprehensive point-intercept survey was started on the lake to provide a better overall picture of the aquatic plant community. Point-intercept surveys contain many more survey points than transect-based surveys (Figure 1 Right). The point-intercept survey method was repeated in 2007, 2008, 2013, and 2014.

Figure 2-1
Comparison of Historic Transit Method to Point-Intercept Method
Source: WDNR and Hey and Associates, Inc.

The historic transects were recreated from the 2006 data from sampling locations from the point-intercept survey that roughly correspond to historic sampling locations; however, methodological differences do exist between the survey types. As a result, comparisons between 2006 through 2014 data and prior years are likely not as precise as comparisons between years where the transect method or point-intercept method was solely applied.

Maps of 2006 through 2014 survey results are included in Appendix B.

Aquatic plant data was available for Fox Lake from 1950 to the present. Data from the historic surveys can be summarized utilizing a series of calculated metrics that can be used for comparison. A brief explanation of each metric follows:

1) Frequency of Occurrence: the number of sites a plant species was collected divided by the total number of sites. The abundance of plants is not taken into account in this calculation. Only the presence/absence is noted. This value is also used to calculate the total percentage of littoral zone supporting aquatic plant growth.

2) Maximum Rooting Depth: the deepest sampling point that contained rooted aquatic plants. This measure is an important estimate of water clarity. Aquatic plants usually grow at 2-3 times the Secchi depth.

3) Floristic Quality Index (FQI, Nichols 1999): a biological index value based on the presence/absence of species and the ability of plants to tolerate disturbed conditions. FQI is calculated by multiplying the average C value for all native plant species by the square root of the number of native plant species collected. “C” is the coefficient of conservatism which is a value assigned to native aquatic plants estimating a plant’s likelihood to occur in an undisturbed lake. The values range from 0-10, with 10 representing an undisturbed condition and 0 representing severely degraded conditions.

Fox Lake supports a plant community typical of a shallow lake in southern Wisconsin. This is evident by the frequency of occurrence of aquatic plants (Figure 2-2), the Floristic Quality Index scores, and the presence of exotic invasive species (Tables 2-2).

The recent trends indicate Fox Lake’s aquatic plant community expanded between 1998 and 2005, declined from 2006 through 2013 and increased in 2014. Anecdotal information for 2015 indicates that plant densities for that year may have increased to 2005 levels.

Figure 2-3 illustrates the trend in the dominant species in Fox Lake from 1998 through 2014. We see that the species of coontail, elodea and Eurasian water milfoil all expanded from 1998 through 2005, declined beginning in 2006 and in 2013, and expanded in 2014. Appendix B illustrates the distribution of the major species from 1996 through 2014.

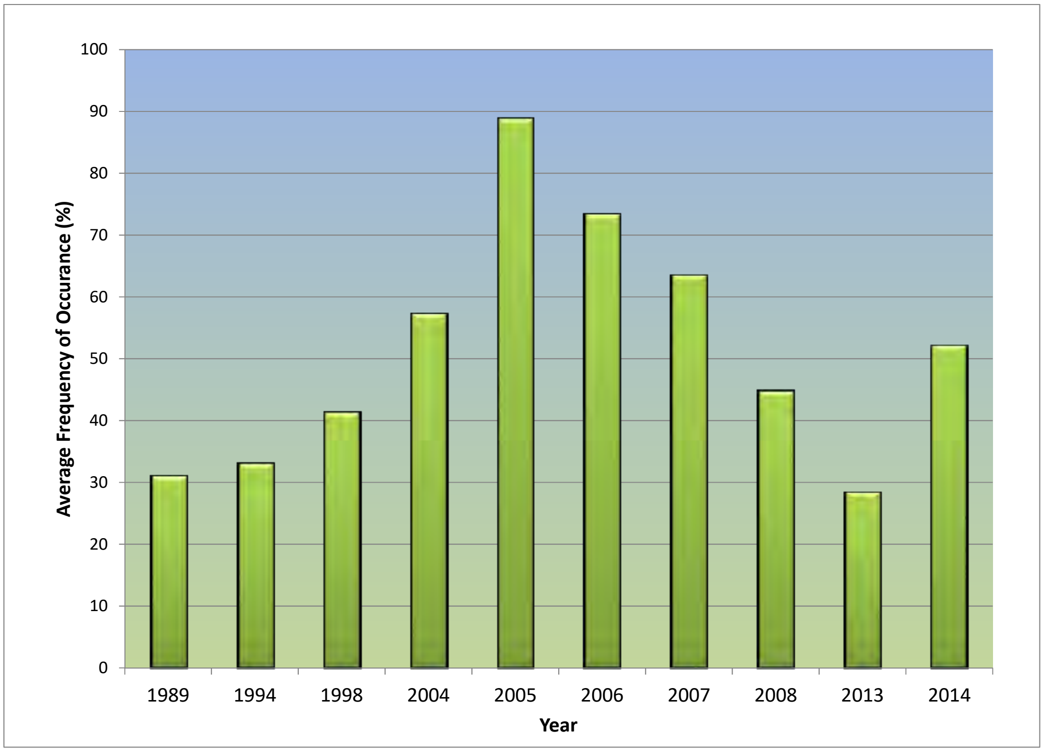


Figure 2-2
Frequency of Occurrence of Aquatic Plants Fox Lake
Source: WDNR, Hey and Associates, Inc., and Ecological Research Partners, LLC.

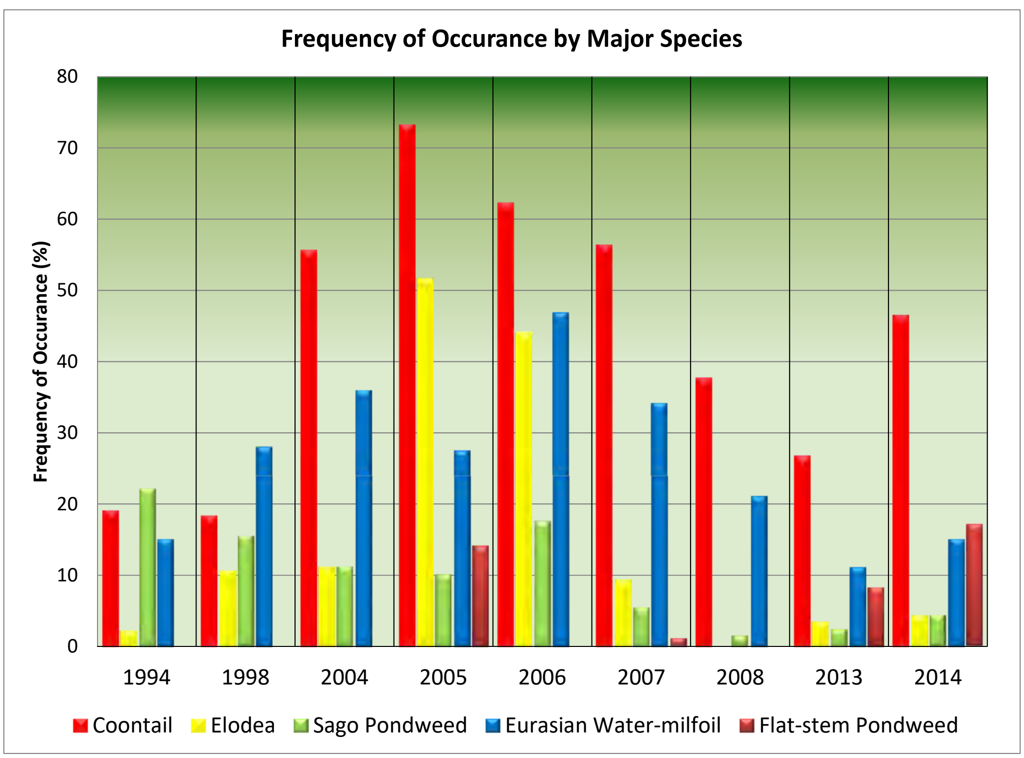


Figure 2-3
Frequency of Occurrence of Dominant Aquatic Plants
Source: WDNR and Hey and Associates, Inc

Table 2-2
Aquatic Plant Community Summary Statistics
Source: WDNR, Hey and Associates, Inc., and Ecological Research Partners, LLC.

Scientific Name	Common Name	C	Frequency of Occurrence								
			1994	**1998**	**2004**	**2005**	**2006**	**2007**	**2008**	**2013**	**2014**
C. demersum	Coontail	3	19	18.3	55.6	73.3	62.3	56.4	37.6	26.6	46.5
Chara spp.	Muskgrass	7	-	-	5.1	8.9	9.4	8.9	2.2	4.1	3.6
E. canadensis	Elodea	3	2	10.6	11.1	51.6	44	9.2	-	3.4	4.2
H. dubia	Water Stargrass	6	3	-	4.3	10.4	-	0.3	0.5	-	0.7
L. minor	Small Duckweed	5	-	2.6	18.8	20.5	4.3	-	-	-	3.5
L. trisulca	Star Duckweed	6	-	-	1	2.6	0.3	-	-	-	0.5
M. spicatum	Eurasian Water-milfoil	NA	15	27.9	35.9	27.4	46.8	34.1	21.0	11.1	15.0
N. flexilis	Slender Naiad	6	1	-	-	-	*	0.2	-	0.2	0.1
N. marina	Spiny Naiad	NA	-	-	1	-	-	-	-	-	-
Nuphar spp.	Yellow Water Lily	8	1	-	1.7	6.8	0.3	-	-	0.7	-
Nymphaea spp.	White Water Lily	6	5	5.1	5.1	4.3	1.2	-	-	1.7	1.6
P. crispus	Curly-leaf Pondweed	NA	5	1.9	8.5	18.5	1	-	0.2	0.2	0.2
P. sp. #1	Unknown Pondweed	6	1	-	1.7	-	0.5	-	-	0.2	-
P. zosteriformis	Flat-stem Pondweed	6	-	-	-	14.1	-	0.9	-	8.2	17.1
S. pectinatus	Sago Pondweed	3	22	15.4	11.1	9.9	17.4	5.3	1.3	2.3	4.3
S. polyriza	Large Duckweed	5	-	-	2.6	-	-	-	-	2.4	-
Sparganium (fluctuans)	Floating-leaf Bur-reed	10	-	-	-	1.5	-	-	-	-	-
V. americana	Water Celery	6	1	-	1	-	*	-	-	2.3	3.3
W. columbiana	Watermeal	5	-	-	-	4.3	-	-	-	-	-
Z. palustris	Horned Pondweed	7	1	-	-	1	-	-	-	-	-
P. pusillus	Slender Pondweed	7	-	-	-	-	-	0.3	-	-	-
P. perfoliatus	Claspingleaf pondweed	NA	-	-	-	-	-	-	-	0.2	-
P. gramineus	Variable-Leaf Pondweed	NA	-	-	-	-	-	-	-	0.2	-
-	**All Species**	**=>**	**33**	**41.3**	**57.3**	**88.9**	**73.4**	**63.6**	**44.8**	**28.4**	**52.2**
-	**Average C**	**=>**	**5.4**	**4**	**5.6**	**5.8**	**5.5**	**5.1**	**4.8**	**4.9**	**5.3**
-	**FQI**	**=>**	**17.1**	**8.9**	**19.3**	**20.9**	**18.1**	**15.3**	**11.8**	**19.0**	**21.6**
-	**Maximum Rooting Depth (ft)**	**=>**	**5**	**6**	**6**	**8**	**14**	**14**	**10**	**7**	**12.0**
-	**Total # Plant Species**	**=>**	**12**	**7**	**15**	**15**	**14**	**9.0**	**6.0**	**15.0**	**17.0**

1994. Winkeman, J. Results of the 1994 macrophyte survey in Fox Lake. WDNR Bureau of Research
1998 Values tabulated from data provided from P. Garrison WDNR Bureau of Research
2006- 2014 Total are results for comprehensive point-intercept survey

Non-Native and/or Invasive Species

There are a total of 2 invasive species in Fox Lake. They are Curly-leaf pondweed, and Eurasian water-milfoil. As seen in Table 2-2 these species are dominate members of the aquatic plant community. Filamentous algae were also found in Fox Lake, which can also pose a recreational nuisance.

1) **Eurasian water-milfoil** (*Myriophyllum spicatum*), a non-native invasive species. Eurasian water-milfoil forms dense mats at the water surface that shade out native plants, deposits large amounts of dead plant material as it dies back in the fall that may cause local shifts in water chemistry and dissolved oxygen, and supports fewer invertebrates than native plants (Cheruvelli et al. 2001). Eurasian water-milfoil was found at a relatively high number of sites in 2006 46.8%, however, since this peak, the population has been declining from 34.1% in 2007, 21.0% in 2008 and 11.1% in 2013. In 2014 the population increased to 15% of the lake.

2) **Curly-leaf pondweed** (*Potamogeton crispus*, CLP) is another non-native invasive species found in Fox Lake. Mid to late summer surveys are inconsistent at detecting the actual extent of CLP in lakes because their life cycle is atypical. CLP begins to grow in the fall, continues to grow throughout the winter, and dies off in late June or early July. As a result, surveys to detect CLP should occur in late May or early June to provide more accurate information. CLP does not appear to be a problem in Fox Lake during mid to late summer. Curly-leaf pondweed provides less value for fish and wildlife than other submersed aquatic plants. While CLP made up 18.5% of the sample sites in 2005, from 2008 through 2014 it was found at only 0.2% of the sample sites and today is not a major concern in Fox Lake.

WATER QUALITY

The steady decline of Fox Lake's water quality has been the focus of a number of studies. The studies indicate that Fox Lake is eutrophic to hyper-eutrophic and capable of a rapid transition from a clear water macrophyte dominated ecosystem into a turbid algal dominated system. Typical goals to manage a shallow eutrophic lake in the clear water state require total phosphorus <100ug/l (Scheffer et al. 1993 and Hosper and Meijer 1992). In-lake phosphorus concentrations rangeing from 100 ug/l to greater than 300 ug/l during the summer months from 2006-2015 (Figure 2-4).

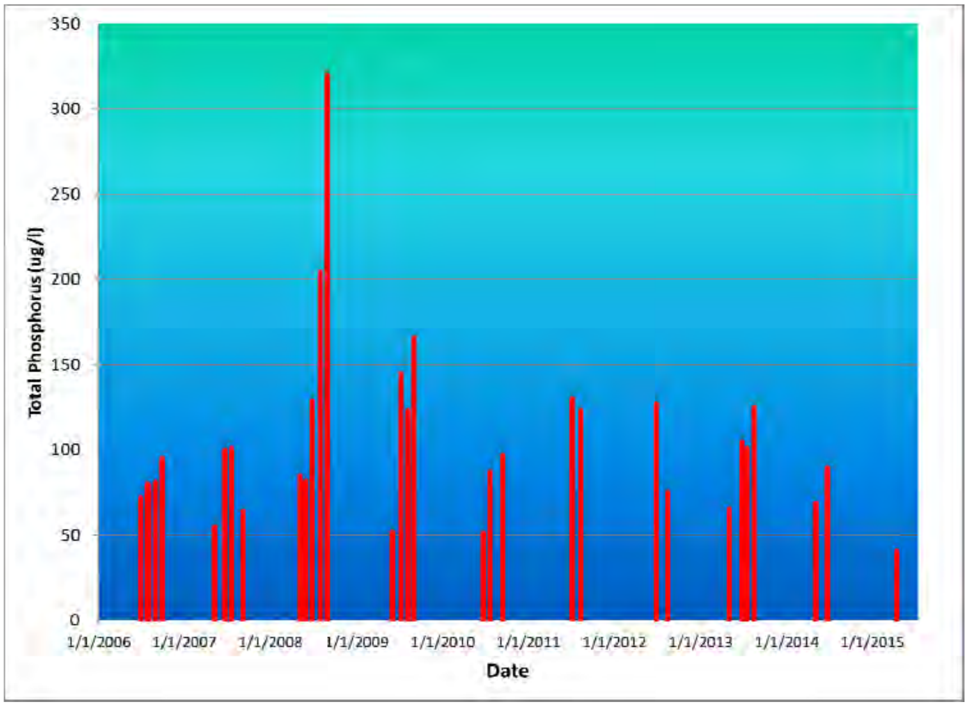


Figure 2-4
Fox Lake Total Phosphorus (**Source: WDNR**)

Mean chlorophyll-a concentrations in Fox Lake range from less than 20 ug/l to as high as 140 ug/l during the summer months from 2006 to 2014 as illustrated in Figure 2-5.

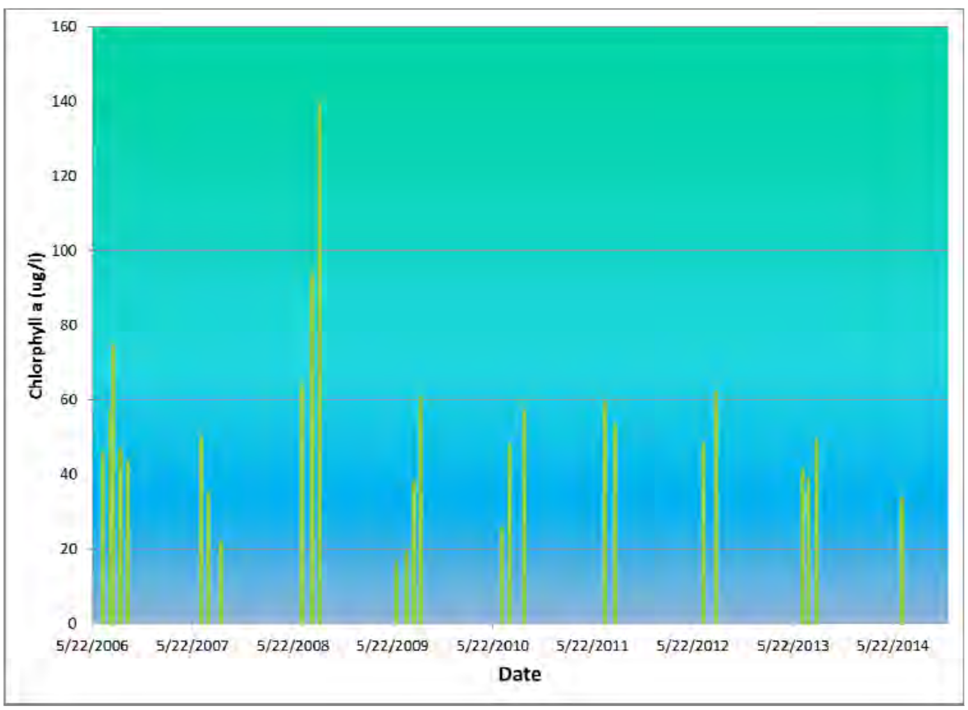


Figure 2-5
Fox Lake Chlorophyll-a (**Source: WDNR**)

Secchi disk readings from 2006-2015 were generally poor, less than two feet in mid-summer (Figure 2-6). Spring values in 2009, 2010 and 2014 did reach as much as 8 and 9 feet, however, the lake did not stay clear for the entire summer.

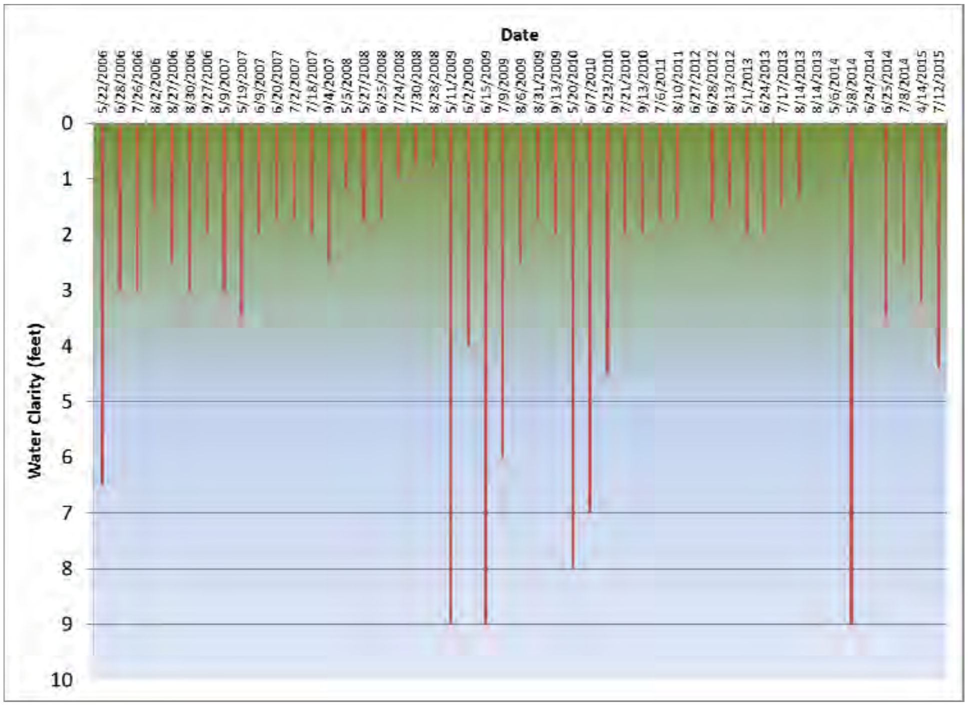


Figure 2-6
Fox Lake Secchi Depth (Source: WDNR)

Analysis of Trophic State Index values for chlorophyll-a, Secchi disk, and total phosphorus indicate that Fox Lake is eutrophic and that lake turbidity may be due to more than just high algal populations, but may be augmented by suspended sediment from nonpoint source pollution and re-suspension of bottom sediment by wind and bottom feeding fish activity (Figure 2-7).

WATERSHED DESCRIPTION

The Fox Lake watershed is approximately 35,600 acres in size, draining areas of Dodge, Fond du Lac, Green Lake and Columbia Counties. The Fox Lake watershed was studied in depth as part of *Beaver Dam River Priority Watershed Project* sponsored by the Wisconsin Department of Natural Resources Nonpoint Source Pollutant Abatement Program. The watershed project focuses on the control of upland pollutant sources of crop erosion, streambank and shoreline erosion, and barnyard waste runoff. The watershed is made up of four sub-watersheds outlined in Table 2-3.

The watershed is comprised of rolling hills and plains interspersed with wetlands. While the original vegetation consisted of prairie grasses, marshland, and shrubs, today greater than 70% of the watershed is in agricultural land use. The geology of the area consists of a bedrock of sandstone and dolomite formations overlain by glacial deposits of clay, silt, sand, and gravel. The major soil types are silty loams on the uplands and muck soils adjacent to stream courses and along the marsh areas of Fox Lake.

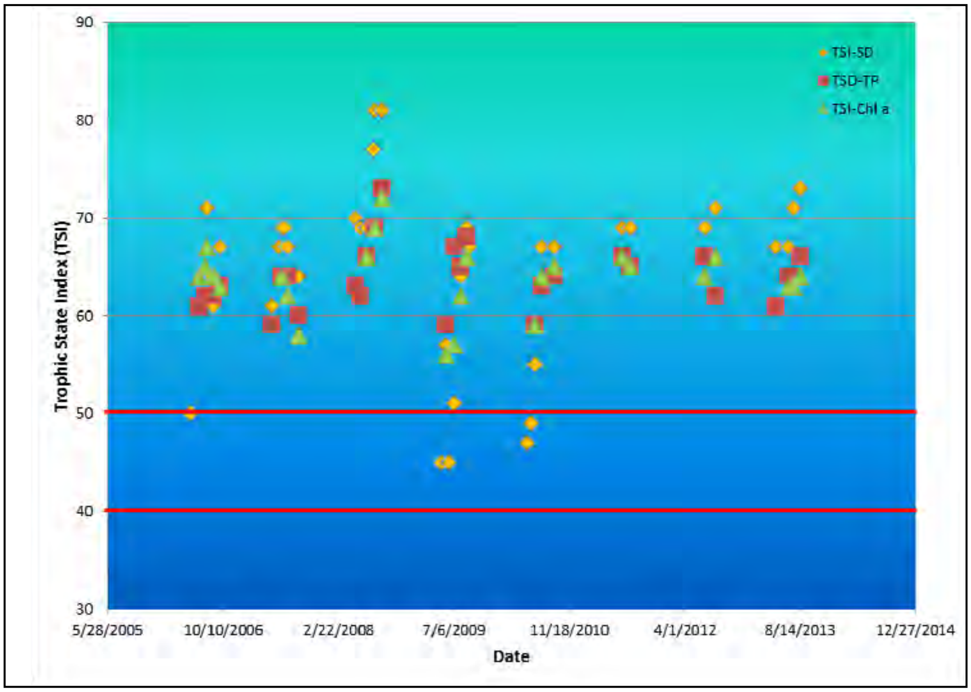


Figure 2-7
Trophic State Index Values 2006 to 2013 Fox Lake (Source: WDNR)

Table 2-3
Fox Lake Sub-watersheds

Sub-watershed	Acres	Percent of Total
Alto Creek	13,693	38%
Cambra Creek	14,900	42%
Drew Creek	3,894	11%
Fox Lake Direct Drainage	3,087	9%
Total	35,574	100%

Source: A Nonpoint Source Control Plan for the Beaver Dam River Priority Watershed Project (WDNR, 1993).

Alto Creek is a polluted tributary to Fox Lake that passes through large tracts of wetlands which buffer the creek from direct surface runoff. Monitoring indicates this stream could support a cold-water fishery if the polluted runoff was controlled. Problems in Alto Creek include sediment loading and possibly pesticides. Watershed-based sediment controls are being used to improve conditions in the creek (Wisconsin Department of Natural Resources, 2002).

Cambra Creek is another tributary to Fox Lake. It is relatively clear due to extensive filtering and buffering by adjacent cattail-dominated wetlands. Extensive farming within the subwatershed is likely delivering nutrients and sediment to Fox Lake. Carp use the shallow and extensive fringe wetlands adjacent to the stream and lake.

Drew Creek is a small stream tributary to Fox Lake that appears to carry a significant sediment load after storm events (Wisconsin Department of Natural Resources, 1993).

Livestock access, animal waste runoff and, silage leachate are other concerns. Sediment at the stream's mouth is creating undesirable near-shore conditions by building up a small delta at the confluence with Fox Lake. Nutrient and sediment loadings from each subwatershed are summarized in Table 2-4. Sources of total phosphorus reported as annual loads within the watershed are located in Table 2-5.

Table 2-4
Fox Lake Sediment and Nutrient Loads by Subwatershed

Sub-watershed	Land Area (acres)	Sediment Load (tons/yr)	Phosphorus Load (lbs/yr)	% total Phosphorus Load	% of Total Load Due to Cropland
Alto Creek	13,693	6,477	23,859	45%	98
Cambra Creek	14,900	4,156	18,530	35%	96
Drew Creek	3,894	1,861	6,834	13%	96
Fox Lake	3,087	1,000	3,845	7%	97
Total	35,573	13,494	53,068	100%	

Source: WDNR, 1993

Table 2-5
Estimated Annual Total Phosphorus Load to Fox Lake

Phosphorus Source	Present Total phosphorus load [lbs/yr]	Priority Watershed Project goal of total phosphorus load [lbs/yr]
Upland sediment erosion	53,068	32,581
Barnyard runoff	2,433	657
Winter manure spreading	1,795	1,041
Shoreline sediment erosion	1,237	618
Groundwater	6,041	6,041
Precipitation	383	383
Wetland reduction	(13,290)	(9,200)
Total	51,668	38,728

Source: Hey and Associates, Inc.

A trophic model was developed for Fox Lake to determine the relationship between watershed loading and in-lake measurements of total phosphorus. The model is shown in Figure 2-8. The watershed loadings for total phosphorus should be below 30,000 pounds per year to maintain the clear water state (TP<0.1 mg/l or 100μg/l).

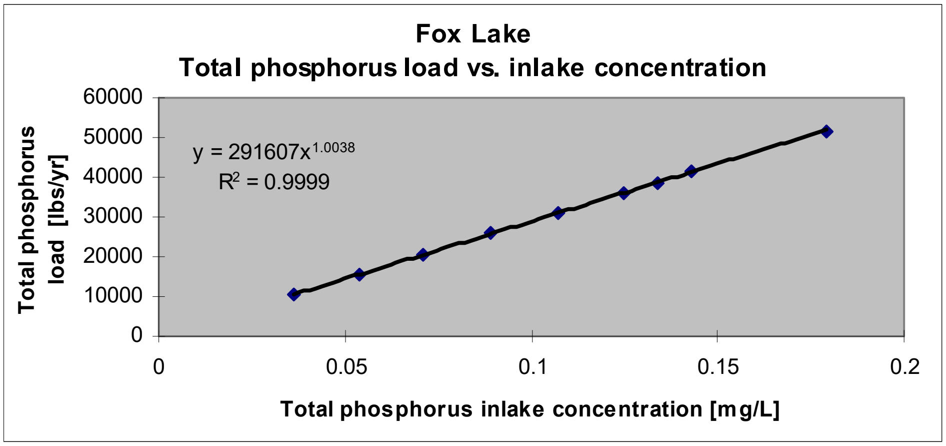


Figure 2-8
Trophic Model for Fox Lake

WATER USE

Fox Lake supports recreational uses typical of many lakes in Wisconsin including fishing, swimming, pleasure boating, personal watercraft, waterfowl hunting, and water skiing. Appendix C contains maps of the public use areas on the lake, areas typically used for waterskiing, and current "Slow No Wake" zones defined by Town of Fox Lake ordinance.

FISHERIES AND WILDLIFE

Fox Lake supports diverse fish, wildlife, and waterfowl including state species of concern, state threatened species and state endangered species. Their state and global element ranks are also included (Table 2-6). A Wisconsin endangered species designation means that its continued existence is in jeopardy based on scientific evidence. A Wisconsin threatened species appears likely--in the near future--to become endangered based on scientific evidence. According to State Statute 29.415 and NR27, it is illegal to take, transport, possess or sell any threatened or endangered species without a permit. Special Concern species are suspected to have limited abundance or distribution, but no scientific proof has documented their status. State and Global Element Ranks portray the overall species' status at the statewide and global scales.

Other waterfowl and wildlife known to inhabit the area are Bald Eagles, otter, Cormorants, many types of ducks, geese, Mute Swan, Loons. The fish community includes Walleye, Largemouth Bass, Northern Pike, and a few Muskie. The panfish community in Fox Lake is dominated by a large Black Crappie population, as well as smaller populations of White Crappie, Bluegill, and Yellow Perch. Other panfish species present in the lake include Pumpkinseed and Green Sunfish. Other species in Fox Lake include Golden Shiner, Common Carp, and Yellow and Black Bullhead.

Many of the species on Fox Lake depend on aquatic plants for their survival. Most waterfowl use aquatic plants as a food source. Many fish species use aquatic plants as habitat over some portion of their life history. Invertebrates eaten by small fish live on aquatic plants while the top predatory gamefish use aquatic plants to ambush their prey. Aquatic plants also provide spawning opportunities for many fish species. Figure 2-9 shows areas of the lake that are important fish nurseries and/or utilized by wildlife.

Table 2-6
Species or Natural Communities of Significance near Fox Lake

Species/Natural Community	WI Status	Special Concern Protection Status	State Element Rank	Global Element Rank	Date Identified
Wet-Mesic Prairie	NA	-	Imperiled	Imperiled	1985
Western Harvest Mouse	Special Concern	None	Imperiled	Secure	1966
Great Egret	Threatened	-	Critically Imperiled	Secure	1997
Black-Crowned Night Heron	Special Concern	Migratory Bird Act	Imperiled	Secure	1974
Southern Dry-Mesic Forest	NA	-	Rare or Uncommon	Apparently Secure	1977
Southern Mesic Forest	NA	-	Rare or Uncommon	Very Rare	1978
Emergent Marsh	NA	-	Secure	Apparently Secure	1979
Shrub-Carr	NA	-	Secure	Secure	1979
Banded Killifish	Special of Concern	None	Rare or Uncommon	Apparently Secure	1995
Blanchard's Cricket Frog	Endangered	-	Imperiled	Secure	1919
Red-Necked Grebe	Endangered	-	Critically Imperiled	Secure	-

Source: WDNR

The fishery of Fox Lake is samples annually by the WDNR staff from the Horicon area office. The results of monitoring from 2013 through 2016 are illustrated in Figure 2-10. Results for key fish species are summarized in Table 2-7 for 2010 through 2016. The results show a general decline in walleye, largemouth bass and black crappie numbers from 2010 to 2016, a large increase in yellow perch numbers in 2016, and generally low numbers of bullhead and carp.

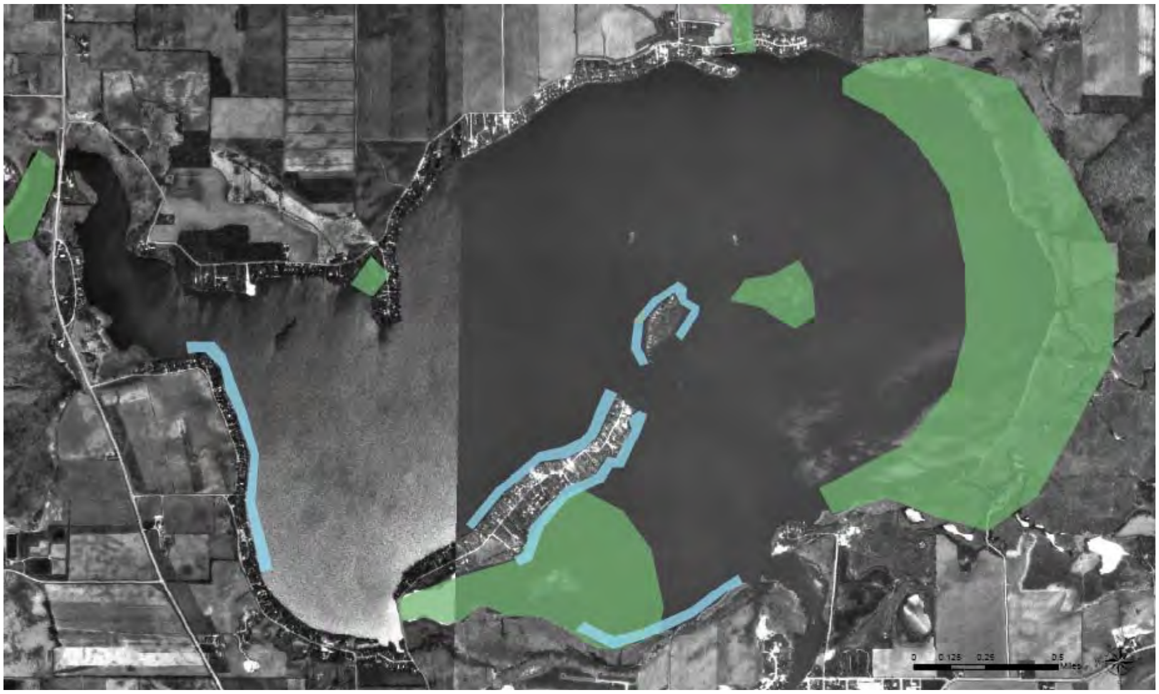


Figure 2-9
Wildlife Areas (green) and Fish Nurseries (blue)
Source: Hey and Associates, Inc. and WDNR

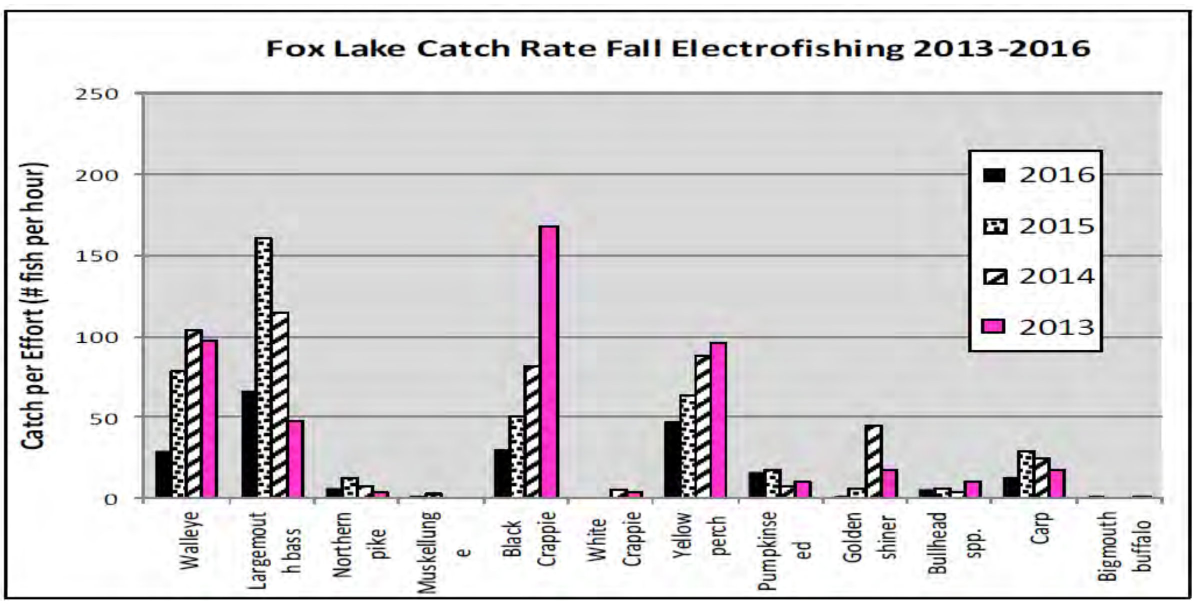


Figure 2-10
Results of Annual Electrofishing Surveys Fox Lake 2013-2016
Source: WDNR

Table 2-7
Results of Fall Electroshocking Surveys Fox Lake 2010-2016
(Source: WDNR)

Species/Sampling Results	2010	2011	2012	2013	2014	2015	2016
Walleye							
Total Catch	357	241	162	631	215	157	60
Catch Rate (fish per hour)	160	116	78	98	103	79	29
Length Range (inches)	6.1-27.2	7.0-25.6	5.6-27.1	6.5-25.3	5.4–25.1	7.1-25.3	7.8-23.6
Average Length (inches)	12.6	14.1	13.4	14.7	15	15.2	15.7
Largemouth bass							
Total Catch	275	140	165	311	238	323	138
Catch Rate (fish per hour)	123	67	79	48	114	162	66
Length Range (inches)	2.5-17.9	3.0-17.4	2.3-17.6	2.6-20.0	2.1-17.9	2.5-18.3	2.6-18.7
Average Length (inches)	9.1	10.6	11	12.8	6.1	6.6	8.6
Northern pike							
Total Catch	5	6	2	19	15	25	13
Catch Rate (fish per hour)	2	3	1	3	7	13	6
Length Range (inches)	20.8-32.5	16.0-31.8	11.7-26.1	11.5-36.0	12.9-32.9	10.4-31.4	9.3-28.9
Average Length (inches)	26.6	25.4	18.9	22.9	19.2	19.5	16.2
Bluegill							
Total Catch	1002	880	1596	415	352	971	1919
Catch Rate (fish per hour)	449	423	767	234	169	485	923
Length Range (inches)	1.3-8.3	1.2-8.9	1.1-7.8	1.2-8.3	1.3-8.8	1.6-8.6	2.9-8.5
Average Length (inches)	4.1	4.7	3.6	4.7	3.6	4.5	4.6
Black crappie							
Total Catch	509	398	376	298	170	99	63
Catch Rate (fish per hour)	228	191	181	168	82	50	30
Length Range (inches)	2.9-11.0	2.4-10.9	2.5-11.6	1.9-10.9	2.6-11.6	2.6-11.6	4.5-11.4
Average Length (inches)	5.9	6.8	8.3	7.4	5.7	8.2	7.0
Yellow Perch							
Total Catch	213	120	31	164	183	127	99
Catch Rate (fish per hour)	96	58	15	93	88	64	48
Length Range (inches)	2.7-7.2	2.2-12.2	3.3-8.8	2.2-9.2	2.9-10.4	3.1-8.4	3.0-8.4
Average Length (inches)	4.6	5.4	6.1	3.1	5.1	5.4	6.1
White crappie							
Total Catch	0	2	1	5	10	1	0
Catch Rate (fish per hour)	0	1	5	0.3	5	0.6	0
Length Range (inches)	N/A	7.5-12.3	N/A	7.7-10.0	8.3-10.8	NA	NA
Average Length (inches)	N/A	9.9	N/A	8.8	10.1	NA	NA

CHAPTER 3 – ANALYSIS AND ALTERNATIVES

INTRODUCTION

The purpose of this section is to analyze Fox Lake's plant community's ecological characteristics and provide alternatives for plant management activities for the next 5 years. The analysis will identify management objectives, review the current status of the aquatic plant community, provide background on alternate stable states and shallow lake ecology, and identify the potential impacts of different levels of management intensity. The three levels of plant management intensity are maintenance, low manipulation, and high manipulation. A review of plant management alternatives, their feasibility for use on Fox Lake, and an estimate of cost, is also included.

Analysis

The management objectives are to provide lake access and nearshore recreational opportunities for lake residents while maintaining the beneficial ecological functions of the aquatic plant community. For Fox Lake, the primary beneficial ecological function of the plant community is to maintain a clear water state. Other secondary benefits provided by the aquatic plant community include enhanced fish and wildlife and shoreline protection.

Aquatic Plant Community

A thorough review of the status of the aquatic plant community was included in Chapter 2 of this report. A planning level summary of the aquatic plant community characteristics follows. Currently Fox Lake,w is in a clear water state dominated by rooted aquatic plants (2014 through 2016). A survey of aquatic plants in 2013 found that between 2006 and the present the frequency of occurrence of plants in Fox Lake has declined from 73.4% to 28.4%, a level below what was found before the start of the restoration project in 1995. Then the plant community rebounded in 2014 to a 52.2% frequency of occurrence, indicating how rapidly rooted aquatic plant abundance can change in Fox Lake.

Previous survey data suggests that in 1998 Fox Lake was in a turbid water state. In 2005 the lake had shifted to a clear water state and was dominated by abundant aquatic plants. Since no data was available from 1998 to 2004, the shift to the clear water state was not entirely documented. Significant increases in the abundance and frequency of aquatic plants were documented from 2004 to 2005. Relatively high levels of aquatic plants were also found in 2006. The areas of the lake supporting dense plant growth were shallow littoral areas with a silty bottom. Figure 3-1 shows the locations of nuisance plant areas in 2006. Nuisance conditions are defined as areas of the lake where recreational uses such as swimming, boating, and fishing are impeded.

Following 2006, the plant community began to decline in density. The frequency of occurrence of plants dropped from 73.4 in 2006, to 63.6 in 2007, 44.8 in 2008, and 28.4 in 2013. Plant abundance increased in 2014 with frequency occurrence rebounding to 52.2%. The greatest reduction in aquatic plants during turbid years is typically in the eastern half of the lake. The inlet areas on Cambra and Alto Creeks have maintained their plant communities through changes in lake turbidity, likely due to the clear water inputs from theses streams during base flow. Figure 3-2 illustrates the areas with dense aquatic plants in 2014, the last aquatic plant survey.

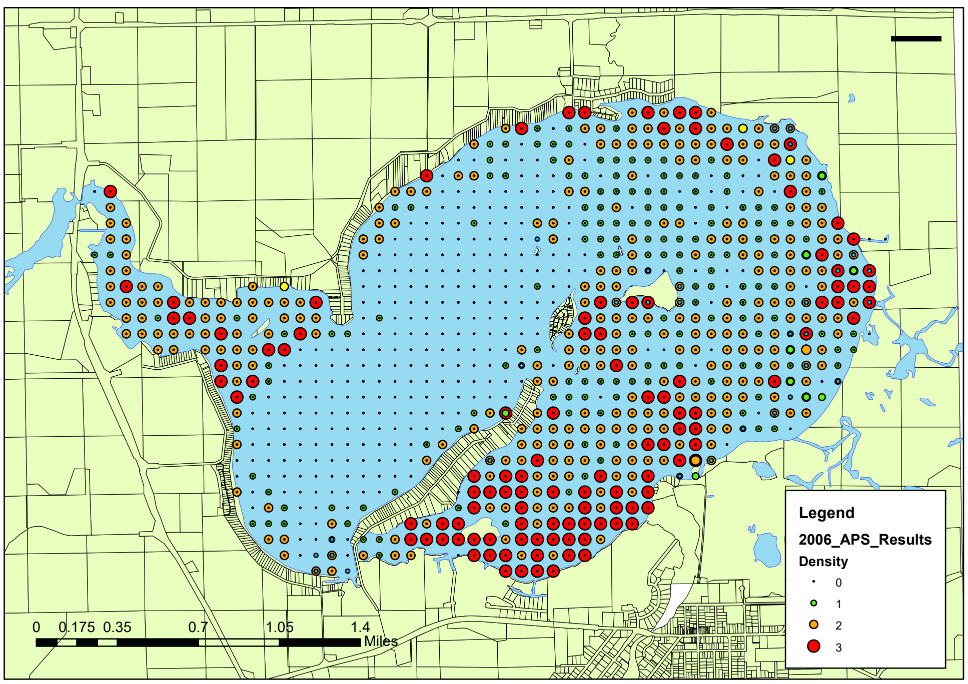


Figure 3-1
2006 Nuisance Plant Areas Indicated by Total Plant Density (Red Dots)
Source: Hey and Associates, Inc

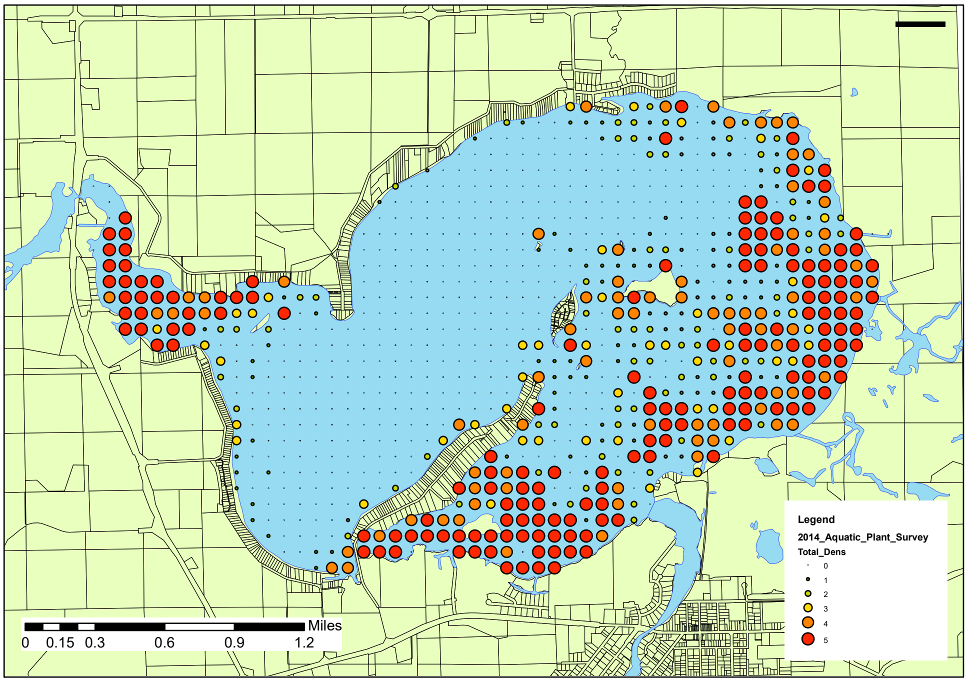


Figure 3-2
2014 Nuisance Plant Areas Indicated by Total Plant Density (Red Dots)
Source: Ecological Research Partners, LLC.

Alternate Stable States

"Alternate Stable States" refers to a model used to explain the often rapid shift that occurs in shallow eutrophic lakes from the clear water macrophyte dominant state to a turbid water algal dominant state (Figure 3-3). Eutrophic refers to a nutrient-rich condition that is very biologically productive with many plants, algae, and fish. The eutrophic condition is usually caused by watershed development or degradation associated with land use changes, but do occur naturally if lakes have very large watershed areas. Oligotrophic lakes are nutrient poor and very unproductive. They are usually found in more pristine landscapes. Mesotrophic lakes are intermediate in terms of productivity. They lie between eutrophic and oligotrophic lakes.

Figure 3-3
Aging Stages of Lakes and their Attributes
Source: University of WI-Extension and SEWRPC

A highly eutrophic lake or hyper-eutrophic lake may contain abundant plant growth but is more likely to develop nuisance algal blooms than support aquatic plants. Hyper-eutrophic lakes have total phosphorus concentrations in excess of 100 ug/l. The excess phosphorus is readily absorbed by algae. As the algae grow the water becomes more turbid. As lake water becomes less transparent, the amount of light reaching the lake bottom decreases. Less light on the lake bottom results in fewer aquatic plants. Plants first become absent from deeper areas of the lake and gradually are lost in shallower areas if water clarity is further decreased. Unfortunately, this cycle operates as a positive feedback loop because plants compete with algae for nutrients and light. When the algae are released from competition with plants, their growth usually increases and may further deplete the aquatic plant community. In some cases, hyper-eutrophic lakes reach a clear water state.

As Figure 3-4 shows, the clear or turbid water state depends on the abundance of nutrients and turbidity. The location of the ball in the model represents the probability that a given state will occur with a combination of nutrient and turbidity conditions. The vertical height of the ball location represents the preferred state of the system at any given time where the lower position is more likely to occur. The humps in the model represent the amount of energy or management required to switch to the alternate stable state. It is clear from this graphical representation that it is unlikely for a hyper-eutrophic lake to persist in the clear water state without management.

Characteristics of the clear water state include abundant aquatic plant growth, a diverse and productive gamefish community, and numerous zooplanktons while the turbid state is free of aquatic plants, produces dense algae populations, and supports an undesirable, bottom-feeding fish population (Jeppesen et al. 1990, Hasler and Jones 1949, Wetzel 1996, Van Donk et al. 1993, Kufel and Ozimek 1994, Timms and Moss1984, Schriver et al. 1995). One of these states *will* occur in shallow hyper-eutrophic lakes. An alternate version of the alternate stable states model is depicted in Figure 3-5.

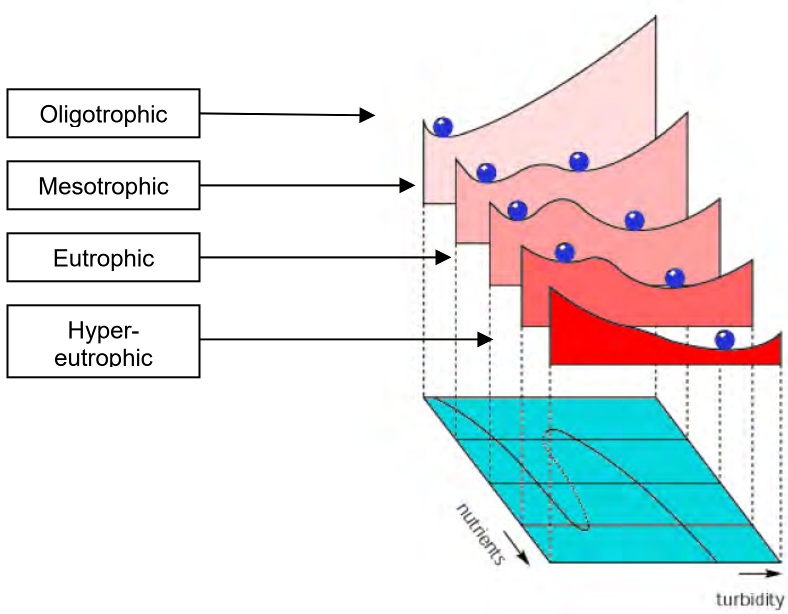


Figure 3-4
"Ball and Cup" model of alternate stable states (left side of model is clear water state)
Modified from Sheffer 2001

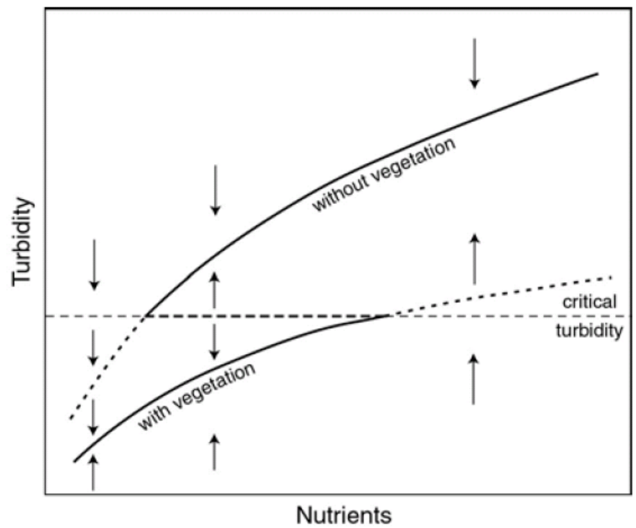


Figure 3-5
Graphical model of interaction for turbidity and nutrients for
lakes between alternate stable states
Source: Sheffer 2001

The precise factors causing a lake to switch between stable states vary from lake to lake and are not clearly understood. It is known that certain circumstances, termed buffers, tend to keep a lake in one of the two stable states.

Buffers that maintain a turbid water state include:

1) Re-suspension of bottom sediment through wind action or boating activities may lead to increased turbidity that shades out aquatic plants and/or adding nutrients directly to the water column benefiting algae (Van den Berg et al. 1997, James and Barko 1990, Hamilton and Mitchell 1997).

2) Fish communities with a large number of Common Carp that typically uproot vegetation and re-suspend sediment and/or large numbers of zooplanktivorous fish. Common Carp can have the same effect as wind or boating on bottom sediment (Whillans 1996). Too many zooplanktivorous fish reduces the capacity for algae grazing and is usually caused by a lack of top predatory fish to regulate lower trophic levels (Ozimek et al. 1990, Van Donk et al. 1990, Hanson and Butler 1994).

3) A lack of structure created by plants can reduce top predators since many fish use ambush techniques to catch their prey. A lack of structure also allows increased predation on grazing zooplankton. Both of these factors can contribute to increased algae density (Timms and Moss 1984 and Shriver et al. 1995).

4) Algae growth early in the growing season due to high nutrient availability. Since algae populations can expand rapidly under favorable conditions, aquatic plants never get established in the spring. This is in part due to the susceptibility of shallow lakes with large watershed to the impacts of nutrient-laden surface runoff (Crosbie and Chow-Fraser 1999).

Buffers that tend to maintain a clear water state are derived from the benefits of aquatic plants and are the opposite of turbid water buffers:

1) Plants minimize the impacts of wave energy on the lake bottom to minimize sediment re-suspension and protect existing plant beds.

2) Plants compete with algae for light and some nutrients.

3) Plants provide refuges for zooplankton from fish predation. This facilitates grazing on algae.

4) Plants provide spawning habitat and ambush sites for Northern pike. Pike are efficient littoral predators on planktivorous fish.

A trophic cascade is a name for complex biological interactions occurring across a food chain. The presence/absence of aquatic plants plays an important role in trophic cascades. Trophic cascades occur in the following manner with respect to algal abundance in lakes. Top predators such as Northern pike are lost from a lake through over-fishing, lack of reproduction, or reduced stocking efforts. Pike no longer feed on panfish populations so they become very large numerically yet the average panfish size decreases or becomes stunted. The overabundant small panfish feed on zooplankton and deplete the zooplankton population. Since zooplankton graze on algae suspended in the water column, reduced populations of zooplankton usually result in lower water clarity. Two of the important ecological services provided by aquatic plants are cover for predatory fish that allow them to ambush their prey (panfish) and refuges for zooplankton to avoid predation by panfish. Sustaining or enhancing the aquatic plant community alters trophic interactions to promote the clear water state. Biomanipulations are management activities that intentionally alter the existing trophic structure to enhance buffers that promote the clear water state (Figure 3-6; Moss et al. 1996 and Sheffer 1998).

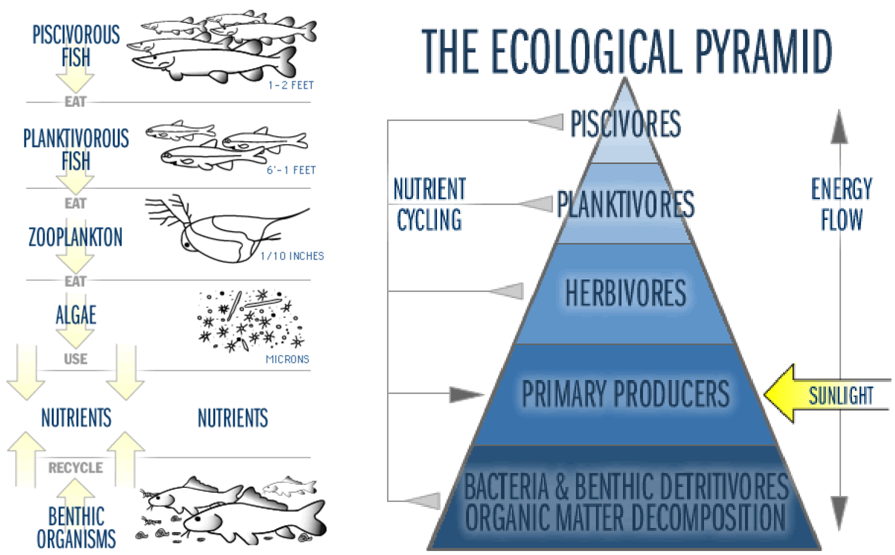


Figure 3-6
Trophic Cascade Interactions in Lakes
Source: Water on the Web

Aquatic plant management on Fox Lake must consider the delicate balance of maintaining the clear water state in a hyper-eutrophic lake. Small changes to the lake ecosystem, including the aquatic plant community, may result in a rapid shift back to the turbid water state. The alternate stable states model predicts there is a threshold for ecosystem changes that cause the shift, but there is no way to know what the threshold limit is. Simulation models have shown that even a small amount of plant management may cause the plant community to collapse or become more vulnerable to shifting to the turbid water state due to weather conditions (van Nes et. al 2002). As a result, aquatic plant management on Fox Lake must take a conservative approach.

Management Intensity

There are three levels of plant management identified by the Wisconsin Department of Natural Resources *Aquatic Plant Management in Wisconsin* (2005). The level of plant management required depends on the goals of the plant management plan and the characteristics of the lake ecosystem. The three levels of control are maintenance, low manipulation, and high manipulation. Figure 3-7 shows the proposed plant management areas in Fox Lake for navigation channels and Figure 3-8 shows areas where large-scale management of EWM would be beneficial based on 2014 levels. All riparian owners are also eligible under Wisconsin NR 107 to apply for nearshore aquatic plant management permits (See Chapter 4).

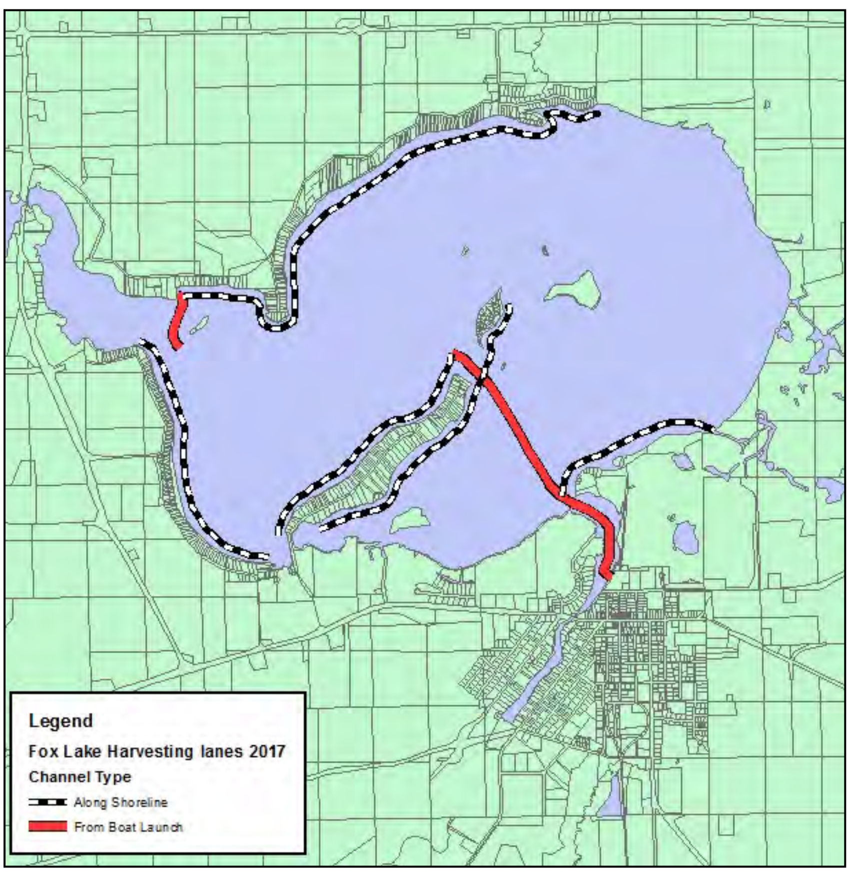


Figure 3-7
Proposed Navigation Channel Locations
Source: Ecological Research Partners, LLC.

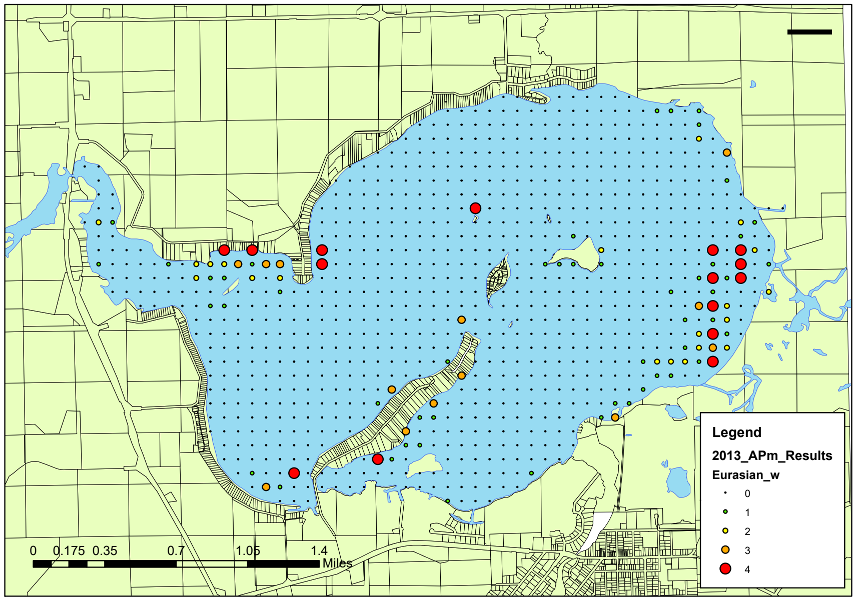


Figure 3-8
Priority Eurasian water-milfoil Management Areas Based on 2014 Conditions
Source: Ecological Research Partners, LLC.

Maintenance control is used as part of a protection orientated plan for lakes with no invasive species or nuisance conditions occur. Since Fox Lake can experience abundant plant growth with nuisance conditions in clear water years and contains invasive species, maintenance level management will not meet the aquatic plant management plan goal of providing lake access and facilitating recreational uses. Maintenance control would meet the plan goal of maintaining a clear water state. If the Eurasian water-milfoil population rebounds from 2014 levels to 2006 conditions, maintenance control may not be sufficient to protect the fish and wildlife. Research suggests that dense Eurasian water-milfoil beds do not provide the same benefits to fish and wildlife as more diverse native plant beds. During turbid years when plant densities are low maintenance, control is a feasible option for Fox Lake.

Low manipulation is an intermediate level of control. This level of control is appropriate for lakes with moderate plant problems but protection is the main goal. A plant management strategy using a low manipulation level of control could meet the needs of lake users and facilitate lake access if local areas of plant control were allowed in nearshore areas. The goal of protecting and promoting the existing native plant community could be met if control methods were selective to remove only invasive plant species. Fish and wildlife may or may not benefit from a low level of plant control depending on how well the native plant community competes with Eurasian water-milfoil. Low manipulation will not facilitate navigation outside of nearshore areas.

High manipulation is the control option with the most intense plant management. It is appropriate for lakes with moderate to severe problems. This type of program might include large-scale plant management such as harvesting or attempts to minimize the effects of exotic plant species. This level of control would meet the goal of the aquatic plant management plan to provide lake access and facilitate recreational uses, but could also cause Fox Lake to return to the turbid water state if too many plants are removed. High manipulation might also remove too many plants and reduce the habitat and food resources available for fish and wildlife. No one knows how much plant control is too much and therefore this level of management is too risky. High manipulation is not an acceptable level of control for Fox Lake if the focus is to meet minimum navigation requirements or to selectively manage EWM.

Management Alternatives, Feasibility, and Cost

There are a number of aquatic plant management options available. Management options can be broken down into the following categories: do nothing, near-shore removal, mechanically harvested navigation lanes removal, chemical control, physical control, and biological control. Each method can be effective depending on lake conditions. Conversely, each method also carries its own set of drawbacks and limitations. As a result, some options may not be appropriate for Fox Lake.

Do Nothing

Do nothing is an option where aquatic plants are not managed in any way, but monitoring typically occurs to track the changes in plant community structure. Programs to monitor for invasive species introduction or expansion are also common. In lakes containing both a healthy aquatic plant community and aquatic invasive or exotic species, allowing the native plant community to function in its natural state may prevent invasive species from spreading extensively through the lake. Other advantages include no financial cost, no harmful effects of chemicals, and no permits are required. The major drawback is that small populations of invasive species may expand and require more extensive management in future years.

No management of the aquatic plants in Fox Lake will meet the goal of maintaining a clear water state, but it will not meet the goals of promoting the native plant community, fish, and wildlife or facilitate lake access and recreational uses. Plant survey data from 2005 and 2006 suggest that aquatic plants during clear water years will continue to present navigation and recreation nuisances. To meet the use and access goals of Fox Lake District residents, management will be required to create navigation channels and in nearshore areas in clear water years. However, in more turbid water years, management may be more costly than beneficial.

Near-Shore removal

As the name suggests, near-shore removal is using a mechanized or non-mechanized implement to physically remove plants from the lake bottom. There are a number of methods in practice to manually remove plants. If manual removal methods are used, it is required by Wisconsin state law that all pulled or cut plants must be removed from the water and taken away from the waterfront.

Hand-pulling or cutting: Hand-pulling or cutting, or “manual removal”, is removing plants from the lake bottom with your hands or a rake. This can be a very selective method of plant removal, but it is also very time and labor intensive. The duration of control varies based on the type of plants removed and whether or not entire root systems or just stems are pulled. This method is preferred for small areas and to control nuisance plants with a patchy distribution such as around docks and piers. No permit is required if plants are removed from areas less than 30 feet wide or if the only plant being removed is Eurasian water-milfoil or other aquatic invasive species. Under Wisconsin Administrative Code NR 109, "*Manual removal*" means the control of aquatic plants by hand or hand−held devices without the use or aid of external or auxiliary power. A lake rake can be purchased for $80 – $115 on the internet or contractors may be hired from aquatic plant management companies. Care must be taken to minimize removal of native plants or Eurasian water-milfoil may colonize managed areas. This option would be very effective for residents on Fox Lake.

Mechanical Pulling or Harvesting: Mechanical Pulling or Harvesting is removing plants from the lake bottom with a mechanized piece of equipment. Like hand pulling the duration of control varies based on the type of plants removed and whether or not entire root systems or just stems are pulled. This method, like hand pulling, is preferred for small areas and to control nuisance plants with a patchy distribution such as around docks and piers. Under Wisconsin Administrative Code NR 109 (2)(a through d) no permit is required if plants are removed from areas less than 30 feet wide and meet the requirements of the state regulations. This option would be an alternative to hand pulling to those with limited physical ability on Fox Lake.

Mechanically Harvested Navigation Lanes

Mechanical Harvesting: Mechanical harvesting is using a large machine to cut and remove aquatic vegetation to create navigation channels or improve fish habitat by creating an edge. The vegetation is removed by using a conveyance system at the shoreline to unload plant material. The plant material is then disposed of. Harvester cutting depths are adjustable on newer machines. Widths of cuts can vary from 4 to 20 feet while depths may vary from 5 to 10 feet. Benefits of harvesting include immediate relief from nuisance conditions and the removal of plant material from the lake that may reduce biological oxygen demand and release of nutrients during the decay process. Drawbacks to harvesting are considerable start-up and maintenance costs, they are not selective and cutting multiple times a season may be necessary. Even though harvesters are equipped with plant collection devices, some fragments may drift into other sections of the lake and alter the plant community composition. This is especially a concern for Eurasian water-milfoil. Harvesters are also difficult to use around piers and in shallow water. Leasing and contracting services are available. Costs are approximately $150 – $800 per acre for contracted services. Mechanical harvesting is an excellent option for Fox Lake to create navigation channels. Mechanical harvesting options also exist to incorporate into a lake-wide Eurasian water-milfoil control strategy.

Mechanical Cutting: Cutters function identically to harvesters with the exception that plant material is not collected by the machinery. This technique carries enormous risk in lakes with invasive plants and is not recommended for Fox Lake and is impractical because there is no effective way to collect and remove cut plants as per Wisconsin state law.

Chemical Control

Herbicides: Herbicides are the lone type of chemical control available for aquatic plant management. They are chemical substances that disrupt the growth cycle of plants. There are different types of herbicides. Systemic herbicides are absorbed and transported throughout the plant effectively killing the entire plant. Contact herbicides only kill the exposed portion of the plant so plants may re-grow from the remaining roots. Another distinction between different types of pesticides is the range of plants they affect. Selective herbicides will only damage the target plants versus broad-spectrum herbicides which effect most if not all plants they come in contact with. Herbicide selectivity depends on the chemical mode of action, the dose, how it is applied, and the timing of the application (Table 3-1). Some level of non-target impacts have been documented regardless of choice of herbicide, timing and application method.

Table 3-1
Herbicides Used to Manage Eurasian water-milfoil

Herbicide Name	Trade Name	Formulation	Mode of Action
2,4-D Butoxyethlester (BEE)	Aqua-kleen, Navigate	Granular	Selective, systemic growth regulator
2,4-D Dimethylamine (DMA)	DMA 4 IVM	Liquid	Selective, systemic growth regulator
Diquat	Reward, Weedtrine-D	Liquid	Nonselective, contact
Endothall Dipotassium salt	Aquathol K, Aquathol Super K	Liquid Granular	Rate and timing dependent selectivity, contact
Endothall Dimethylalkylamine salt	Hydrothol 191	Liquid or Granular	Nonselective, contact
Fluridone	*Avast!, Sonar*	*Liquid or Granular*	*Rate dependent selectivity, systemic*
Triclopyr	*Renovate 3*	*Liquid*	*Selective, growth regulator*

Italics indicate best suited for large-scale or whole lake treatments; remaining chemical may be used for spot treatments
Source: Aquatic Ecosystem Restoration Foundation (2005)

Many systemic herbicides will provide longer control of target plants often extending into the following growing season. Contact herbicides tend to produce shorter periods of control. Concerns related to herbicide include potential toxic effects on aquatic invertebrates, adding additional decaying plant material to the lake bed that may reduce oxygen levels and increase nutrients, and water use restrictions. Each chemical has its own limitations and it is important to determine whether or not an application will cause use conflicts between lake users (Table 3-2).

Table 3-2
Water Use Restrictions for Herbicides Used to Manage Eurasian water-milfoil

Herbicide Name	Trade Name	Water Use Restrictions
2,4-D Butoxyethlester (BEE)	Aqua-kleen, Navigate	Drinking until below 70 ppb Irrigation until below 100 ppb
2,4-D Dimethylamine (DMA)	DMA 4 IVM	Same as Navigate May be toxic to invertebrates
Diquat	Reward, Weedtrine-D	Drinking 1-3 days Recommended 1-day recreational use (reduces effectiveness)
Endothall Dipotassium salt	Aquathol K, Aquathol Super K	Fish consumption 3 days Irrigation 7-25 days May be toxic to fish
Endothall Dimethylalkylamine salt	Hydrothol 191	Same as Aquathol K
Fluridone	Avast!, Sonar	Recommended irrigation tress 7 days, crops 14-30 days
Triclopyr*	Renovate 3	Irrigation 120 days or until below detection Fish 30 days

Chemical control is an effective short-term management option along shorelines and around piers. Another advantage to chemical control is that it is affordable to many riparian homeowners. Treatment of small areas (50 feet by 150 feet) cost ranges from $200 – $400 depending on the number of treatments and chemicals used. Large-scale treatments usually have a lower cost per acre and range from $100 – $1,200 per acre depending on the chemical used. A permit is required for all chemical controls under NR 107. It is required by law in most cases that riparian homeowners wanting to use chemicals to treat aquatic plants hire a licensed, certified professional applicator. Applying chemicals in a manner inconsistent with label instructions is prohibited by law. Chemical controls used around piers to facilitate navigation would be beneficial for lake residents. Selective chemical controls are also an option to develop a lake-wide plan to manage Eurasian water-milfoil.

Physical Control

A number of options for physical control of aquatic plants are available depending on the characteristics of your lake and the management site.

Dredging: Dredging the removal of lake sediments using mechanical or hydraulic equipment. It is a non-selective technique that removes all plant material and lake-bottom material. Dredging will also increase the depth of management sites and will expose the original lake bed. In many lakes, cultural eutrophication and increased sediment loads have covered the lake bottom with decaying plant material and silt. Removing this material may improve the spawning habitat for some species and decrease it for others. The disadvantages of dredging include high costs ($25 – $30 per cubic yard) and general disruption of the aquatic habitat. This technique is not recommended for Fox Lake unless it is conducted as part of a lake-wide plant management strategy.

Water Level Drawdown: Drawdowns are a common method of aquatic plant control in lakes with water level manipulation capacity. Winter drawdowns are the most common as many plants species cannot tolerate freezing conditions. Drawdowns in the summer months rely on heat and desiccation to reduce plant abundance. Once the lake level is brought up, some species may show a positive response to the drawdown; however, responses from Eurasian water-milfoil are unpredictable. Other potential effects of a drawdown are: reduced oxygen levels in winter due to reduced water volume, benthic organisms may be impacted and affects to shorelines and wetlands. Water level drawdown during the summer months is likely undesirable for the residents on Fox Lake due to limited lake access. A drawdown on Fox Lake of 6 feet would be required to limit plant growth in nuisance areas. The feasibility of a lake-wide drawdown would require an extended planning process and public support.

Dyes: Dyes are water-soluble compounds mixed in lake water that limits light penetration and reduce plant growth. Dyes favor species tolerant to low light conditions and may be used to create open water conditions where they might not otherwise occur. The disadvantages of using dye are that they are generally not effective in depths less than 4 feet and require repeated applications as they degrade or flush from the application area. Due to the large water volume, this technique is not applicable to Fox Lake.

Biological Controls

Biological control in lakes is currently in the experimental phases of development. As with many biological interactions, the effects of releasing organisms into a lake are only predictable to a certain degree. In addition, biological controls tend to operate in a cyclical nature so the effectiveness as a management tool may vary from year to year.

Grass Carp (Ctenopharyngodon idella): Grass Carp are an exotic carp species native to Eastern Europe and Asia. It is known as an aggressive consumer of aquatic plants, especially elodea and pondweeds. Grass Carp may completely eliminate aquatic plants once introduced. Grass Carp are illegal to introduce in Wisconsin waters.

Milfoil Weevil (Euhrychiopsis lecontei): The Milfoil Weevil has been documented in isolated circumstances to control Eurasian water-milfoil populations in Wisconsin, Illinois, and Vermont. Adult females lay eggs on the tips of the plant. The larval weevils emerge and attack milfoil at its growth points and stems. Most evidence to date suggests that the feasibility of long-term control is unknown and that intensive stocking is required for lake-wide control (3,000 adults per acre) for a cost of $15,000 per acre. Evidence also suggests that Milfoil Weevils are most effective on dense stands of milfoil and tend to avoid other plants. This technique is relatively unreliable and results are unpredictable and best applied on a whole-lake scale. At this time the Milfoil Weevil is not an attractive management alternative for Fox Lake.

Native Plants: Native plants may compete with Eurasian water-milfoil if there is a healthy, diverse community present. Eurasian water-milfoil thrives in disturbed conditions whether natural or human-induced. Even in cases where herbicide treatments have been highly effective, the most likely plant to re-colonize a treated area is an invasive plant. Two strategies to prevent re-colonization are spreading seeds of native species or transplanting adult plants. Spreading the seeds over a treatment area must occur early in the growing season so plants may complete their life cycle. If annuals go to seed, control may be effective the following year. This technique requires planning and the acquisition of seeds from in-lake sources or reputable nurseries. Transplanting adult plants to treatment areas should occur after plants reach full-size and before seeds are dropped. Costs for plant relocation are approximately $150 per hour. Large-scale native plant relocation is an important consideration to complement large-scale lake management of Eurasian water-milfoil. However, it should be noted that a drawback of this method is unreliable outcome or survival of the introduced plants.

Summary

Fox Lake in the last decade has flipped more than once from a turbid-water algae dominant state to clear-water rooted aquatic plant dominated condition. Clear-water states are difficult to maintain in hyper-eutrophic lakes. At this time plant management activities should be designed to promote the clear water state while facilitating lake access and recreational uses. Beneficial plant management in the lake would include strategies that reduce nutrient inputs from the watershed, and methods to explore re-introduction of plants to the lake.

Aquatic plant management on Fox Lake will require a combination of low and high manipulation to accomplish this plan's stated goals. Suggested activities include mechanical harvesting to improve navigation in off-shore areas, a mixture of hand-pulling and chemical treatments around lake residents' shoreline and piers, selective herbicide treatments to manage Eurasian water-milfoil on a lake-wide scale, and re-introduction of plants in critical areas where they have been lost.

CHAPTER 4 – RECOMMENDATIONS, IMPLEMENTATION, MONITORING, AND EVALUATION

TABLE OF CONTENT

INTRODUCTION

The following sections will provide a set of recommendations for aquatic plant management for the 5-year period beginning in the summer of 2018 through 2022. The section will identify key plan recommendations, implementation of key activities, and strategies for monitoring and evaluation. These recommendations should be reviewed at the end of the 5-year period and adjusted accordingly.

There are a number of main components to the following recommendations. They are:

- Address the continuing changing conditions experienced in Fox Lake and include recommendations for a variety of conditions ranging from an overabundance of rooted aquatic plants to those with spare vegetation in the lake,
- Facilitate recreational lake uses in nearshore areas for lake residents that have recreational impairment caused by abundant plant populations,
- Facilitate navigation to open water in selected shallow areas affected by abundant aquatic plant growth,
- Address the introduction of the exotic wetland species Phragmites,
- Continue to educate the local community on the benefits of aquatic plants, and
- Promote ecologically sound management strategies, and establish a long-term monitoring strategy.

Need for an Adaptive Management Strategy

As outlined in Chapter 2 and illustrated in Figure 4-1, the abundance of aquatic plants varies from year to year in Fox Lake. Prior to the start of the lake restoration efforts in 1995 (red line Figure 4-1) abundance of aquatic plants, as measured by frequency of occurrence, was very low with around 30 percent sites sampled on the lake having rooted aquatic plants. By 2005 the percent of sites with aquatic plants increased to almost 90%. However, after the 2005 peak plant frequency began decreasing and reached a low of 28% in 2013, lower than any survey conducted even before the lake restoration. Plants began to rebound in 2014, and while there were no surveys in 2015 or 2016, based on anecdotal information, 2016 may have had plants frequency of occurrences similar to 2005 at close to 90% occurrence.

The original five year Fox Lake Long-Range Aquatic Plant Management Plan was prepared in 2006, and adopted in 2007 when rooted aquatic plants were abundant and the plan focused on control of nuisance plant growth. Nuisance aquatic plant growth, for the purposes of this plan, is defined as abundant plant growth that impedes navigation or recreational use on the lake. When the plan was updated in 2013 & 2014 aquatic plant abundance had declined to very low levels and the updated plan focused on protection of plants and methods to promote plants in the lake.

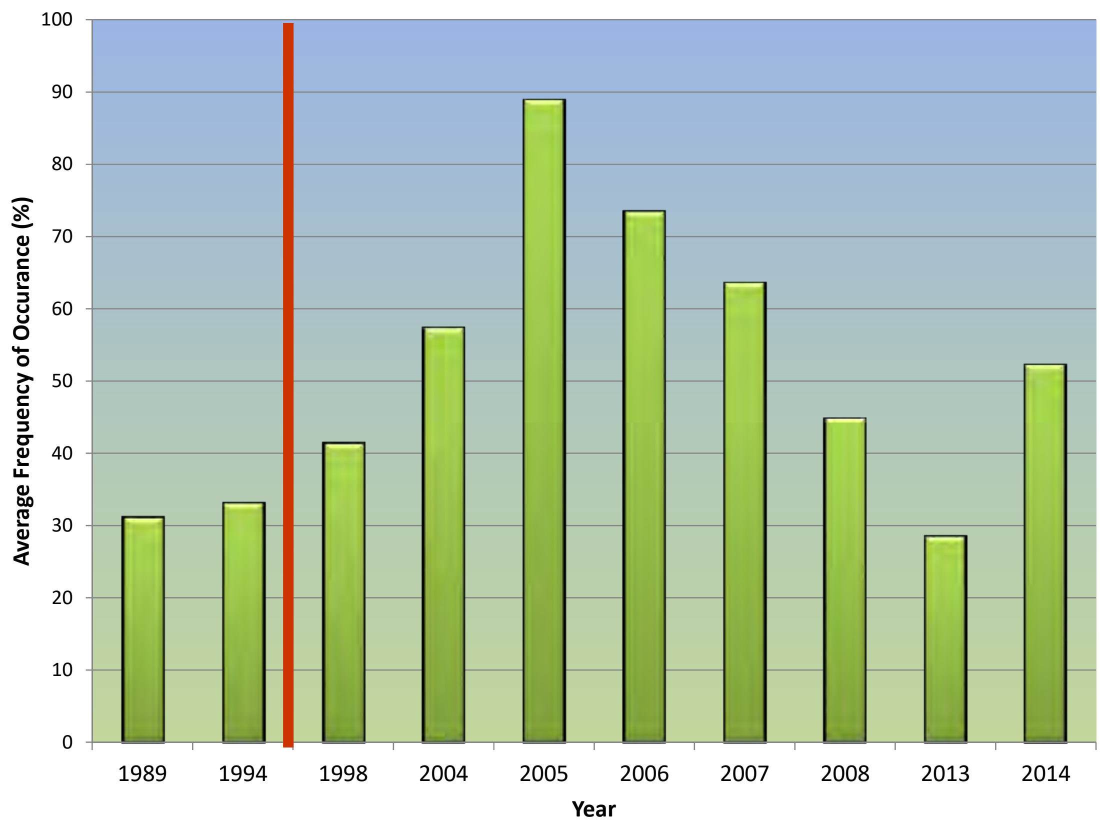


Figure 4-1
Average Frequency of Occurrence of Rooted Aquatic Plants Fox Lake
1989 through 2014

As Figure 4-1 illustrates Fox Lake can flip-flop from clear water years with abundant rooted aquatic plants, to years dominated by dense algal blooms and limited rooted plants in the lake. The cause of the varied abundance of aquatic plants from year to year may be due to variability in spring surface water runoff from the lake's watershed and varying ice clarity from the prior winter.

The aquatic plant management plan for the lake needs to be adaptable to address the varying conditions in the lake. The goal of the plan is not to influence the condition of the lake plants but is to cope with the plants in a way that maximizes reasonable recreational potential without hurting water quality. To address the need for an adaptable plan the recommendations will be divided into three categories based on plant abundance. The three categories are:

1. **Abundant** density of aquatic plants
2. **Moderate** density of aquatic plants
3. **Sparse** density of aquatic plants

Figure 4-2 outlines the definition of the three plant abundant categories.

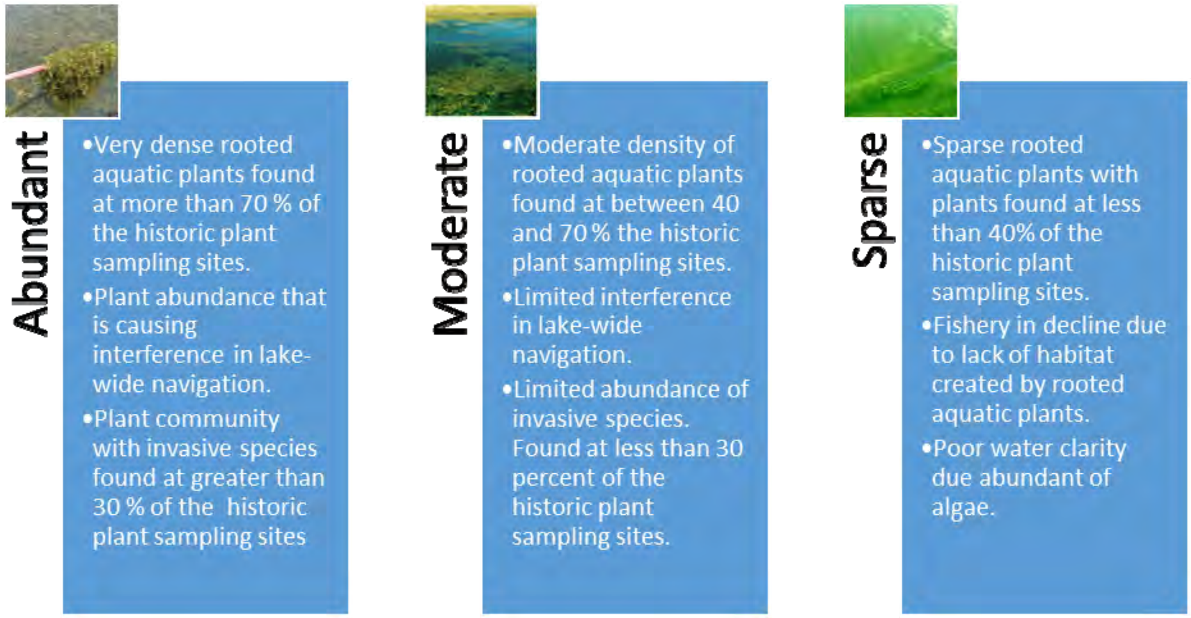


Figure 4-2
Definition of Categories of Aquatic Plant Abundance

<u>Abundant</u> density plant community is a condition where the large presence of aquatic plants is interfering with lake-wide recreation, including boating, swimming, and fishing. An abundant plant community is defined as a population of rooted submerged aquatic plants that have a density rating of 3, on a scale of 0 to 3 using the Wisconsin Department of Natural Resource's sampling protocol outlined in Chapter 2 of this report, at greater than 70% of the 886 sampling sites. Under this category rooted aquatic plants are causing interference with lake-wide navigation from the shoreline to open water. Invasive species, such as Eurasian watermilfoil, during previous periods meeting the definition of abundant, have been present at more than 30% of the formal sampling locations.

<u>Moderate</u> density plant community is a condition where the plant community is in balance with the lake, protecting the fish and wildlife on the lake while providing limited interference with recreational activities such as boating, swimming, and fishing. A moderate plant community is defined as a population of rooted submerged aquatic plants that have a density rating of 2 to 3 at between 40 to 70% of the 886 sampling sites. Under this category rooted aquatic plants are causing limited interference with lake-wide navigation from the shoreline to open water. Invasive species, such as Eurasian watermilfoil, are present at less than 30% of the formal sampling locations.

<u>Sparse</u> density plant community is a condition where the rooted aquatic plant population has dropped below a level that can support a healthy fish or wildlife community. Under this condition rooted aquatic plants are found at less than 40% of the 886 established sampling sites. The lake is dominated by dense algal blooms.

Table 1
Summary of Lake Conditions under Categories of Aquatic Plant Abundance

Condition	Abundant	Moderate	Sparse
Plant Types	Eurasian Water Milfoil found at >30% of sample sites	Eurasian Water Milfoil found at <30% of sample site	All plants species are present at <40% of the sample sites
Average Plant Density	Density rating of 3 at greater than 70% of sampling sites	Density rating between 2 to 3 at 40 to 70% of sampling sites	Density rating of 1 or less at most sites and plants found at less than 40% of sampling sites
Water Clarity	Clear-water	Varies	Turbid Algae Dominated
Level of Navigational Use Impairment	High	Varies on the location in lake	Limited Impairment
Interference with Swimming	High	Varies on the location in lake	Limited Interference

Established rooted aquatic plant sampling sites are illustrated in Figure 4-3.

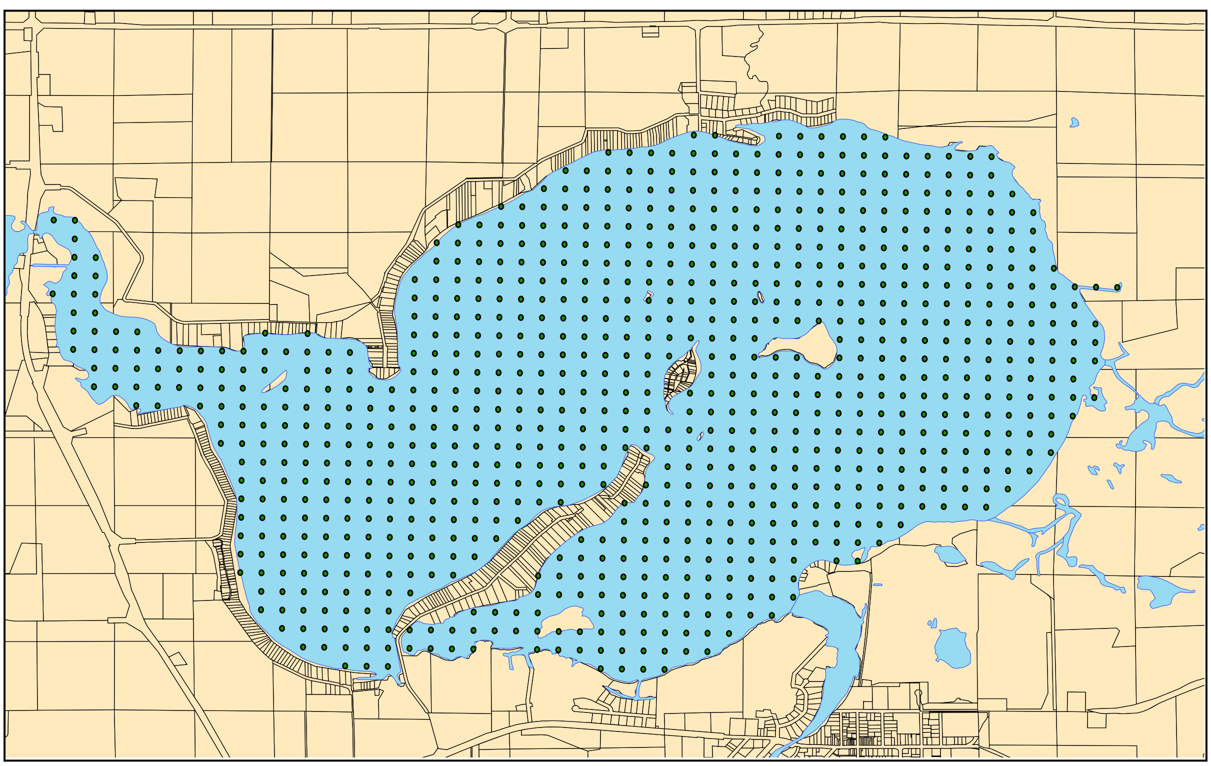


Figure 4-3
Rooted Aquatic Plant Sampling Sites on Fox Lake

Each category of aquatic plant abundance will have their own set of management strategies; from a more aggressive plant removal program when plants are abundant, to a more protection strategy when plants are sparse. Determination of which category the lake is in will be based on the following factors:

1. Results of the previous year's rooted aquatic plant survey and the increasing or declining trend in lake-wide plant abundance.

2. Results of the previous year's fishery surveys and whether or not critical species that rely on rooted aquatic plants for successful reproduction and survival are stable or in decline.

3. Abundance and density of aquatic plants at the treatment property at the time of the proposed treatment, and whether or not there is interference of recreational use at the site. For the purposes of aquatic plant management, recreational use is defined as boating, swimming, and nearshore fishing. Under Wisconsin Administrative code NR 107 this determination will be made by the Wisconsin Department of Natural Resources.

RECOMMENDATIONS

The general aquatic plant management recommendations for the Fox Lake Inland Lake Protection and Rehabilitation District (FLILPRD) are:

- Develop an integrated plant management strategy to facilitate lake access and recreational use in nearshore areas and navigation channels that minimize impacts to the overall aquatic plant community and protects ecologically significant areas of the lake,

- Develop and implement a plant enhancement program when the plant community is in drastic decline,

- Develop a strategy to control Phragmites in the lake watershed,

- Continued control of Purple Loosestrife,

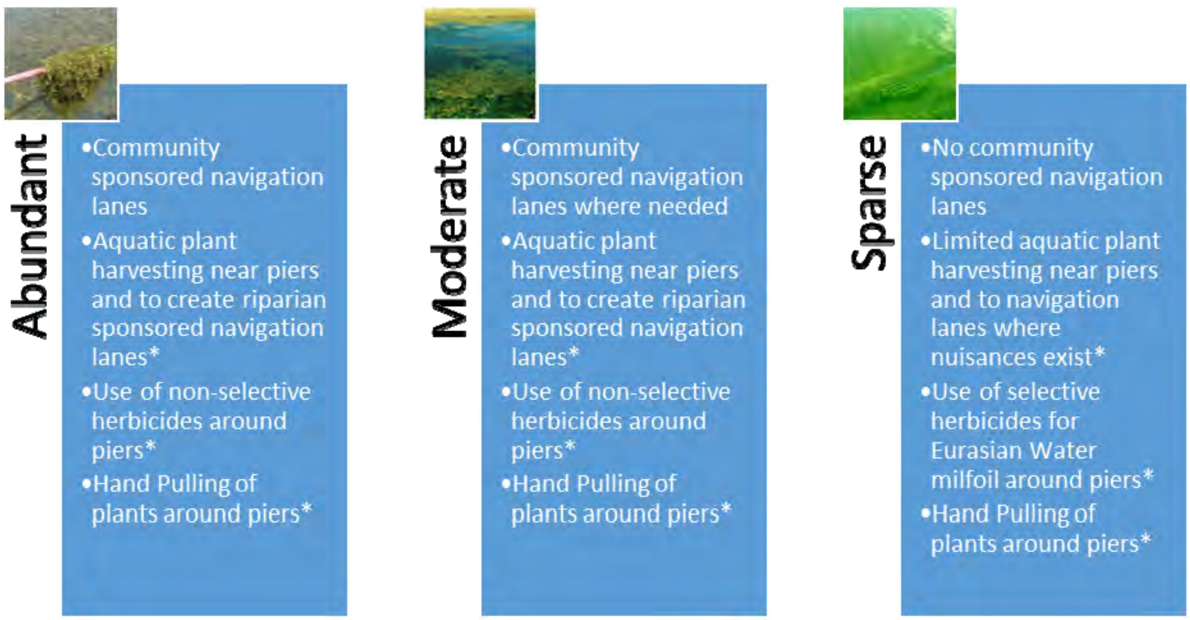
- Establish a long-term monitoring strategy,

- Educate the public on the value of a healthy native aquatic plant community and shallow lake ecology.

Utilizing the three plant abundance categories described above in Figure 4-2, Figure 4-4 outlines the types of rooted aquatic plant management that are recommended by category.

Integrated Plant Management Strategy

An integrated aquatic plant management strategy (Figure 4-4) applies a number of different methods to effectively allow recreation while maintaining ecological benefits. For Fox Lake, this management strategy will require a combination of low and high-level manipulation including manual pulling, herbicides, and mechanical harvesting. This strategy focuses on minimizing the impact to native plants, reducing invasive species such as Eurasian watermilfoil (EWM) in select areas, and promotes lake access and recreational use. The management can be broken down into practices for nearshore areas near piers and shorelines, and offshore management to allow navigation to open water.



* Activities to be sponsored by Riparian (shoreline) Landowners. Aquatic plant harvesting and use of herbicides require a permit from the Wisconsin Department of Natural Resources.

Figure 4-4
Types of Rooted Aquatic Plant Management Associated with
Levels of Plant Abundance

Under this integrated approach, property owners would manage plants around their piers by hand pulling and the use of herbicides. A series of off-shore community sponsored navigation lanes would be maintained to provide access to open water (shown in dark blue in Figure 4-5). Homeowners would connect to the community sponsored navigations channels through a series of riparian sponsored navigation channels (shown in light green in Figure 4-5).

Any use of herbicides and/or mechanical harvesting requires permits for the Wisconsin Department of Natural Resources under Wisconsin Administrative Codes NR 107 and NR 109 respectively.

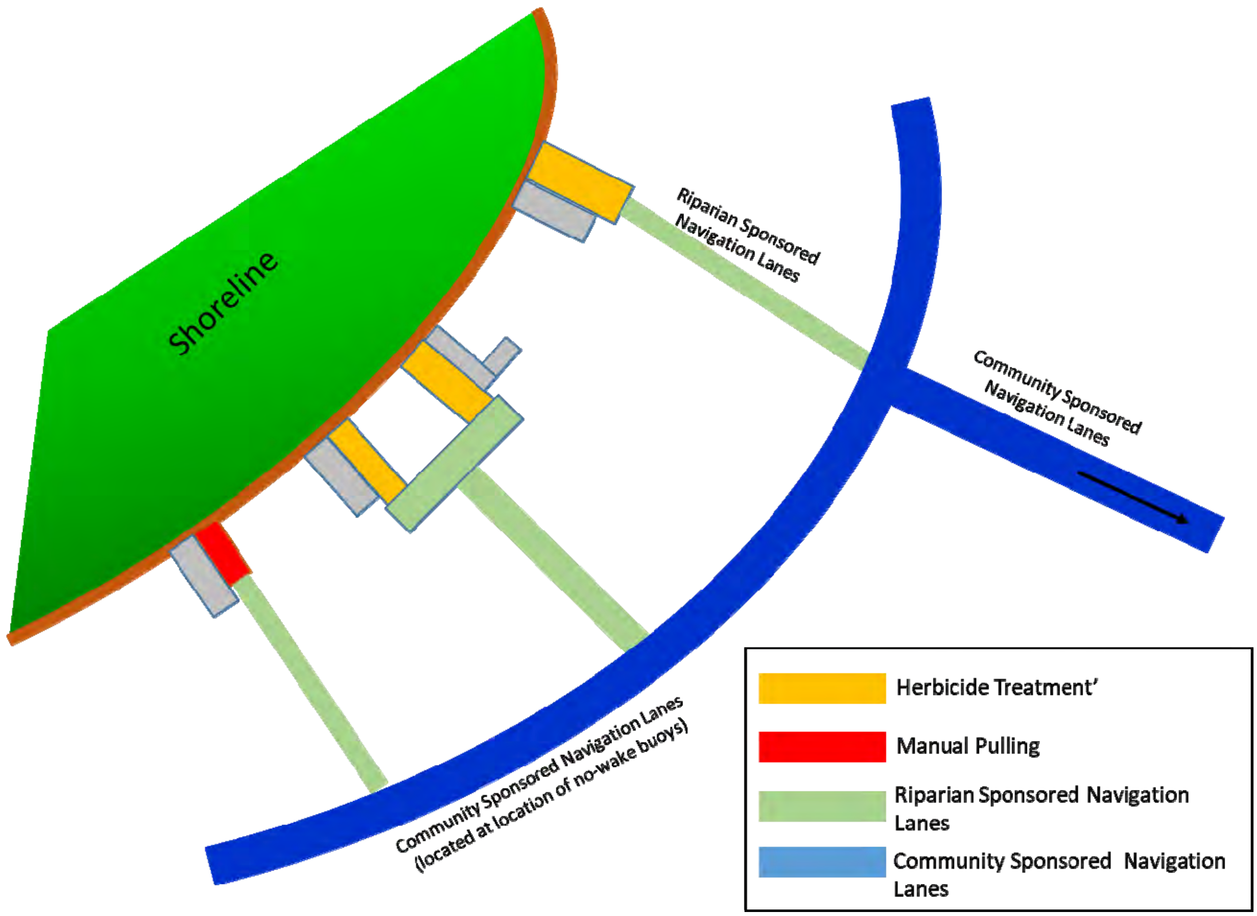


Figure 4-5
Integrated Aquatic Plant Management Strategy
Source: WDNR and Ecological Research Partners, LLC.

Nearshore Areas

Allowed control techniques for rooted aquatic plants in nearshore areas will include the following practices depending on plant abundance:

Abundant and Moderate Plant Abundance

- Hand-pulling, or raking of a 30-foot wide area perpendicular to shore in accordance with NR 109.06(2),
- Use of non-selective herbicides, with a state permit, to control any plants around piers that are inhibiting boat access, swimming or fishing,
- Use of nonselective herbicides, with a state permit, to create riparian sponsored navigation lanes,
- Aquatic plant harvesting, with a state permit, near piers and to create riparian sponsored navigation lanes.

Nonselective or contact herbicides are products designed to kill all rooted aquatic plants. This group of herbicides includes products such as Diquat or Endothall. Note, that these products can only be used by a certified herbicide applicator licensed by the State of Wisconsin.

Previous aquatic plant management plans discussed the use of the herbicide 2,4-D as a selective product to treat Eurasian Watermilfoil. Recent research has indicated the 2,4-D easily drifts from the treatment area and is difficult to maintain at effective concentrations to obtain adequate control. Therefore, the Wisconsin Department of Natural Resources is no longer recommending the use of this product.

Note that if you use a combination of techniques the waiver for a permit for manual pulling no longer exists and a state permit will be required. With regards to nearshore navigation lanes, these can be created and maintained by either mechanical harvesting or chemical herbicides. Neighboring property owners can also work together to create common riparian sponsored navigation lanes or swimming areas (Figures 4-5 and Figures 4-6).

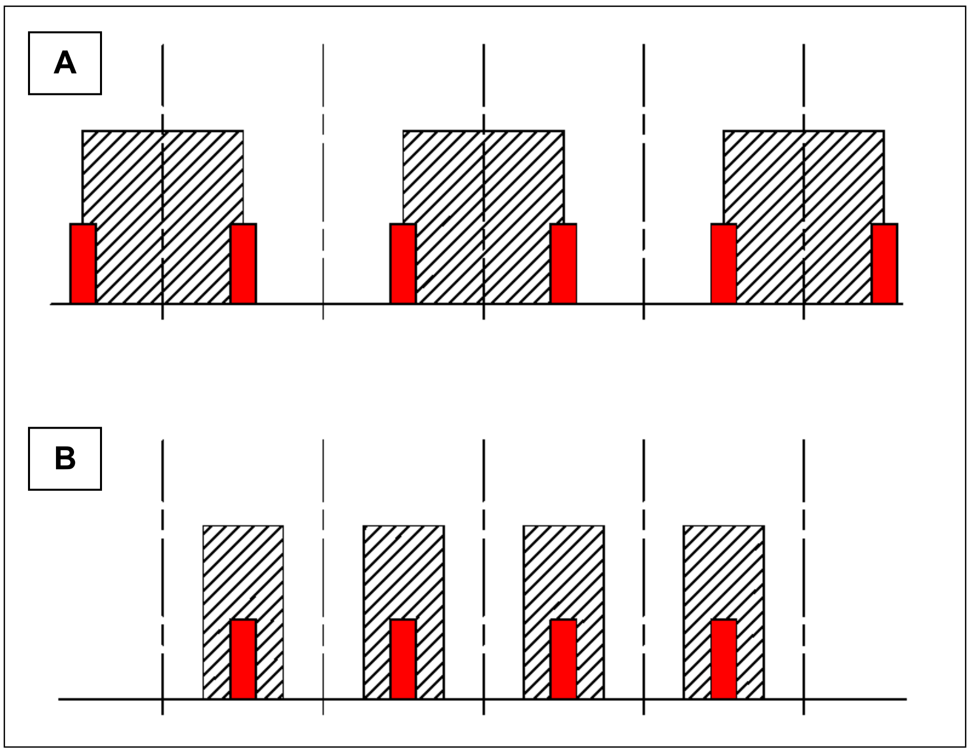


Figure 4-6

Alternate Contact Herbicide Application Strategy (not to scale)

Source: Ecological Research Partners, LLC.

All financial obligations for plant management in nearshore areas are the responsibility of the local riparian homeowner[1]. Whenever possible, treatments that affect non-nuisance native plants should be avoided.

[1] Other local landowners such as the District, the Town, and the City of Fox Lake may also sponsor nearshore applications near boat launches, fishing piers, or swimming areas as needed.

Fox Lake is a highly productive lake so it is unrealistic to expect shallow areas of the lake to be plant free. It is essential that beneficial native plants such as Elodea or pondweeds are not removed or minimally removed because they are important to the health of the fishery and water clarity. Elodea and Sago pondweed are high-value aquatic plants for fish and wildlife and should be removed sparingly. Aquatic plants also provide the added benefits of reducing shoreline erosion and improving water clarity.

The use of herbicides or mechanical harvesting on Wisconsin lakes is regulated under Wisconsin Administrative codes NR 107 and NR 109 respectively. Under these codes, a permit from the Wisconsin Department of Natural Resources is required. Failure to acquire or follow the conditions of these permits can result in a citation, monetary fines and jail in severe situations. Information on these needed permits can be found on the Department's website at http://dnr.wi.gov/lakes/plants/.

To ensure adequate protection of native plants, all properties that request aquatic plant management by chemical methods should be inspected prior to chemical treatment to determine the optimal management strategy. The inspection will include using a rake type sampler to determine the types and density of plants present at each management site. Results of the inspection should be recorded to ensure the chemical application reports are accurate to track aquatic plants at each property from year to year. If inspections cannot be conducted by the Wisconsin Department of Natural Resources (WDNR), an independent third party will be hired by the Fox Lake Inland Lake Protection and Rehabilitation District to supervise the chemical treatments.

As has been the policy in the past, the onsite supervisor will determine if herbicides can be used based on plant density. For example, herbicide treatment would be denied if any of the following conditions exist:

1. The site is very shallow and has muck substrate making the area unsuitable for swimming.

2. Plants present are washed in and floating, and rooted plants are sparse.

3. There is no pier.

4. Fish spawning is actively occurring.

Manual removal methods, such as hand-pulling, or raking, that focus on selective removal of Eurasian water-milfoil and Coontail are preferred. Residents are allowed to remove native and non-native plants without a permit in a 30-foot wide area around their piers to allow for navigation and recreation. Eurasian water-milfoil may be selectively removed (hand-pulled or raked) outside of the 30-foot area without a permit, but other plants are limited to a 30-foot wide area. All removed plants must be disposed of on dry land in a manner that will not allow the plants to wash back into the lake and infest other areas. Composting is one way to dispose of plant material.

Chemical treatments may be allowed for property owners with nuisance rooted aquatic plant densities that clearly inhibit recreational uses such as boat access, swimming or fishing from the shoreline or off the pier. **All chemical treatments require a permit from the Wisconsin Department of Natural Resources.**

Typically chemical treatments are centered on piers, but an alternate strategy that may provide more relief would be to center the treatment on the property boundary between parcels (Figure 4-6A). This would increase the average size of the remaining plant beds. If an adjacent property owner does not need or want a chemical treatment, then piers may be used as the treatment centerline (Figure 4-6B). It is the responsibility of the homeowner to determine where the center of their treatment area should be located and accurately represent its location on their permit application.

It is important to note that treatment strategies are NOT additive. Riparian property owners may NOT treat 30-feet of frontage with herbicides and hand-pull plants from an additional 30-foot wide area. Plant management is only allowed only for a 30-foot wide area for contact herbicide treatment or manual removal. Situations creating a total management area in excess of the above specifications are illegal. The only exception to this rule is that Eurasian water-milfoil may be selectively removed by hand-pulling anywhere along a property's frontage. Plant removal using multiple methods is allowed if it is confined to a single 30-foot wide area where plants closest to shore are manually removed and plants in deeper water are chemically treated (Figure 4-5). Also, any free-floating plants that accumulate along the water's edge can be removed without a state permit.

Finally, it would be in the best interest of the lake residents for a central entity such as the District to oversee all plant management permit applications. The Fox Lake Inland Lake Protection and Rehabilitation District (FLILPRD) has developed a program whereby local residents can jointly apply for a group permit and coordinates treatment through a single contractor to minimalize cost to the residents. We encourage residents to take advantage of this program and avoid individual treatments. Multiple permit applications and herbicide applicators would make it more difficult to schedule the suggested site monitoring activities and result in higher costs to residents.

Community Sponsored Navigation Channels

Due to the past dominance of aquatic plants in shallow areas in Fox Lake, actions to facilitate navigation to deep water areas may be required in some years. This will include a community sponsored navigational channel program. The proposed location of navigation channels on the lake correspond to;

- The areas of highest plant density,
- Minimal depth requirements for operation of harvesting equipment, and
- Locations that will not interfere with near-shore recreation.

The areas were determined during planning meetings open to the public.

The channels would be approximately 150-feet off shore just inside the existing no-wake buoys. At 50 foot in width, the channel will extend from 150 feet off-shore to approximately 200 feet off-shore, within the lake no-wake zone. It was the recommendation of the WDNR boating safety warden and the aquatic plant management advisory committee that the community sponsored navigation channels should not be too close to piers, swimming rafts or other off-shore recreational equipment to prevent user conflicts and that located at 150-feet off-shore would protect public safety. The committee also wanted to take advantage of the Town of Fox Lake's no-wake buoys to help mark the location of the channels. The locations of the channels are illustrated in (Figure 4-7). The location of these channels may be modified from year to year depending on plant densities and nuisance conditions.

Figure 4-7
Proposed Navigation Channel Locations & Potential Location of Harvesting Loading and Unloading Sites

The community sponsored navigation channels will be 50-foot wide located just inside the no-wake buoys to facilitate the passing of two boats. No-wake speeds are approximately 20 mph. The channels will be created in May or June when plants become abundant and maintained with up to two additional cuttings if needed, for a maximum of three cuttings per year. The need for harvesting will be based on surveys conducted by the Fox Lake Inland Lake Protection and Rehabilitation District (FLILPRD) or its designated representative. Harvesting will take place when the plant growth interferes with navigation and the harvesting contractor is available.

Frequent use of cut channels by boaters should be encouraged to reduce the number of cuttings (and cost) required to maintain the channels. During periods of moderate plant densities, the number of navigation channels may be reduced to only areas with nuisance conditions.

The community sponsored navigation channels will be sponsored by the Fox Lake Inland Lake Protection and Rehabilitation District (FLILPRD) through a special assessment levy on lake properties. Maintenance of the navigation lanes will only take place if adequate funds are placed in the annual budget by the electorate at the annual meeting, the first Saturday of August each year. For the calendar year 2017 the electorate approved a budget of $70,000 for this purpose. Any money not used in an annual year for navigation channels maintenance will be placed in a segregated account for future navigational channel maintenance.

The navigation channel could be created by either mechanical harvesting or chemical herbicide treatment. Mechanical harvesting has the advantage over herbicides that plant biomass is removed from the lake during the process and therefore reduces the buildup of organic sediment and nutrients in the lake. Therefore, for this reason, mechanical harvesting is recommended for the creation and major maintenance of the channels. Herbicides could be used for limited maintenance of the channels later in the season when plant densities are low.

The 2017 harvesting should be conducted by a contractor. Any plans to purchase equipment to conduct a community sponsored harvesting operation would require additional study by the community to determine costs and logistics.

The District will need to develop loading and unloading sites for harvesting equipment and disposal sites for harvested materials prior to implementing any program. Due to the large size of the lake, several loading and unloading locations will be identified to reduce travel time by the harvesters and transport barges on the lake. Some potential loading and unloading locations are illustrated in Figure 4-7. In addition, a large-scale permit[2] including an application fee will be required under Wisconsin Administrative code NR 109 prior to the commencement of any harvesting activities

[2] Large-scale permits are required for areas larger than 10-acres. Since the area on Fox Lake approaches 10-acres for the primary channels, it is recommended that a large-scale permit is acquired to facilitate cutting in any secondary areas.

Lake-wide Eurasian Water-Milfoil Strategy

Eurasian water-milfoil (EWM), an invasive species, has been established in Fox Lake for several decades. The plant was found in plant surveys dating back to the 1980's. The original aquatic plant management plan adopted in 2007 included a lake-wide management strategy to limit the ecological impacts of this exotic invasive species. In 2006 Eurasian water-milfoil had spread to most of the lake (Figure 4-8). In 2007 priority areas for a lake-wide management strategy were established for areas with the densest infestation (Figure 4-9) and progress to areas of lesser density

Aquatic plants surveys conducted on Fox Lake in 2007 through 2013 showed a dramatic decline in EWM. Figure 4-10 illustrates the decline in EWM in Fox Lake from 2007 to 2014. Due to the decline in EWM in 2013, the 2014 aquatic management plan did not recommend any large-scale plant management of EWM. In 2013 the aquatic plant technical advisory committee felt due to the overall decline in rooted aquatic plants, any plant, even an exotic, was important to maintaining fish habitat in the lake. The 2014 plan stated that "*If EWM levels return to 2007 conditions it is the recommendation of the plan that the FLILPRD consider the implementation of a large-scale plant management program to control this exotic plant. Implementation of this recommendation will only take place if financial resources are available through the District's annual budgeting process. Funding through the Aquatic Invasive Species Grants from the Wisconsin Department of Natural Resources is available, though these grants are extremely completive and are not guaranteed."*

Based on anecdotal information, it appears that in 2016 EWM has rebounded in Fox Lake. The last aquatic plant survey was conducted in 2014. No surveys were conducted in 2015 or 2016, in accordance with the previous plan's recommendation that aquatic plant surveys be conducted every three to five years. Initial cost estimates for a large-scale plant management of EWM range from ~$100,000 - $500,000 to treat the initial 625-acres identified as containing EWM in 2006. A plant survey is planned for 2017. The results of the 2017 aquatic plant survey should be used to develop a new EWM strategy.

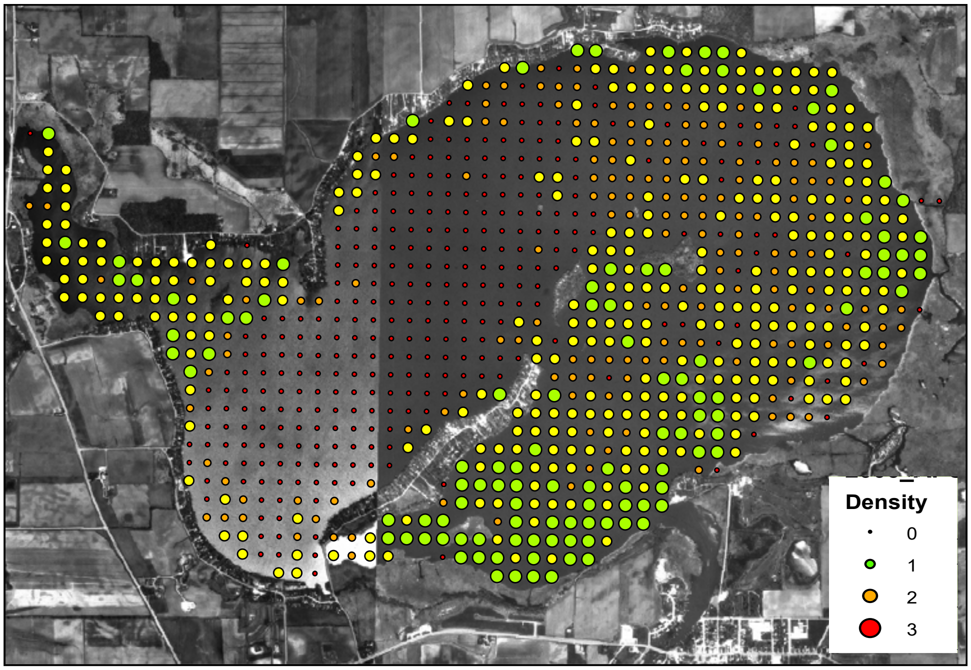


Figure 4-8
Lake-wide Eurasian water-milfoil Distribution 2006
Source: Hey and Associates, Inc.

Figure 4-9
Potential Lake-wide Eurasian Water-milfoil Control Areas Based on 2007 Conditions
(Treatment Areas are shown in Red)

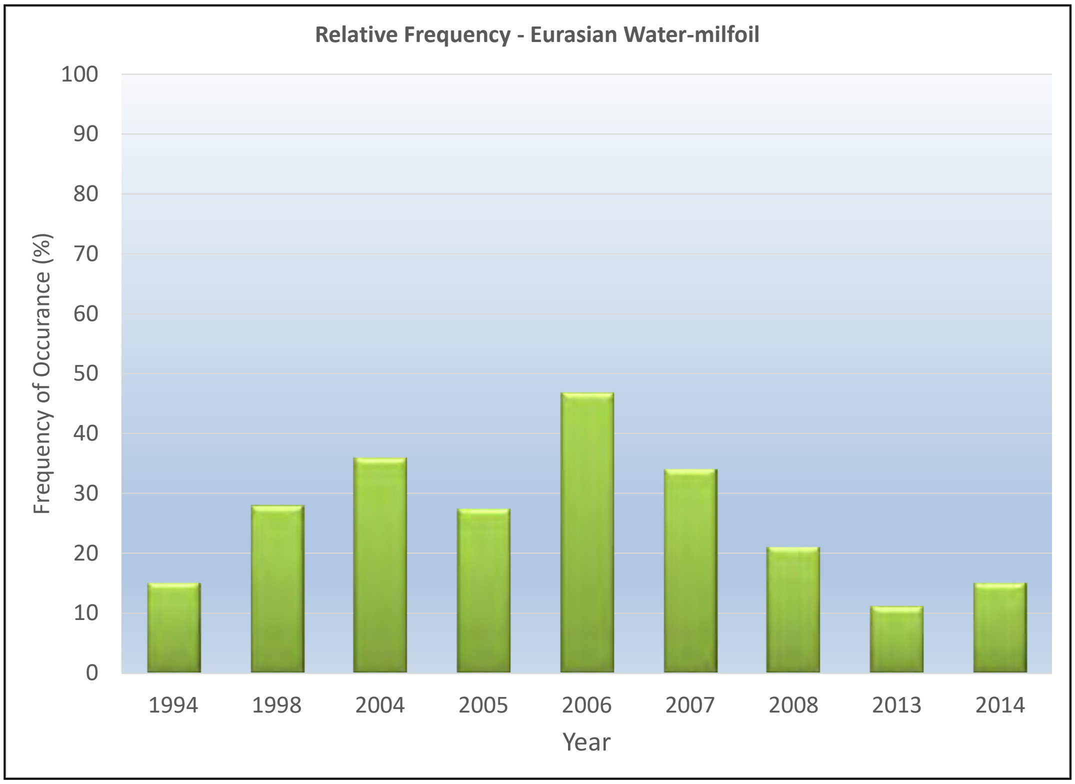


Figure 4-10
Abundance of Eurasian Water-Milfoil 1994 through 2014
Source: Ecological Research Partners, LLC.

Table 4-1
Frequency of Occurrence Submerged Rooted Aquatic Plants in
Fox Lake from 2005 through 2014

Year	Frequency of Occurrence	Average Density
2005	89%	-
2006	73%	1.25
2007	64%	1.28
2008	45%	0.63
2013	17%	0.47
2014	52%	1.72

Phragmites Control

Phragmites australis (frag-MY-teez), also known as common reed, is a perennial, wetland grass that can grow to 15 feet in height (Figure 4-11). While Phragmites australis is native to Wisconsin, an invasive, non-native, variety of phragmites is becoming widespread and is threatening the ecological health of wetlands. The invasive phragmites has been found in the Fox Lake area at several locations.

Figure 4-11
Native and Introduced Phragmites

The invasive variety of phragmites creates tall, dense stands which degrade wetlands and coastal areas by crowding out native plants and animals, blocking shoreline views, reducing access for swimming, fishing, and hunting and can create fire hazards from dry plant material. It is thought to have been introduced to North America in the early 20th century from packing material and ballast on ships from Europe that contained peat and sediments which was frequently dumped in coastal marshes (Wisconsin DNR, 2013).

Phragmites typically grows in shoreline and interior wetlands, lake margins, roadside ditches, and other low, wet areas, although it can also be found in dry areas. It spreads rapidly due to its vigorous rhizomes (horizontal roots that produce new shoots) which can exceed 60 feet in length, grow more than six feet per year, and readily grow into new plants when fragmented. Rhizomes broken by natural actions such as waves, or human actions such as dredging or disking, quickly take root in new locations. Rapid expansion is also facilitated by other disturbances that give phragmites a competitive edge, including the discharge of nutrients, wetland drainage, fire suppression, and road salt.

Control

Phragmites can be controlled using an initial herbicide treatment followed by mechanical removal (e.g., cutting, mowing) and annual maintenance. For large areas with dense stands of phragmites, prescribed burning used after herbicide treatment can provide additional control and ecological benefits over mechanical removal.

Control Sequence

In Fox Lake the control sequence will be as follows:

1. In the summer of 2017, a field reconnaissance survey should be conducted of the Fox Lake shoreline. The lake-shore survey will be conducted by boat.

2. Once problem phragmites beds have been identified a management strategy will be developed for each bed.

3. A grant application will be prepared for the implementation of a control program.

4. If grant resources are available, the FLILPRD will contact the owners of any phragmites beds on private property to request permission to conduct a control program on their property.

5. Based on the management strategy a licensed contractor will be hired to implement the program.

6. Follow-up monitoring will be required annually to determine the need for follow-up treatments and to identify any potential new beds.

The cost of a phragmites control program is unknown until the field reconnaissance survey is completed and the degree of infestation is known.

MONITORING STRATEGY

Due to the sensitive nature of the aquatic plant community in Fox Lake exhibited by its tendency to alternate between the turbid and clear water states, a comprehensive aquatic plant survey should occur every year to assist with future planning. The cost of a comprehensive aquatic plant survey is about $6,000 to $10,000 per survey. The cost of annual monitoring for phragmites is unknown until a field reconnaissance survey is completed and the degree of infestation is known.

PUBLIC EDUCATION

Twelve meetings of the FLILPRD Aquatic Plant Management Citizen and Technical Advisory were held to develop this management plan update (9/1/2016, 9/16/2016, 9/23/2016, 10/11/2016, 10/14/2016, 11/2/2016, 11/16.0216, 12/2/2016, 1/17/2017, 2/2/2017, 6/26/2017, and 7/12/2017). The Advisory Committee meeting were all open to the public. A public informational meeting was held to introduce the draft plan to the district residents on August 5, 2017. The plan update was adopted by the Fox Lake Inland Lake Protection and Rehabilitation District on December 14, 2017.

The exotic species Eurasian Water-milfoil and Zebra Mussels are present in Fox Lake. Other exotic species listed in Wisconsin Administrative Code NR 40 are not present in the lake. To keep new exotic species from entering Fox Lake, and from moving existing exotic species from Fox Lake to other lakes, it is recommended that the Town of Fox Lake and /or the FLILPRD consider implementing a “Clean Boats, Clean Waters” program. The “Clean Boats, Clean Waters” watercraft inspection program is a volunteer-based effort to minimize the spread of aquatic invasive species. Volunteers are trained to organize and conduct a boater education program in their community. Adults and youth teams educate boaters on how and where invasive species are most likely to hitch a ride into water bodies. Volunteers perform boat and trailer checks for invasive species, distribute informational brochures, and collect and report any new water body infestations.

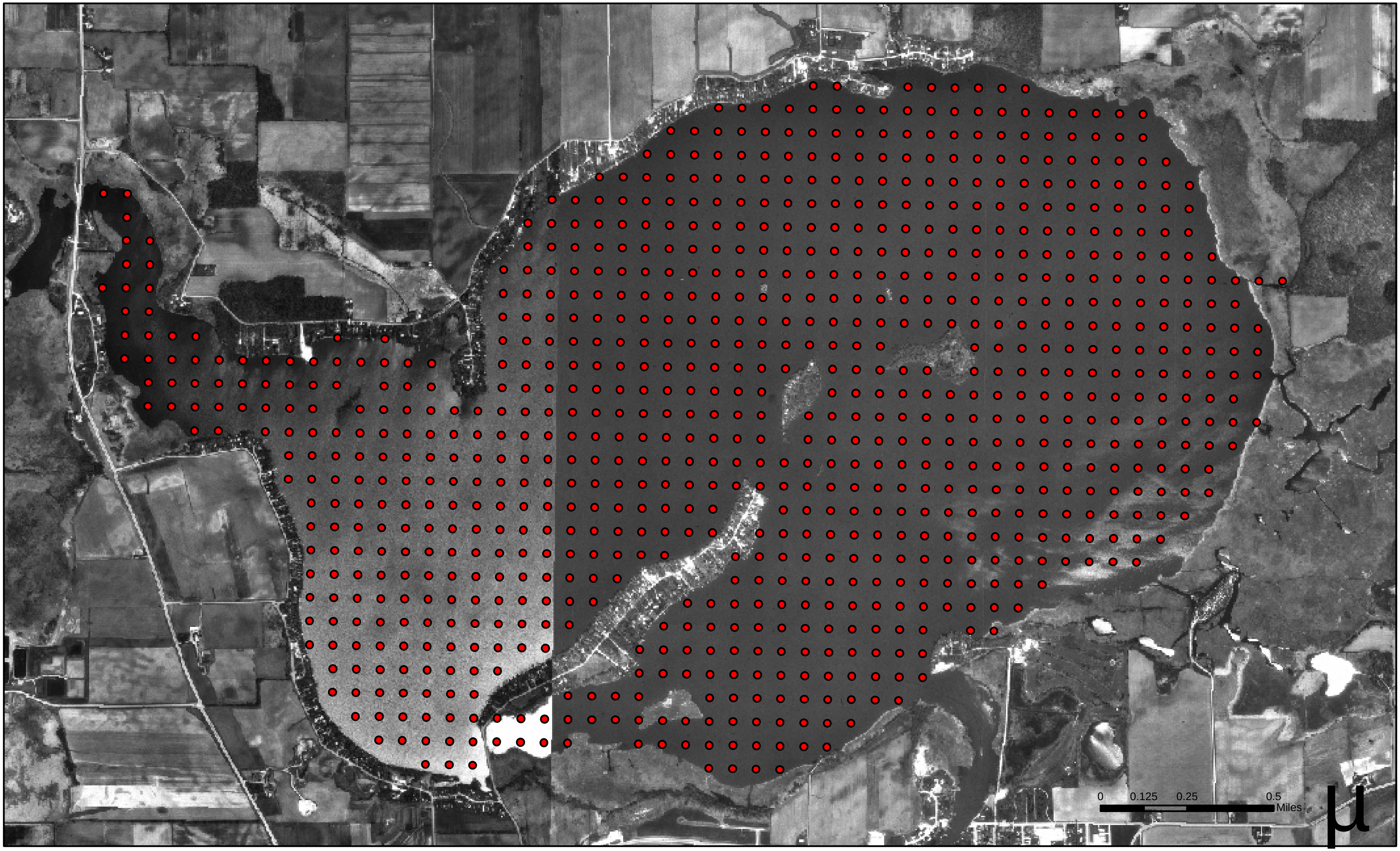
A “Clean Boats, Clean Waters” program could be eligible for grant funding through the Wisconsin Department of Natural Resource’s Clean Boats Clean Waters Grants program. The state may issue a grant for 75% of project costs up to a maximum $4,000 per boat landing. The remaining 25% of the project cost must be provided by the project sponsor in the form of cash, donated labor or services, or “in-kind” items. Information on the grant program can be found at http://dnr.wi.gov/lakes/cbcw/.

EVALUATION

The Fox Lake Long-term Aquatic Plant Management Plan should be revised in 5 years utilizing a planning effort similar to the initial plan development. Benchmarks to gauge the success of the current plan include data from aquatic plant surveys, feedback from the public regarding navigation and recreation, and maintaining water clarity. Information on the implementation of the plan will be published in the Lake District's newsletter and on their website. Annually the Lake District should hold an informational meeting and listening session to determine if the recommendations of the plan are meeting the public's needs.

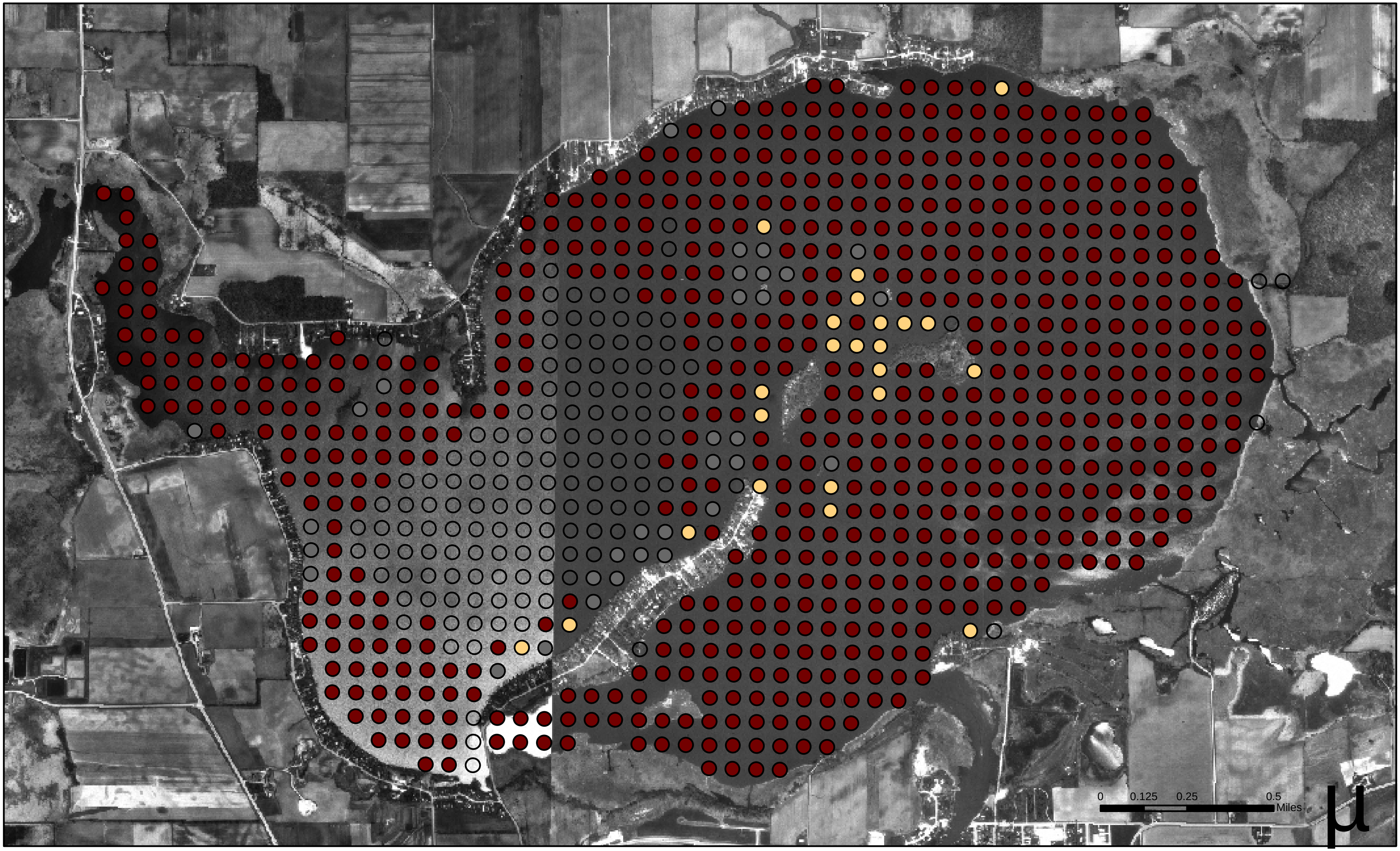
APPENDIX A

Lake Maps



Point-Intercept Plant Survey Sites
Fox Lake - Dodge County, WI

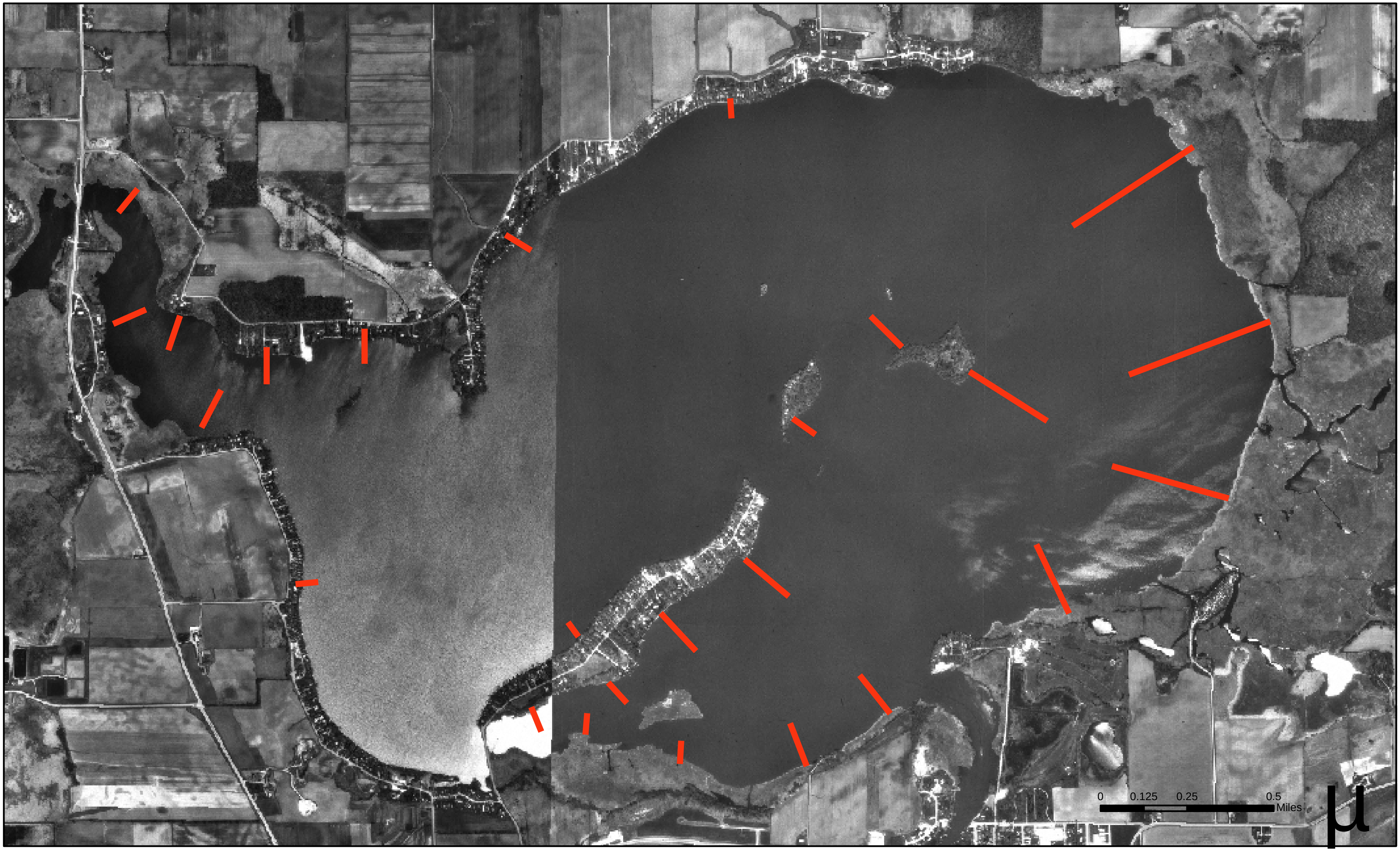
Hey and Associates, Inc.
Water Resources, Wetlands and Ecology



Lake Sediments
Fox Lake - Dodge County, WI

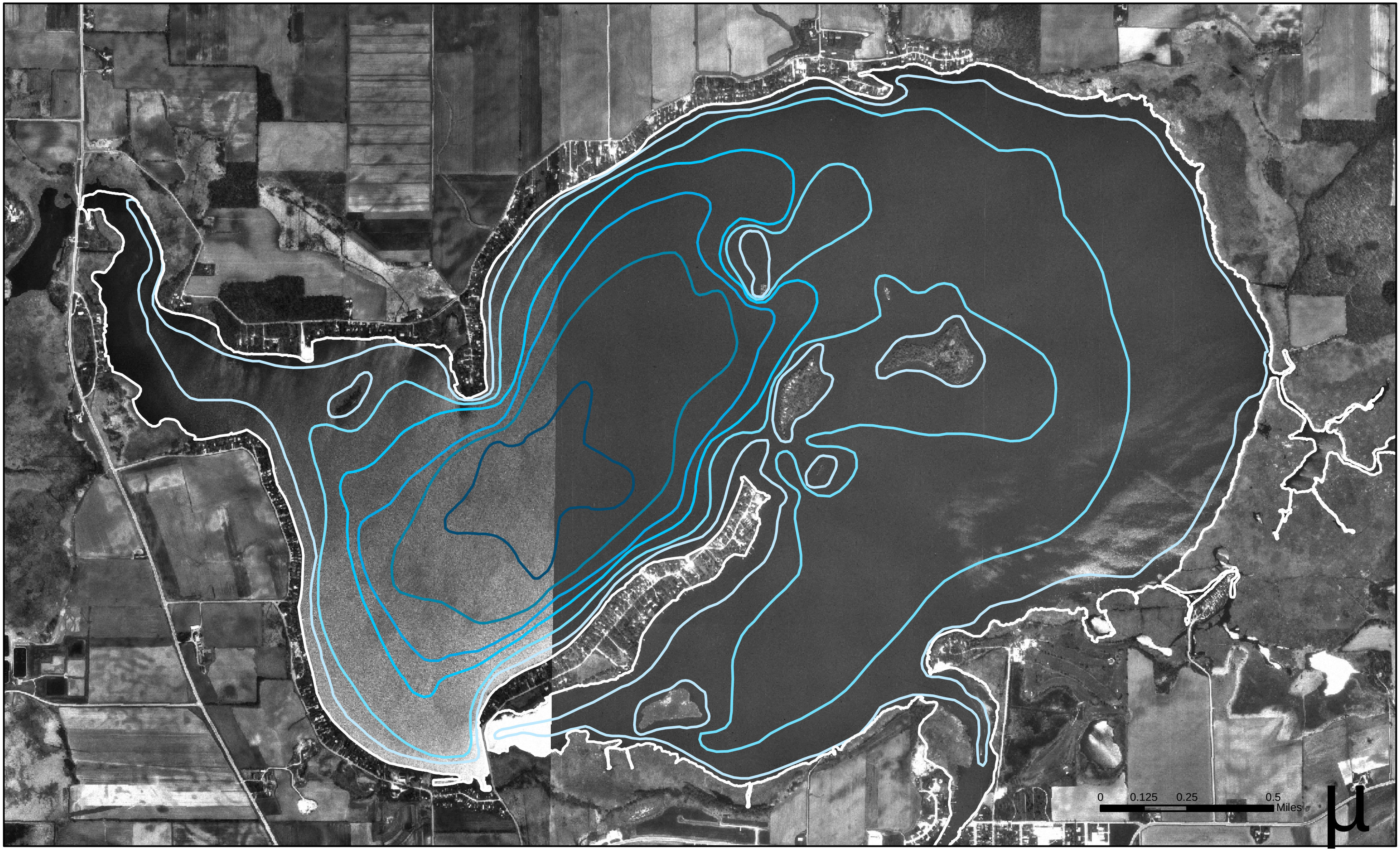
Hey and Associates, Inc.
Water Resources, Wetlands and Ecology

Sediment Type
- No Data
- Mud or Muck
- Rock
- Sand



Historic Plant Survey Transects
Fox Lake - Dodge County, WI

Hey and Associates, Inc.
Water Resources, Wetlands and Ecology

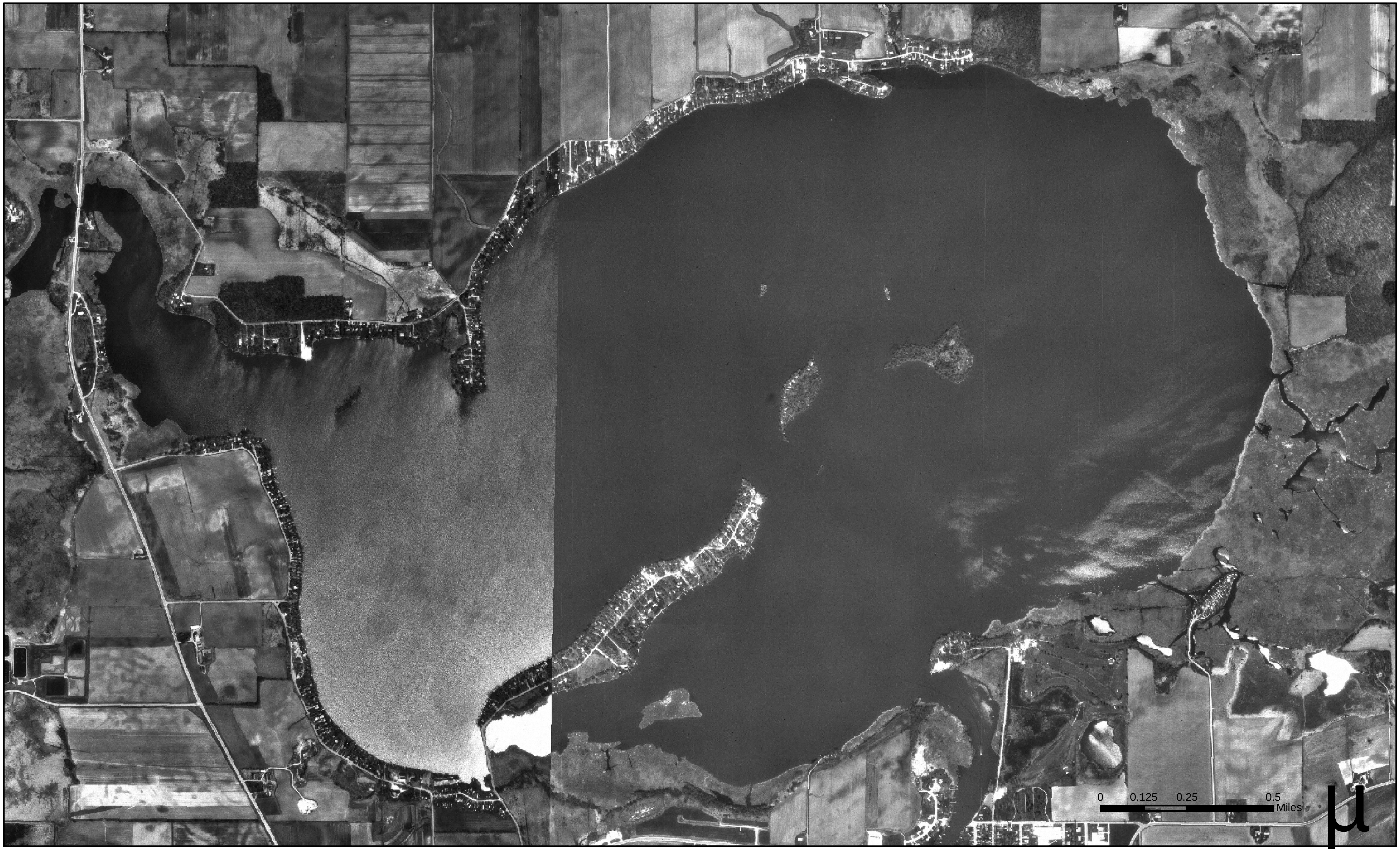


Legend

0'	12'
3'	15'
6'	18'
9'	

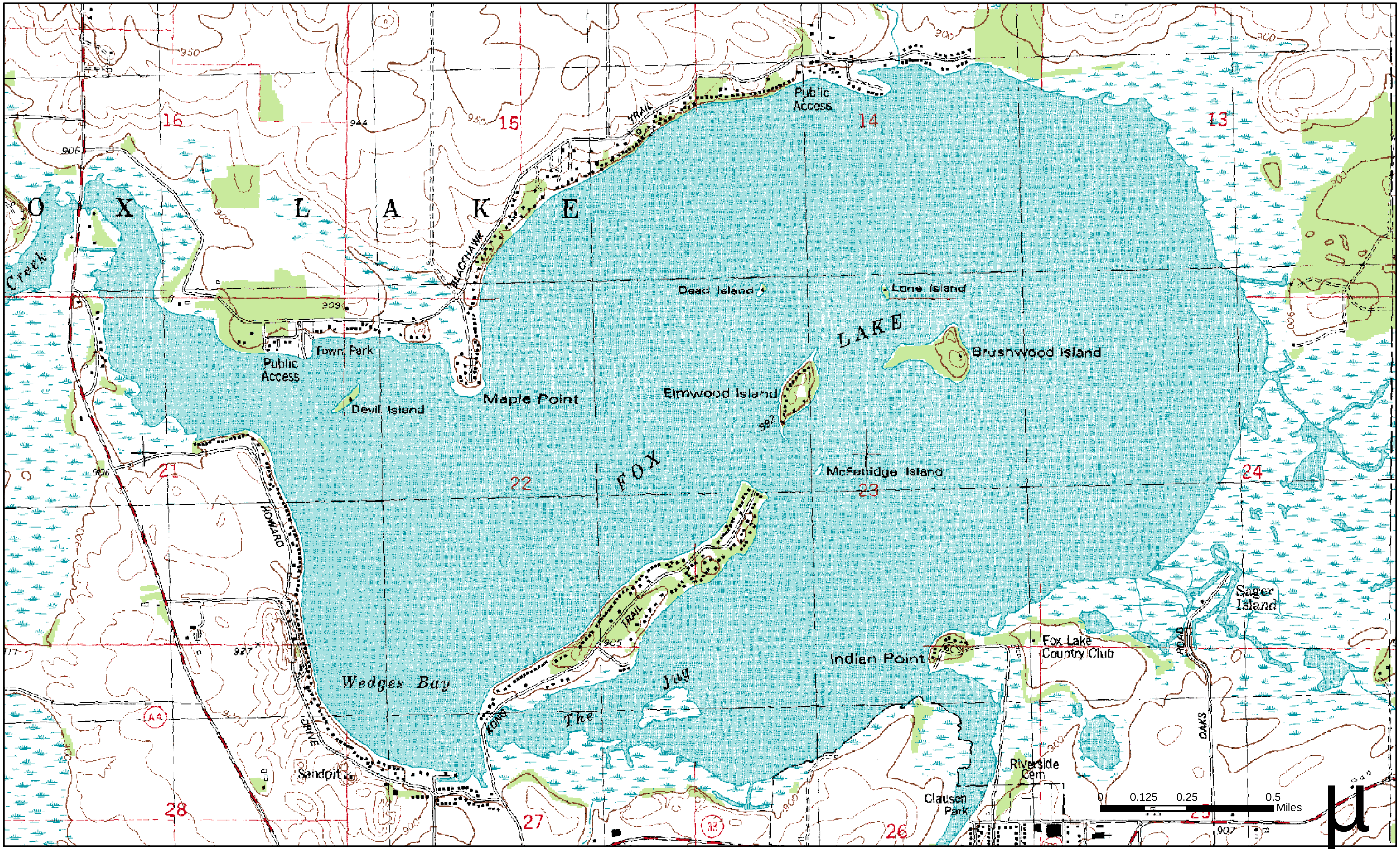
Bathymetric Map
Fox Lake - Dodge County, WI

Hey and Associates, Inc.
Water Resources, Wetlands and Ecology



Aerial Orthophotograph
Fox Lake - Dodge County, WI

Hey and Associates, Inc.
Water Resources, Wetlands and Ecology

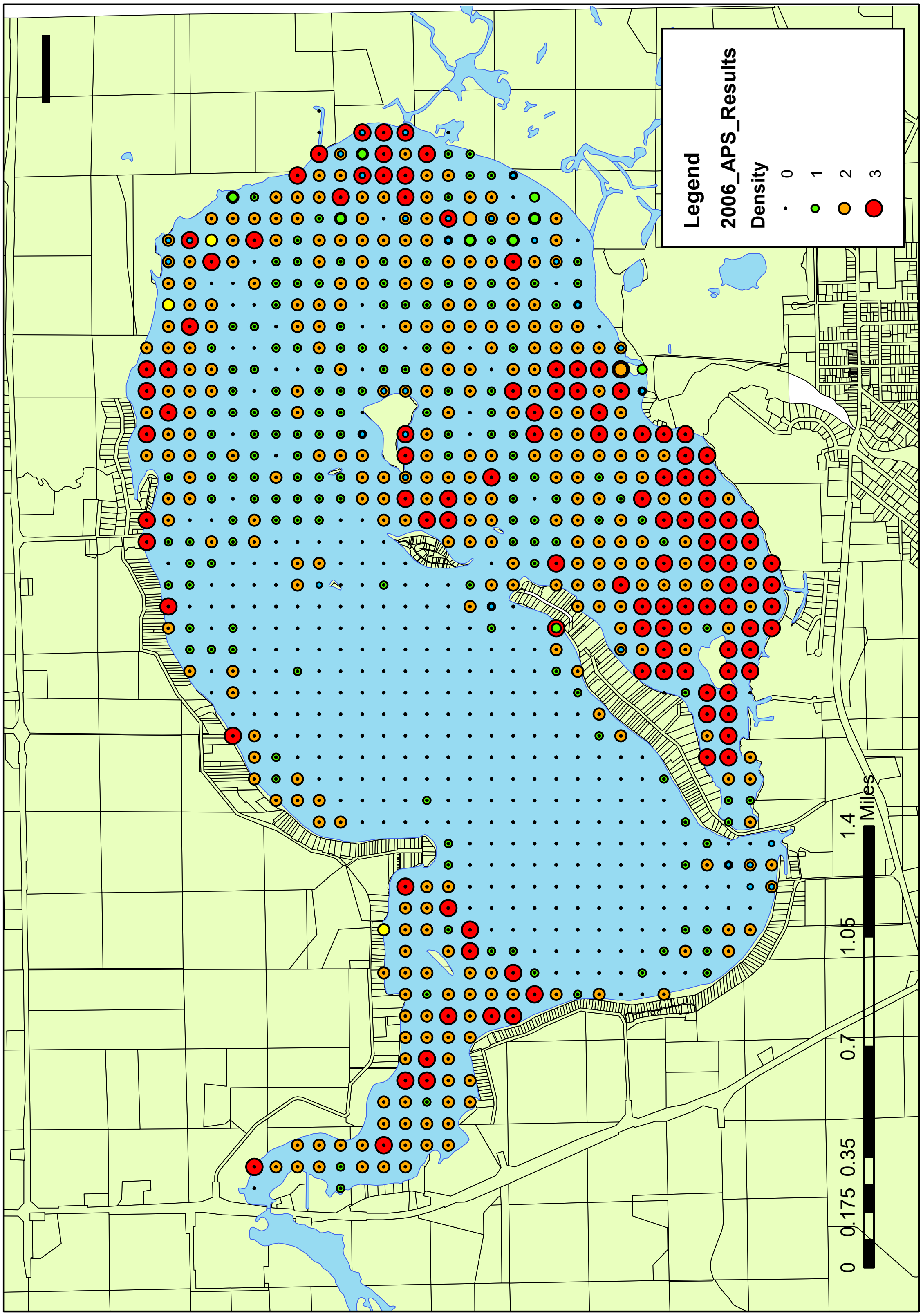


1:24000 USGS Topographic Map
Fox Lake - Dodge County, WI

Hey and Associates, Inc.
Water Resources, Wetlands and Ecology

APPENDIX B

Aquatic Plant Survey Results 2006 – 2014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3
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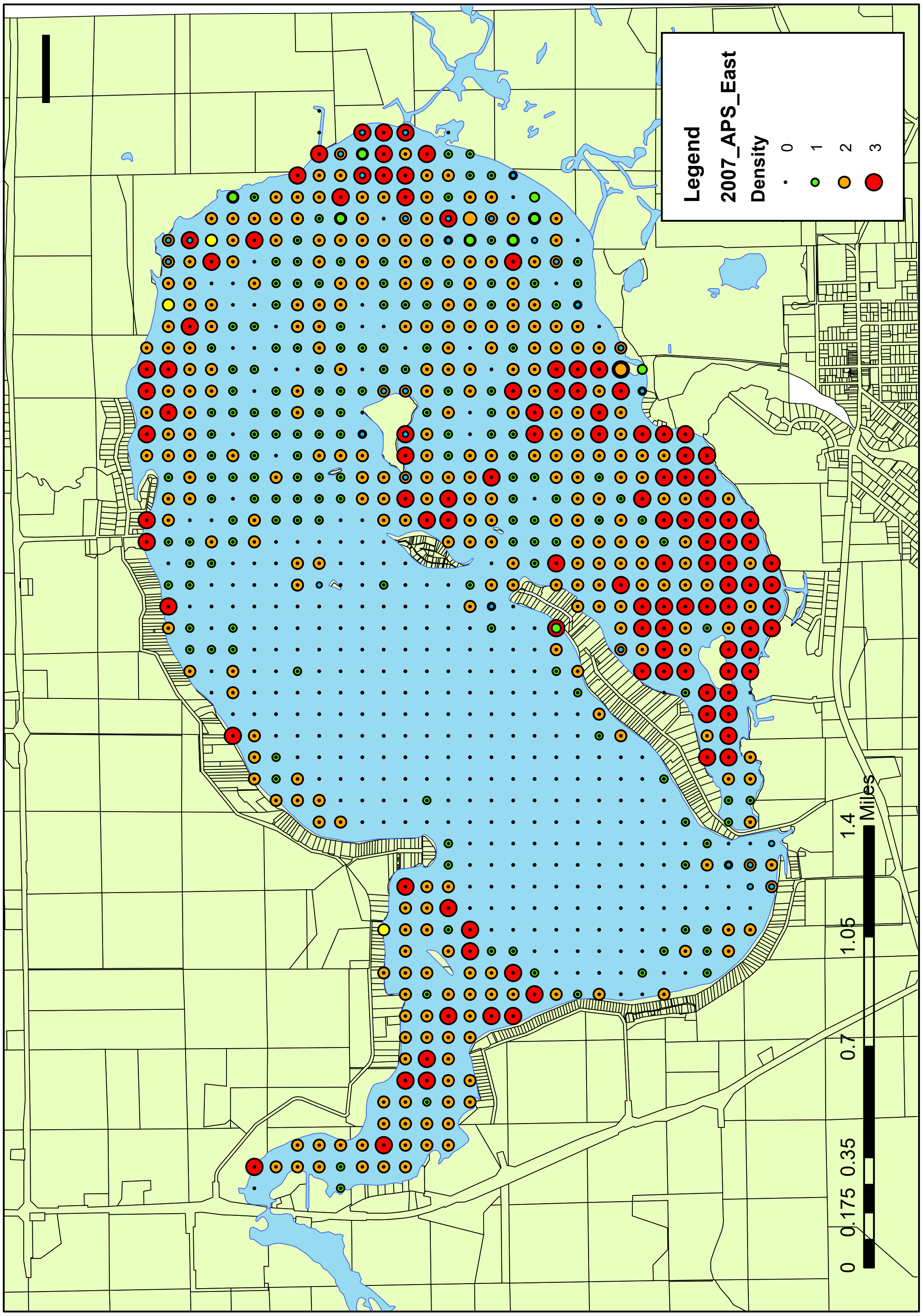
Miles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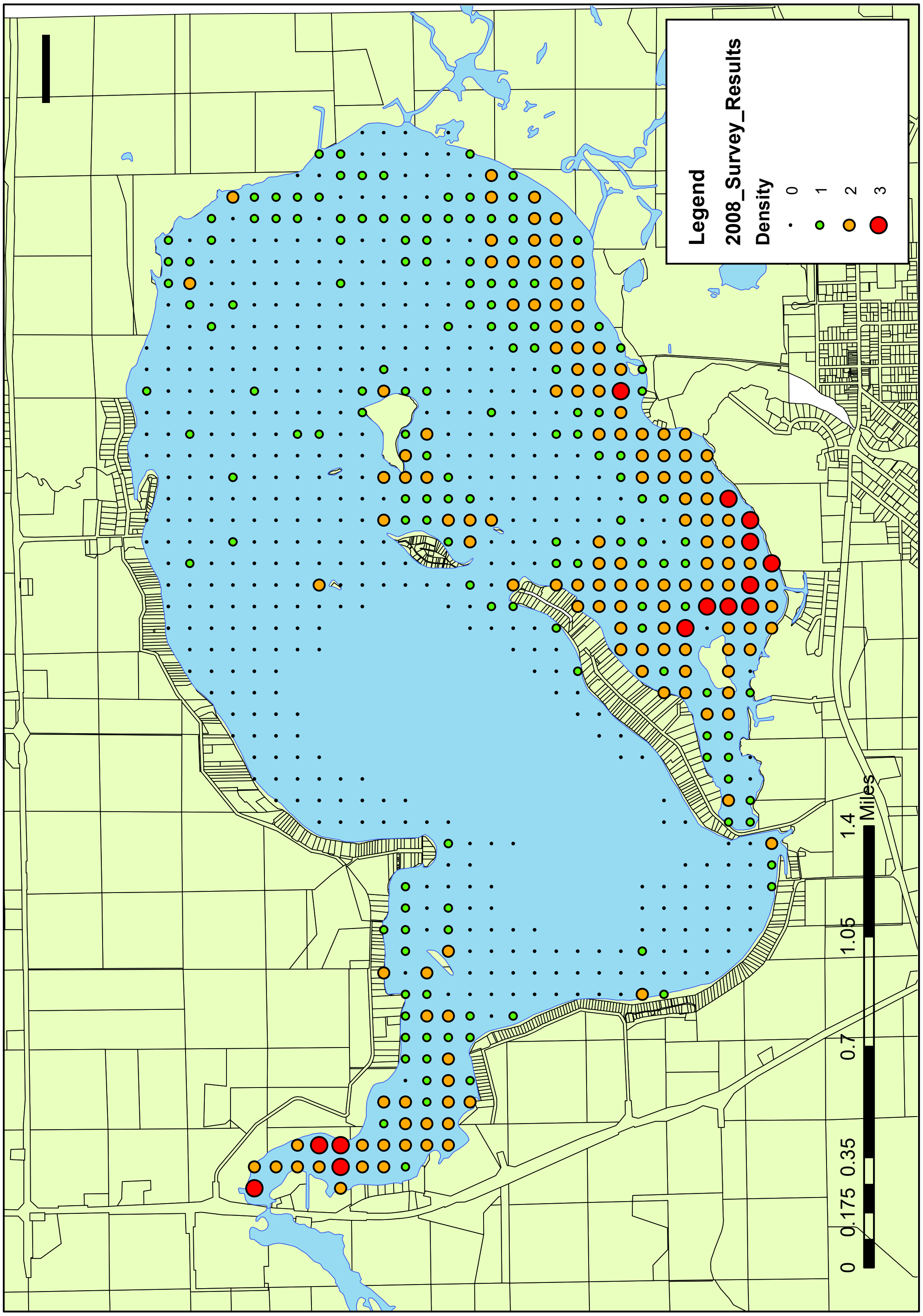
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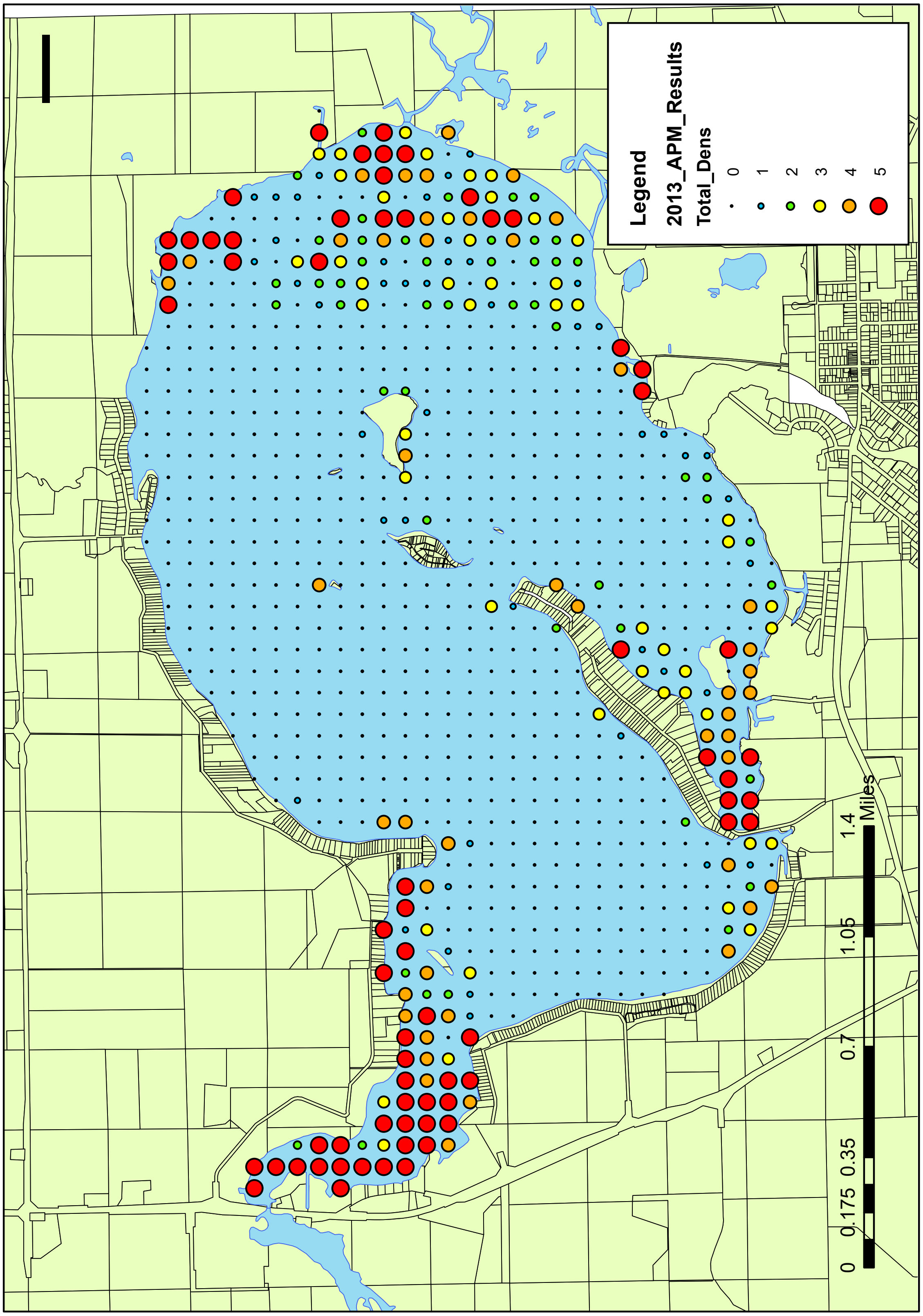
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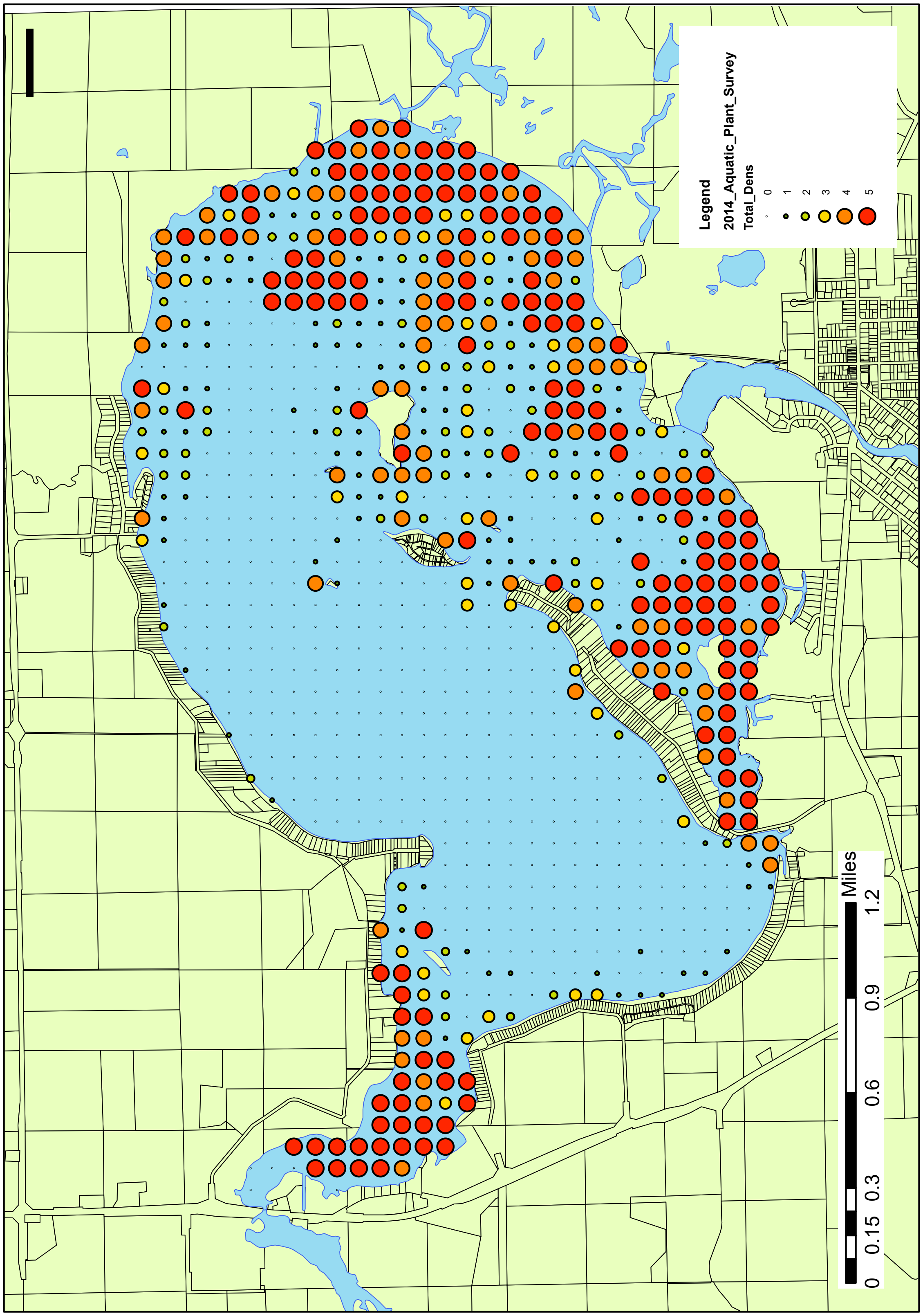
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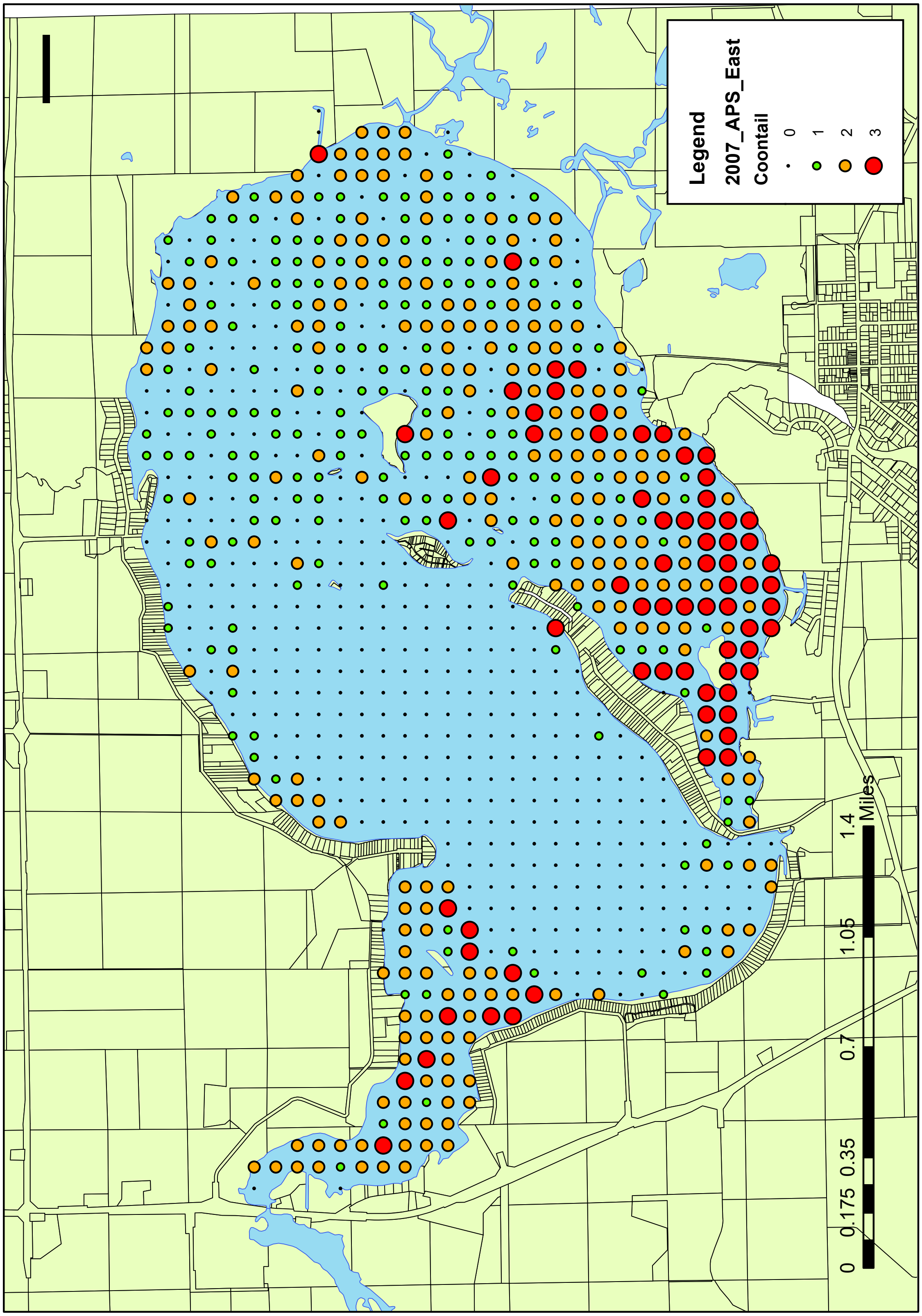
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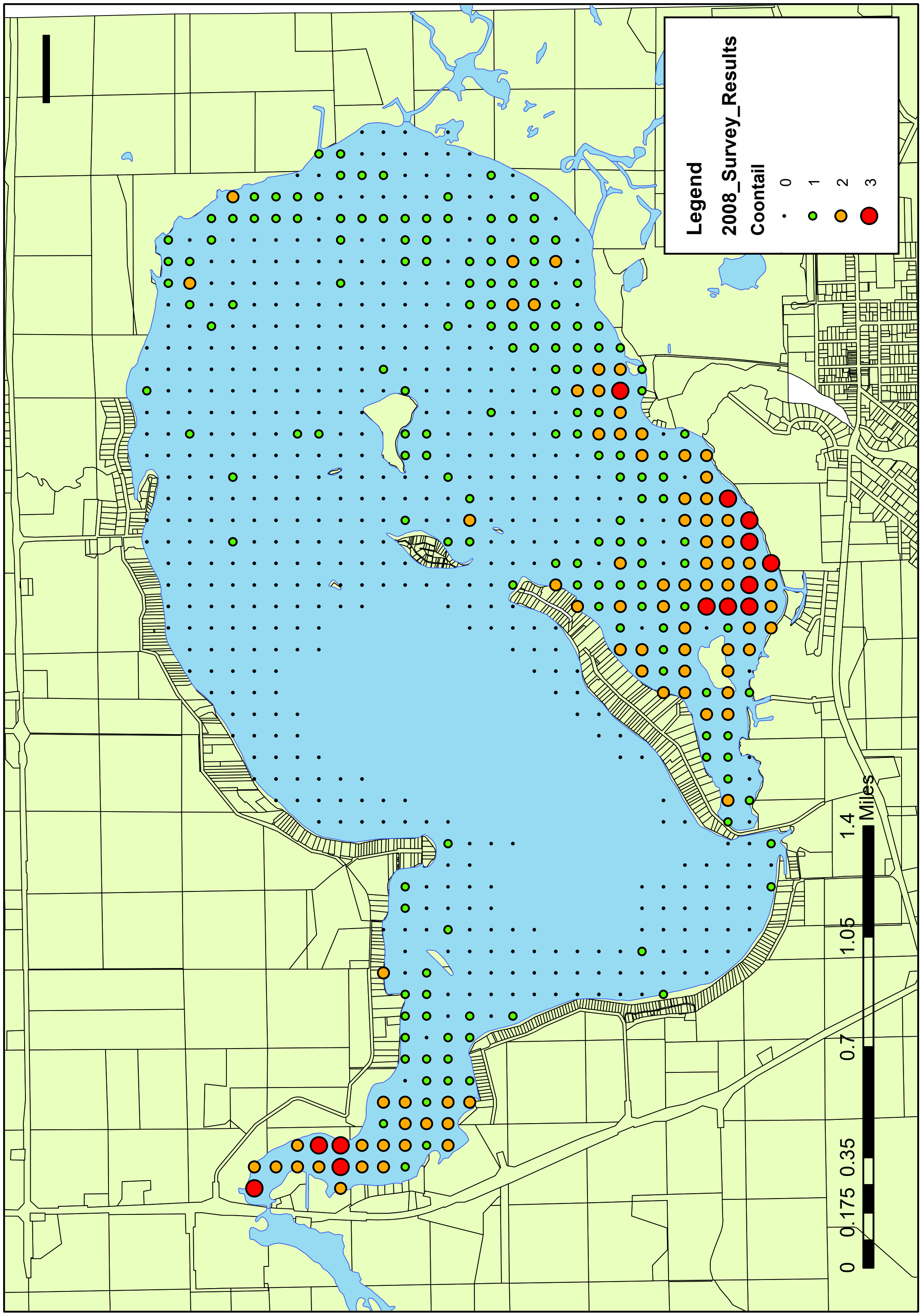
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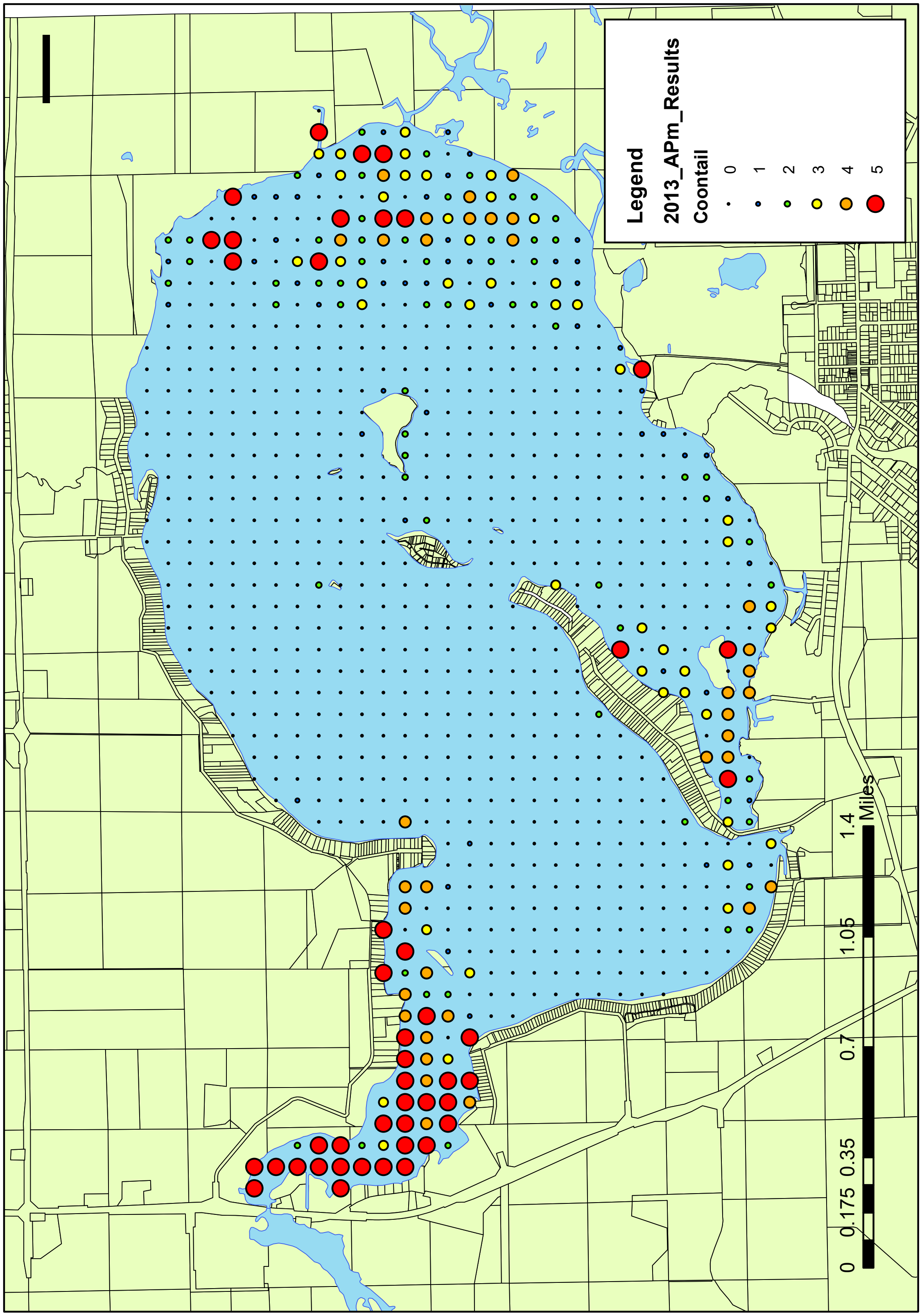
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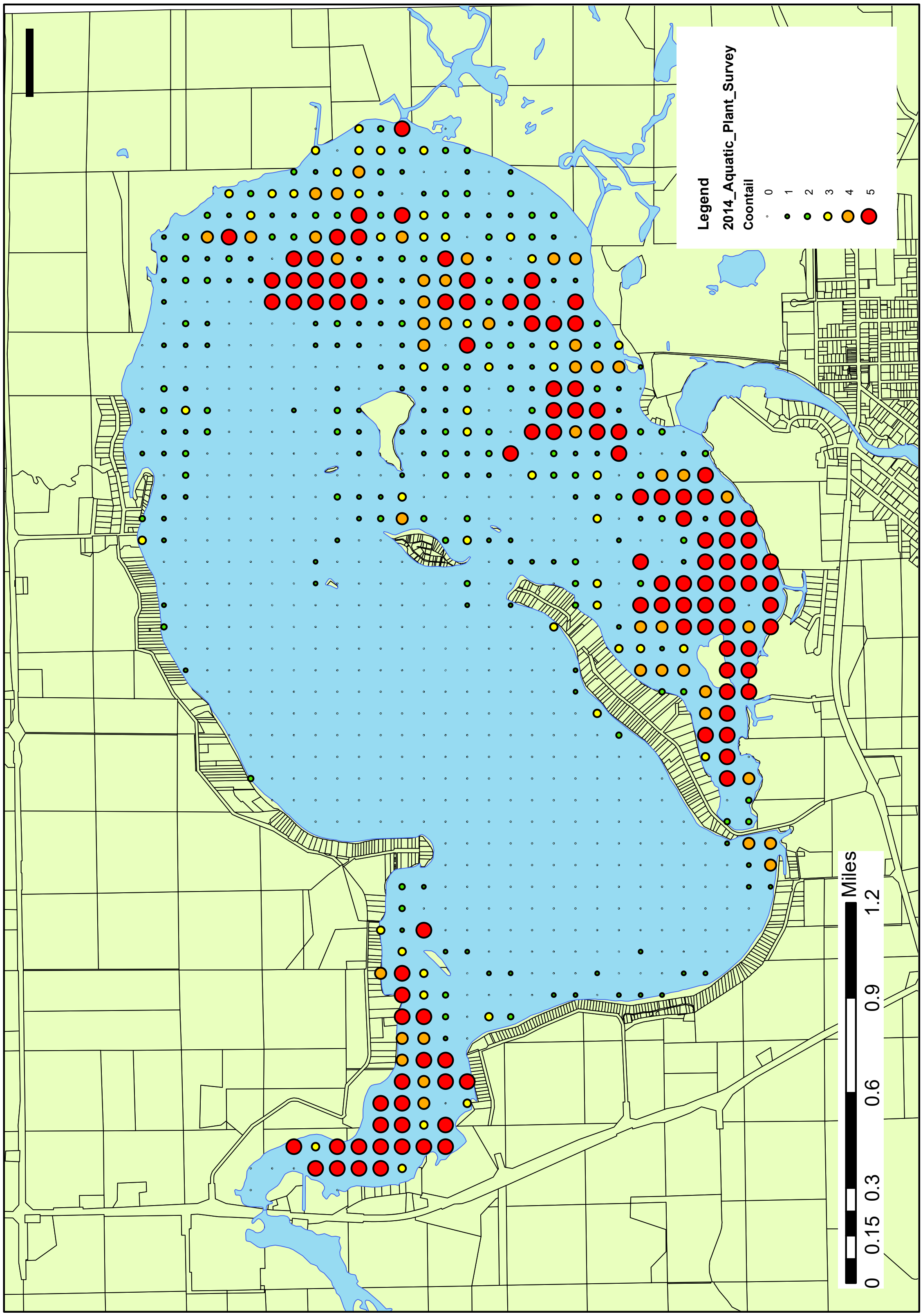
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3
4
5
Miles
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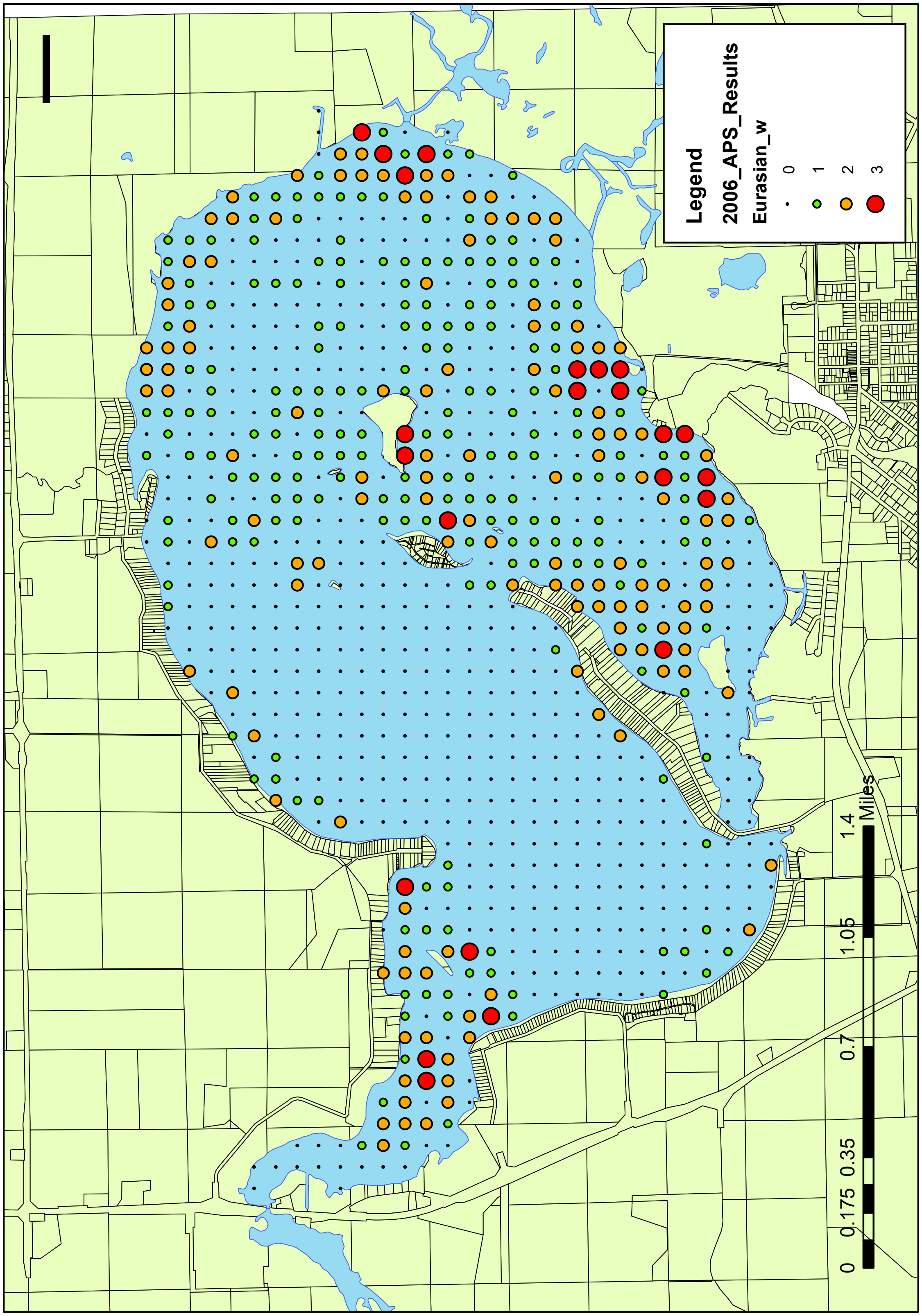
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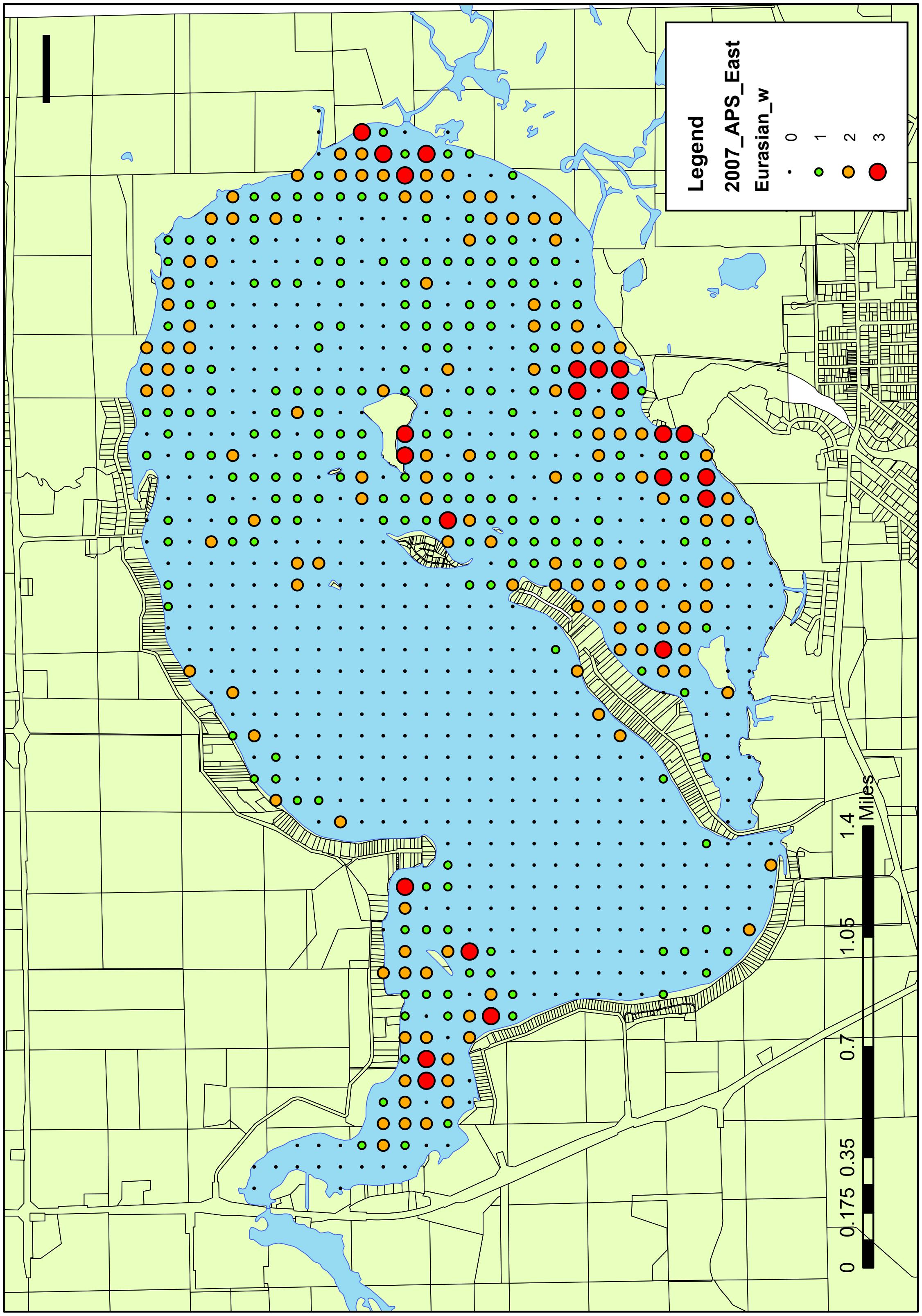
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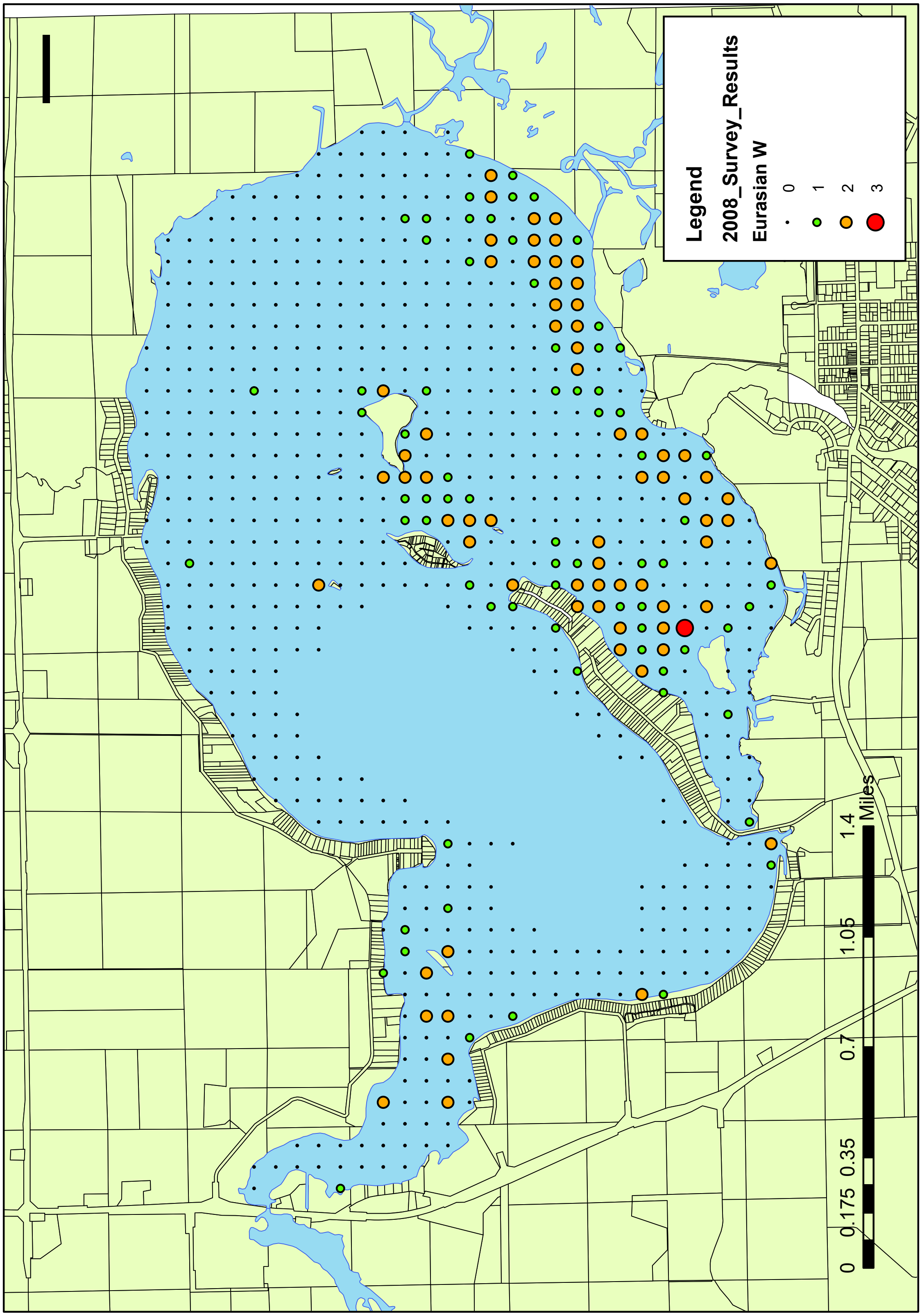
Miles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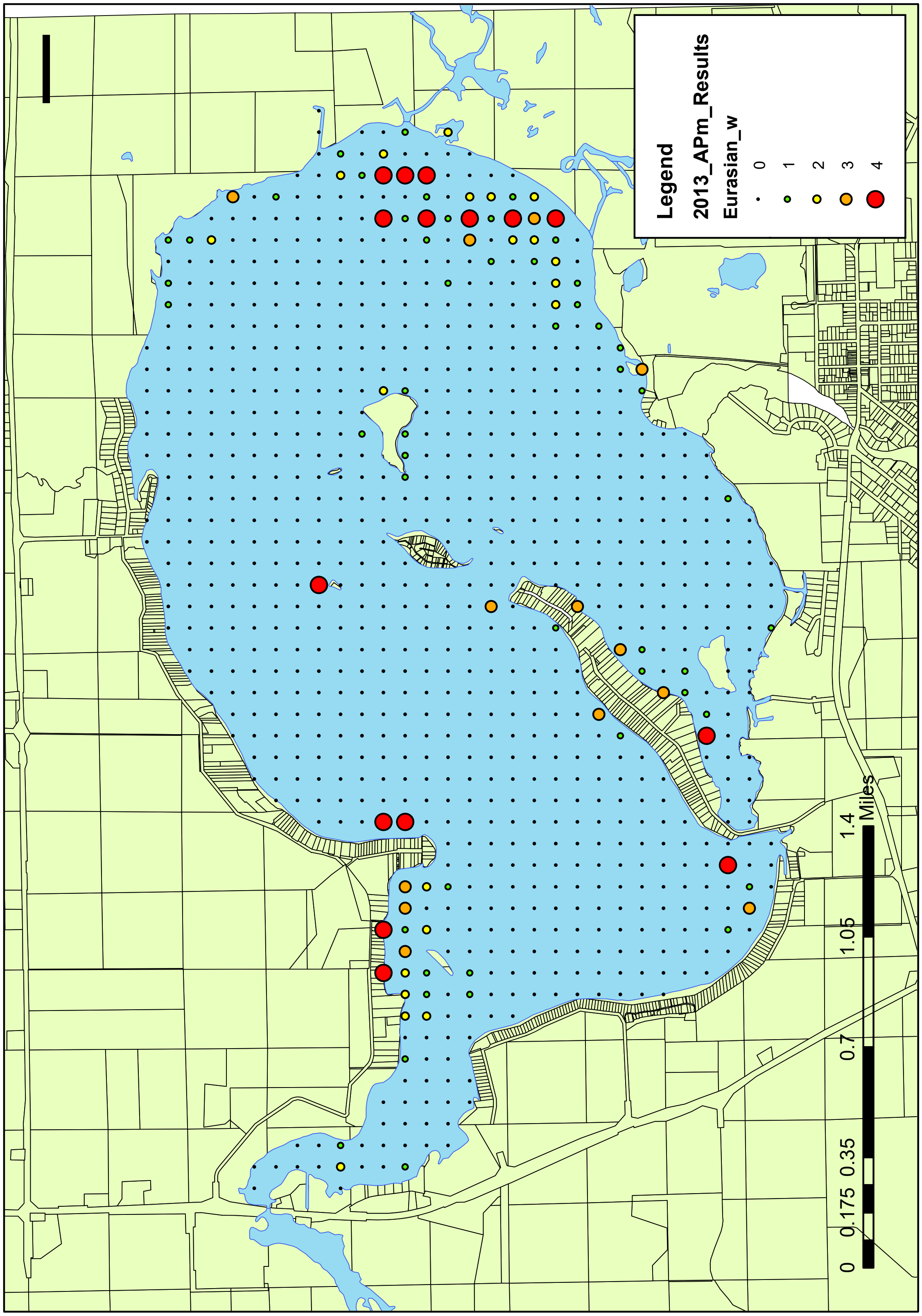
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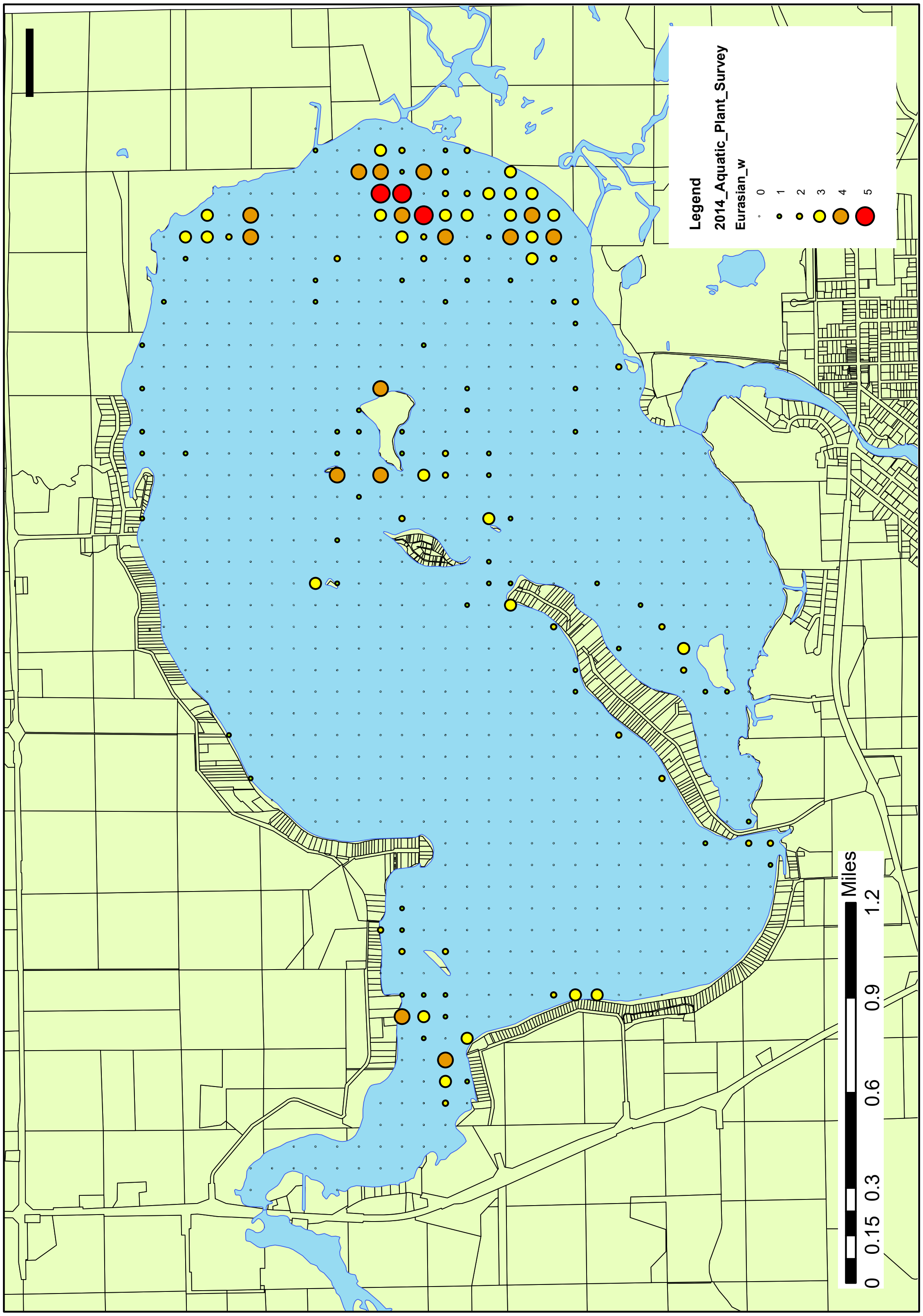
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Miles
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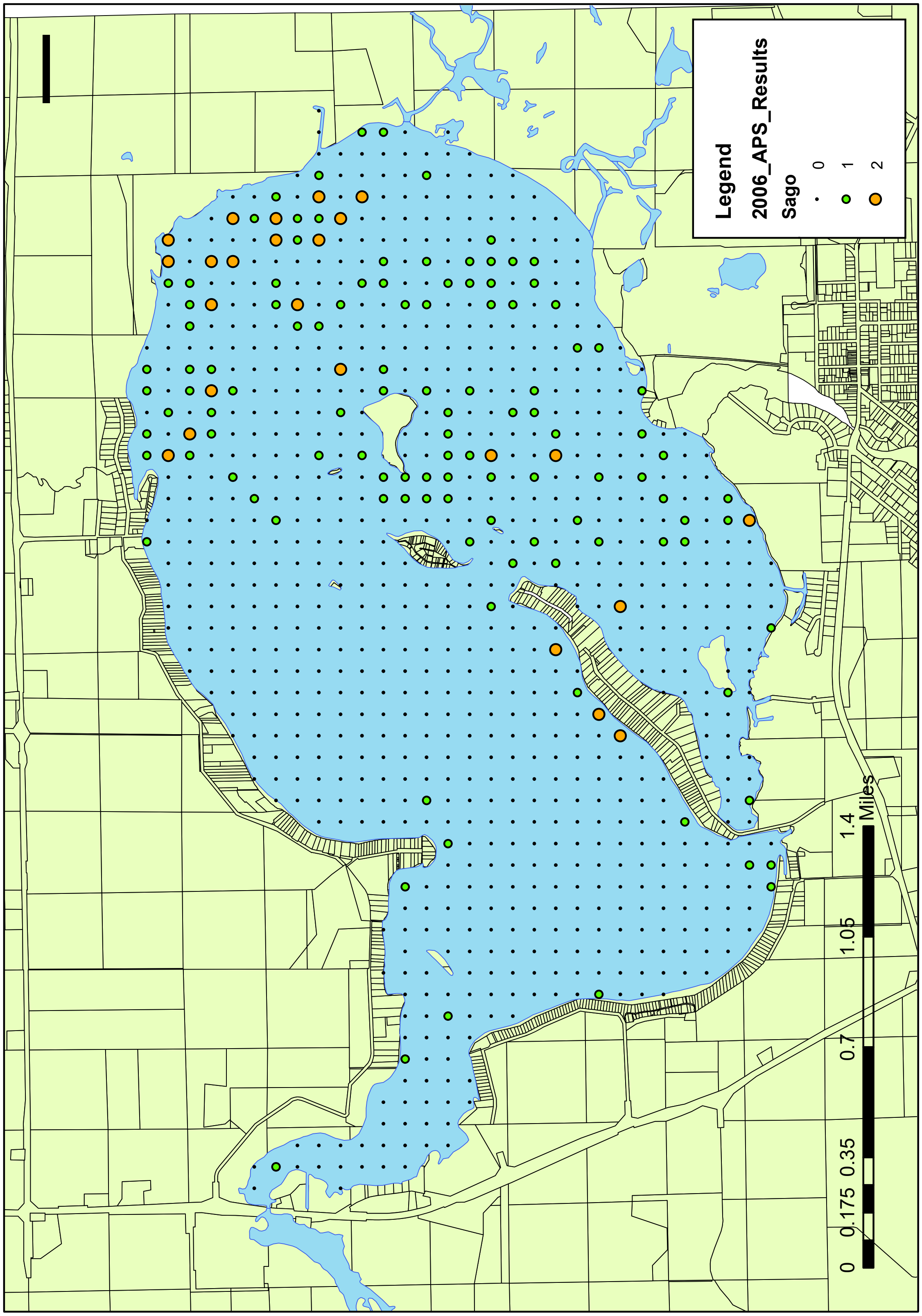
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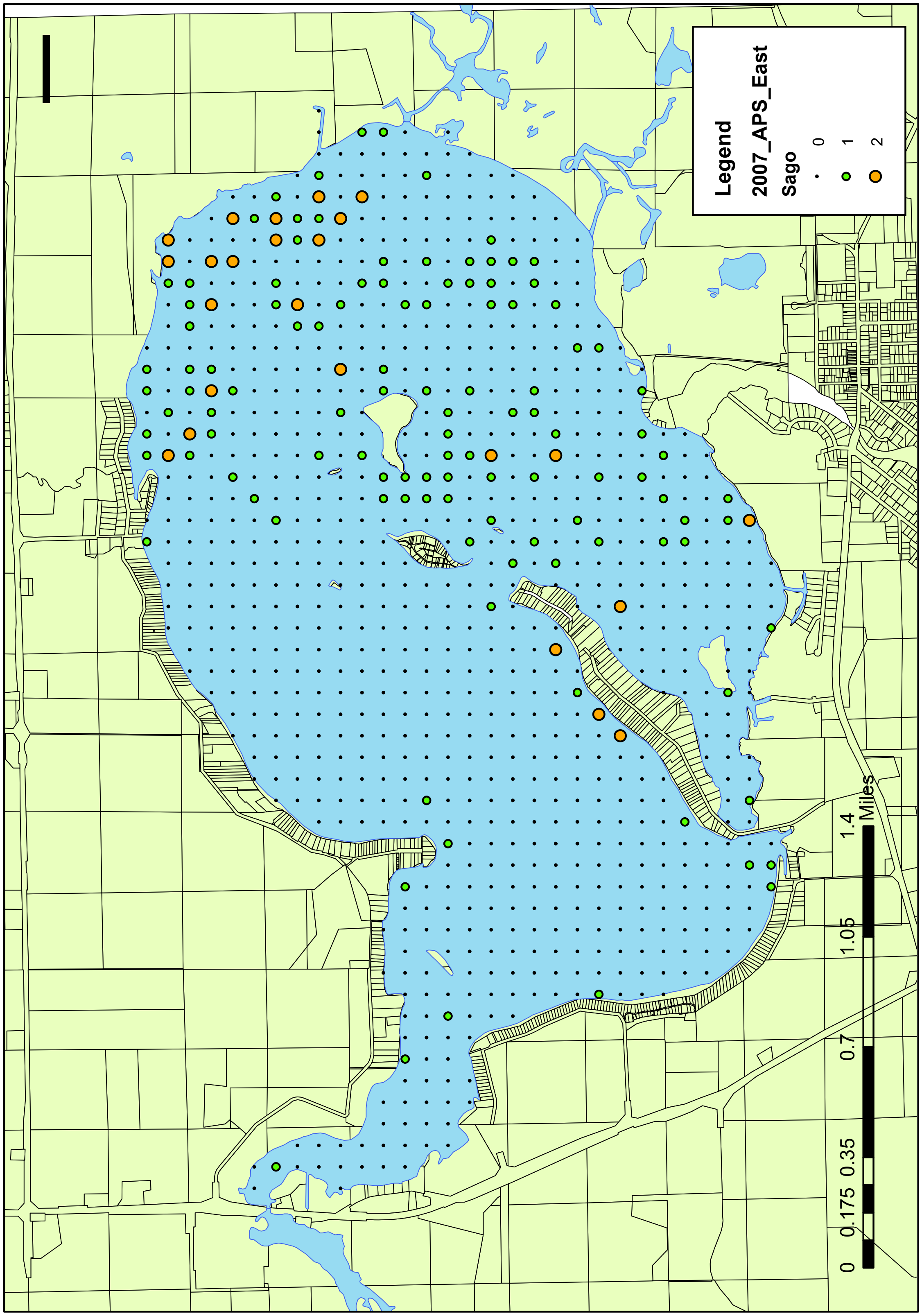
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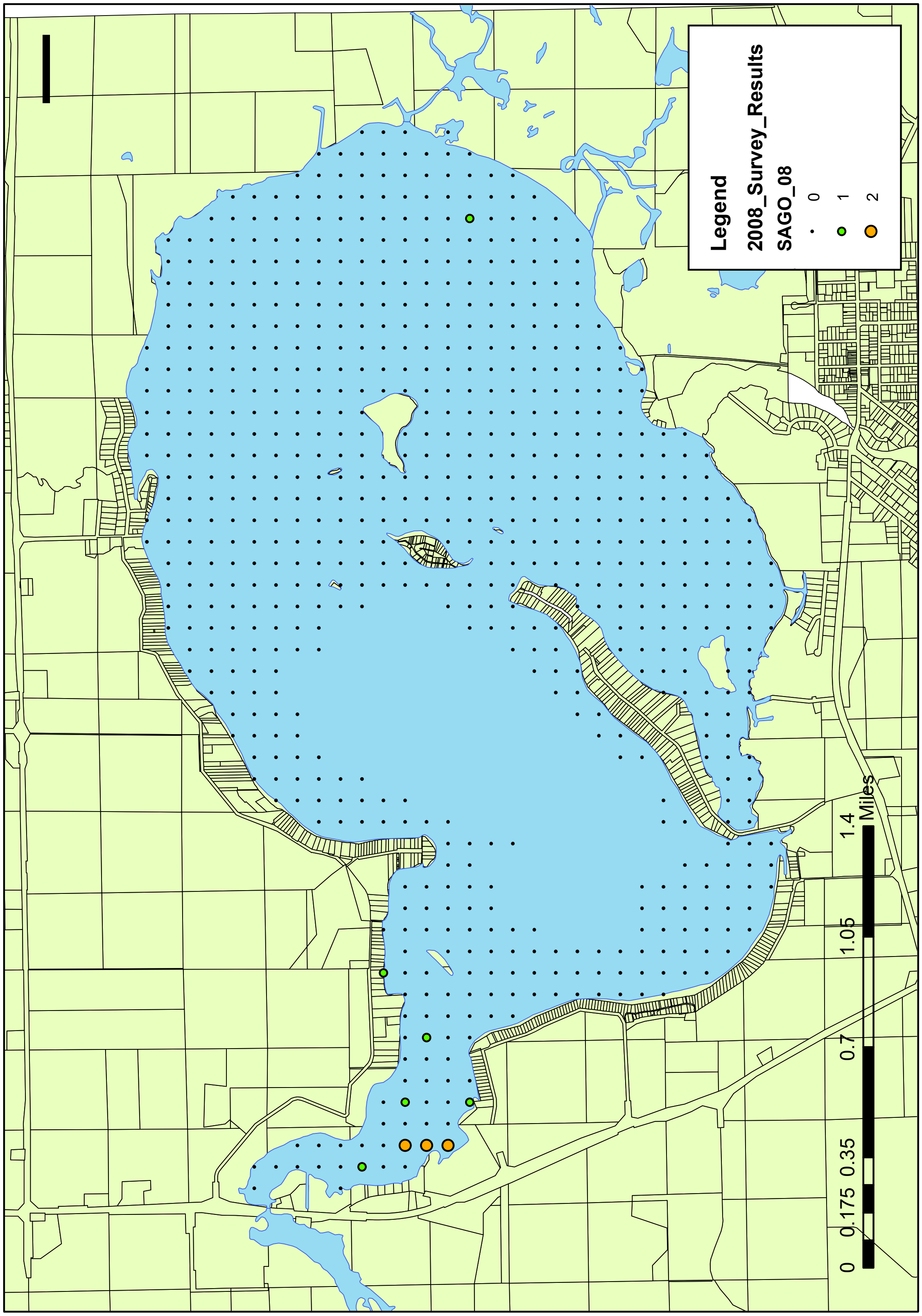
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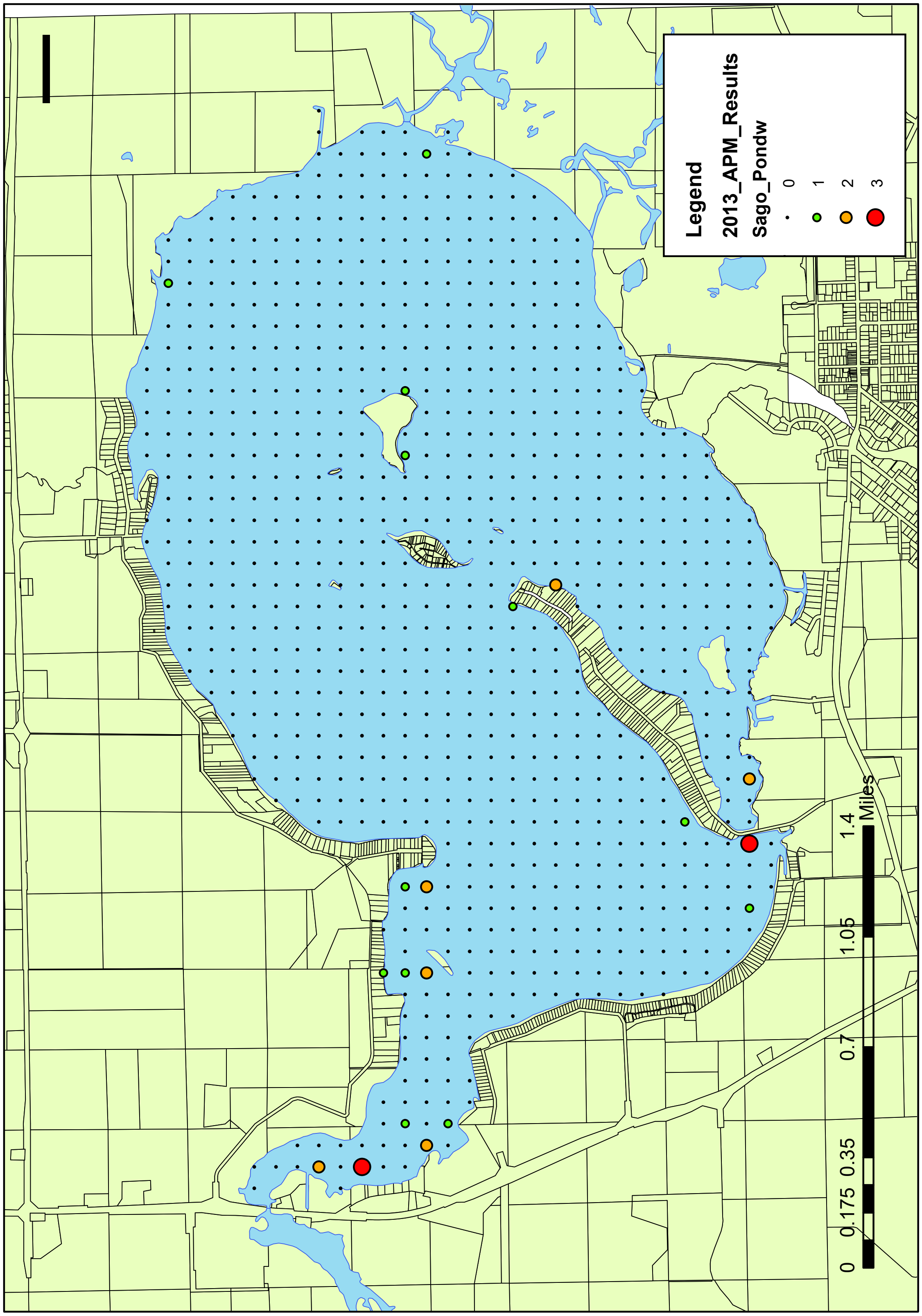
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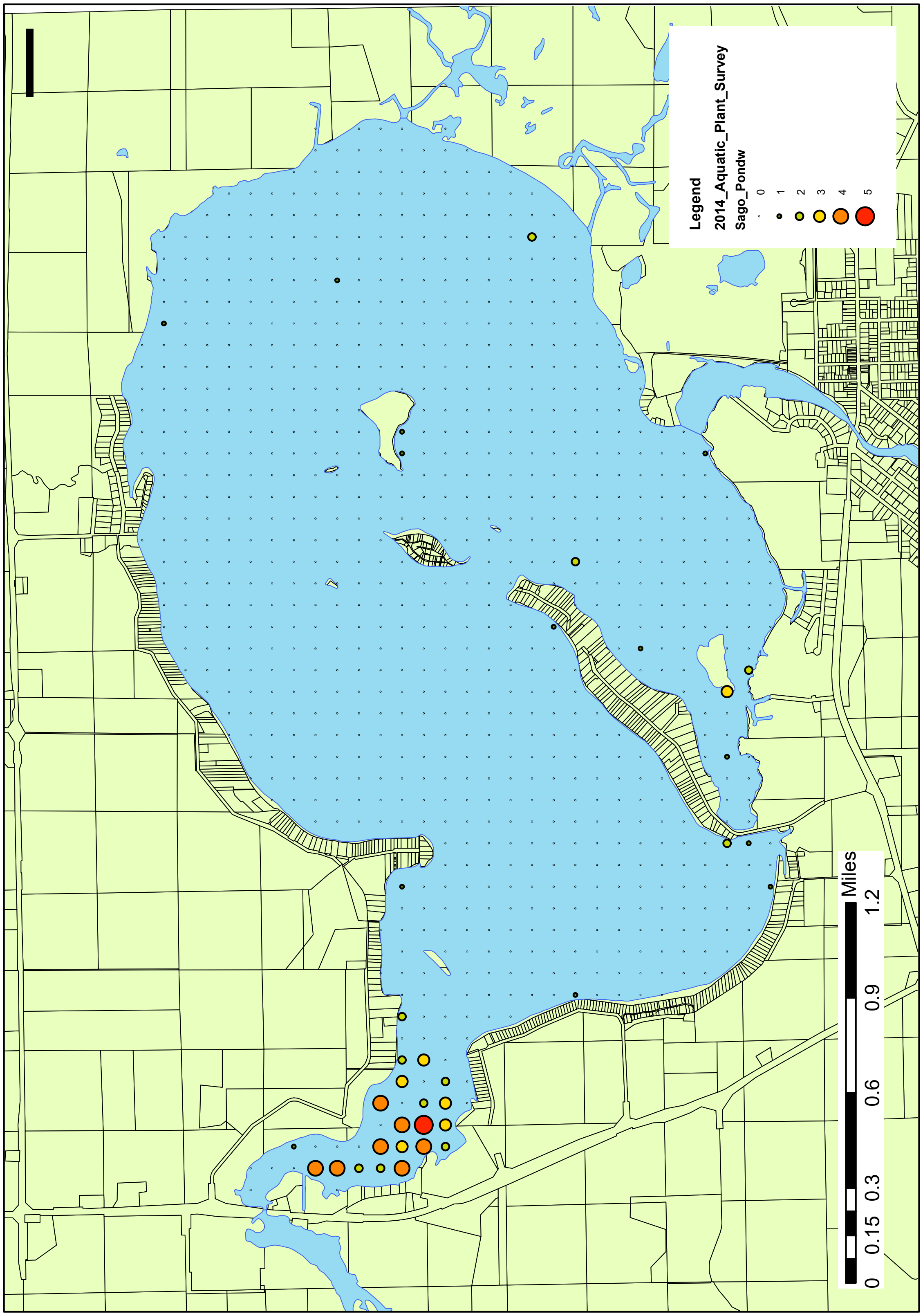
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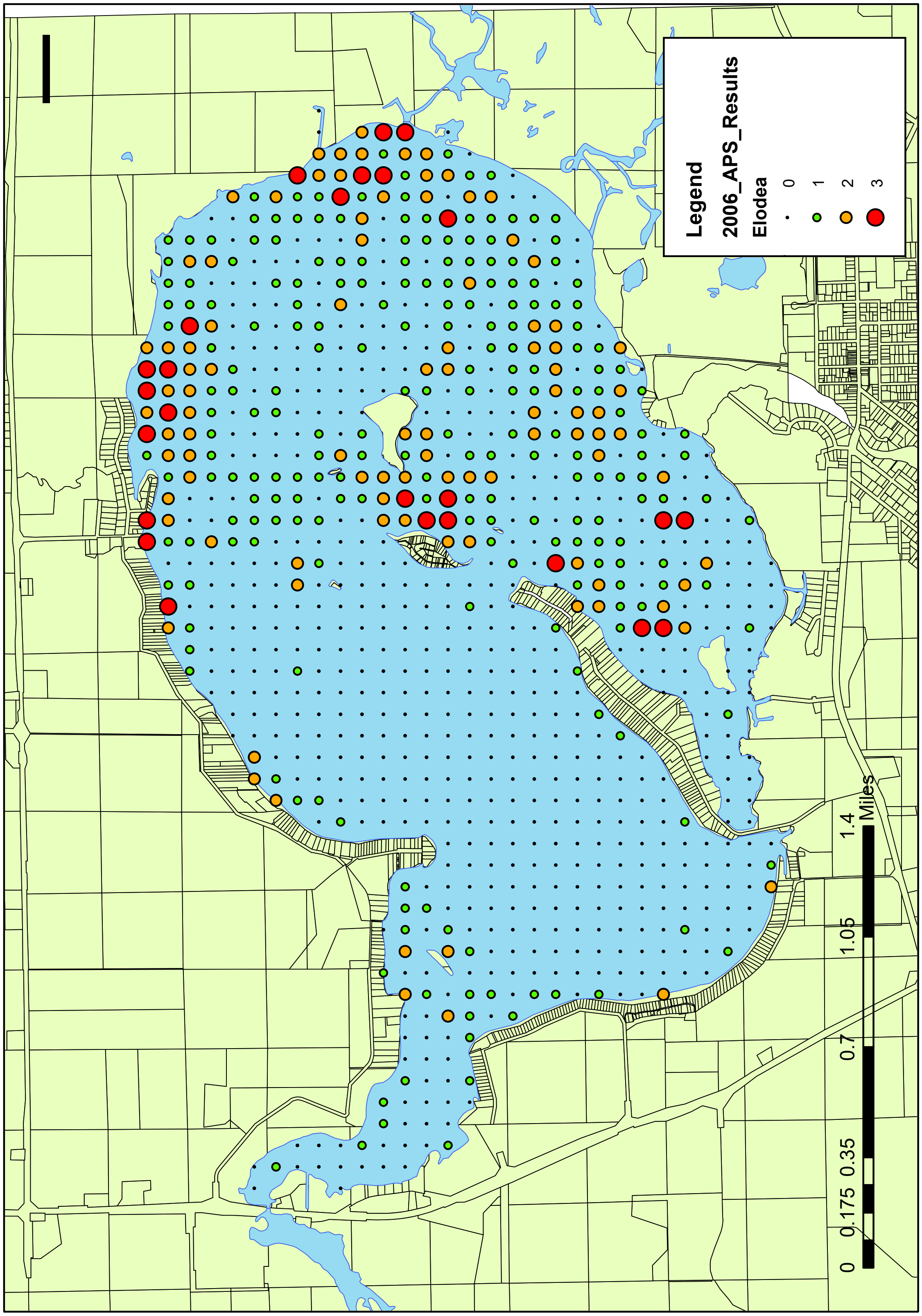
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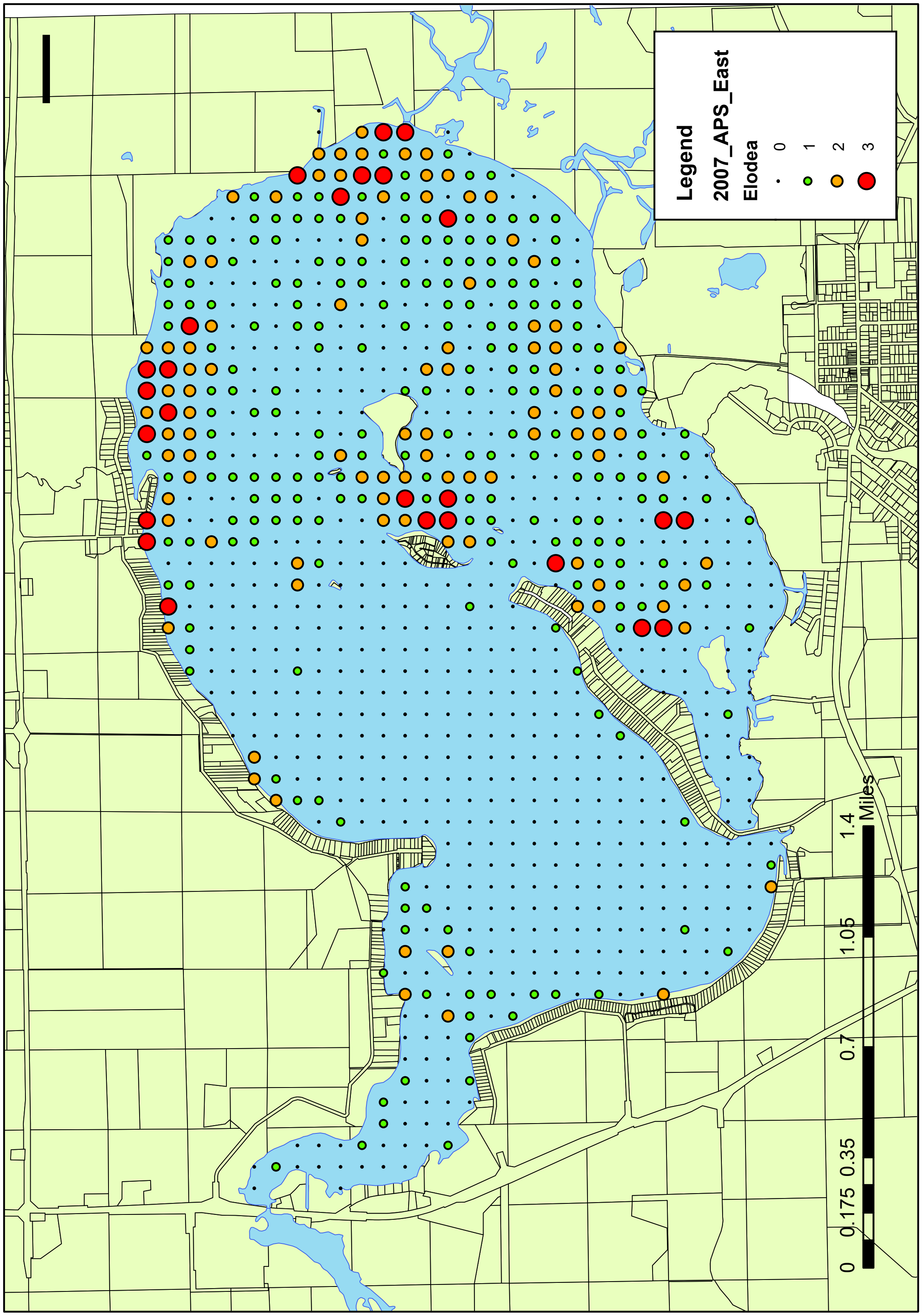
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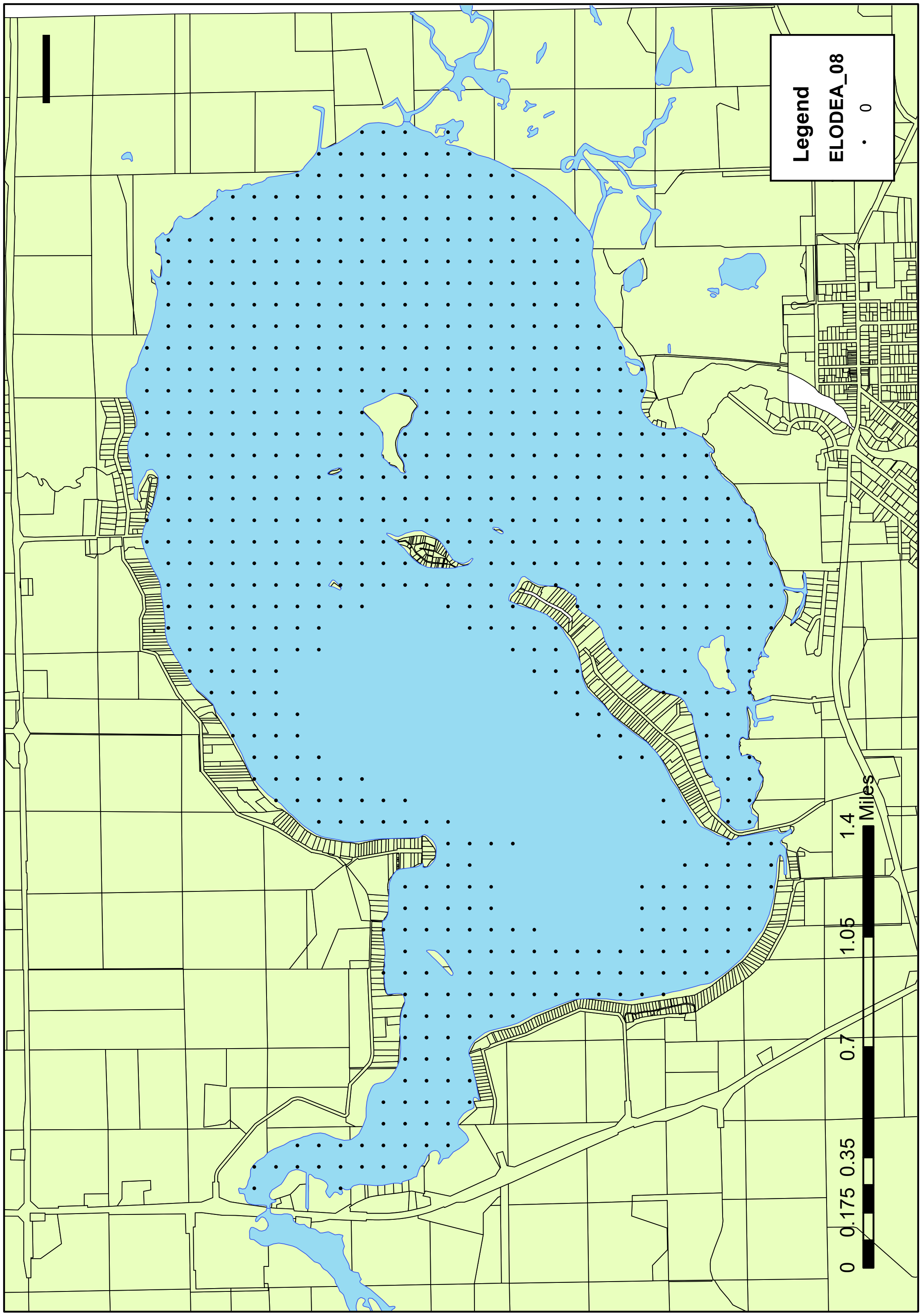
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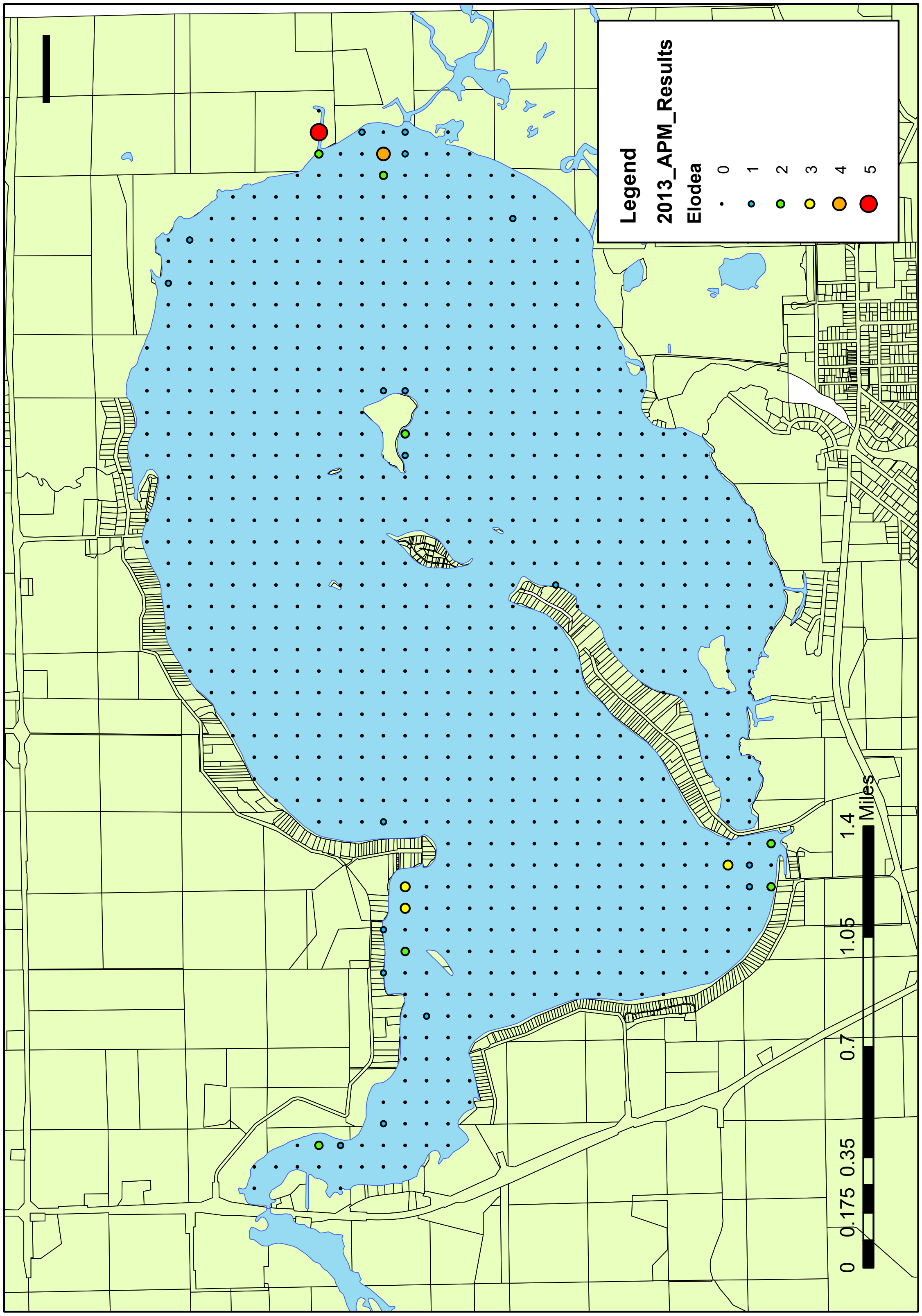
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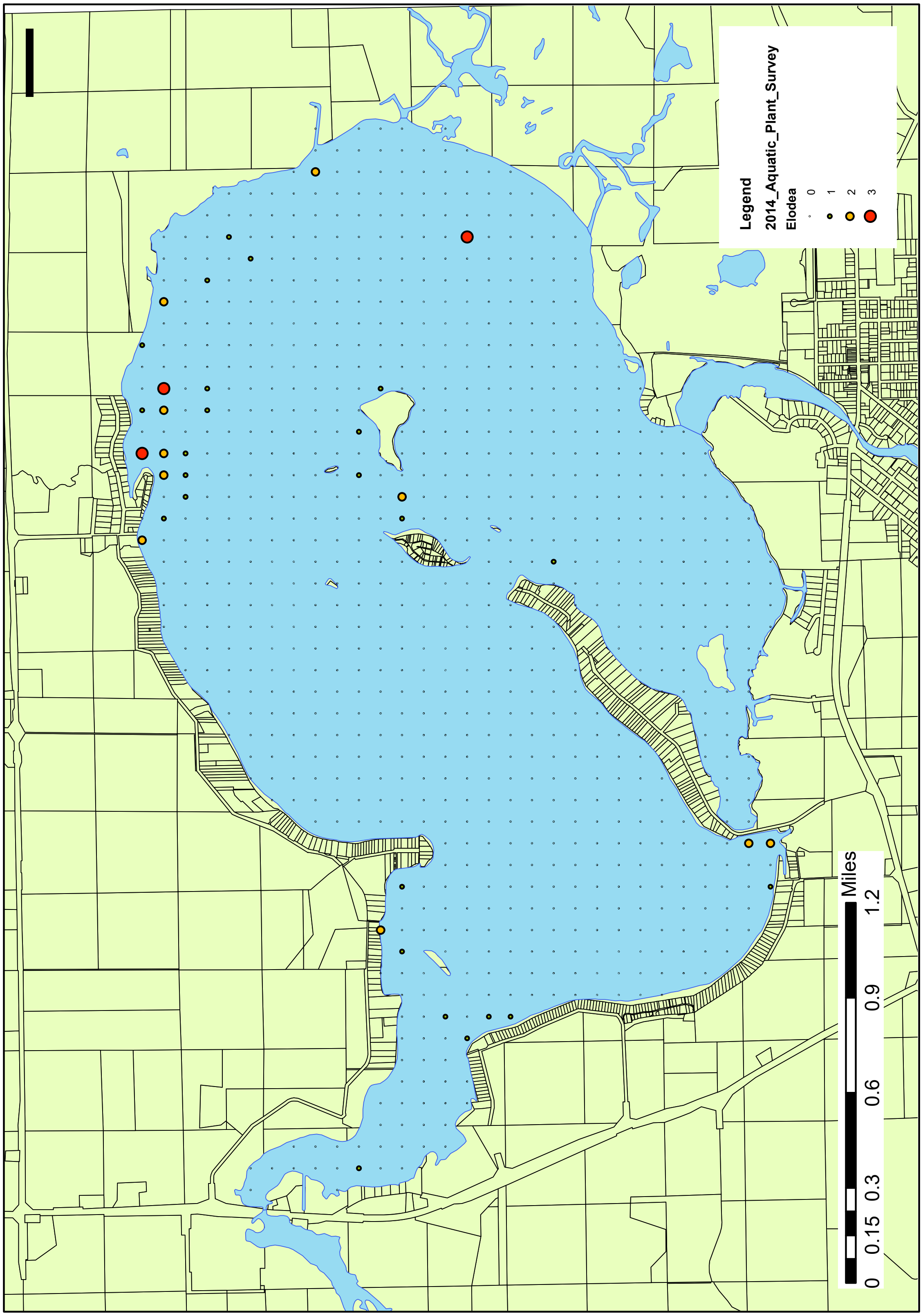
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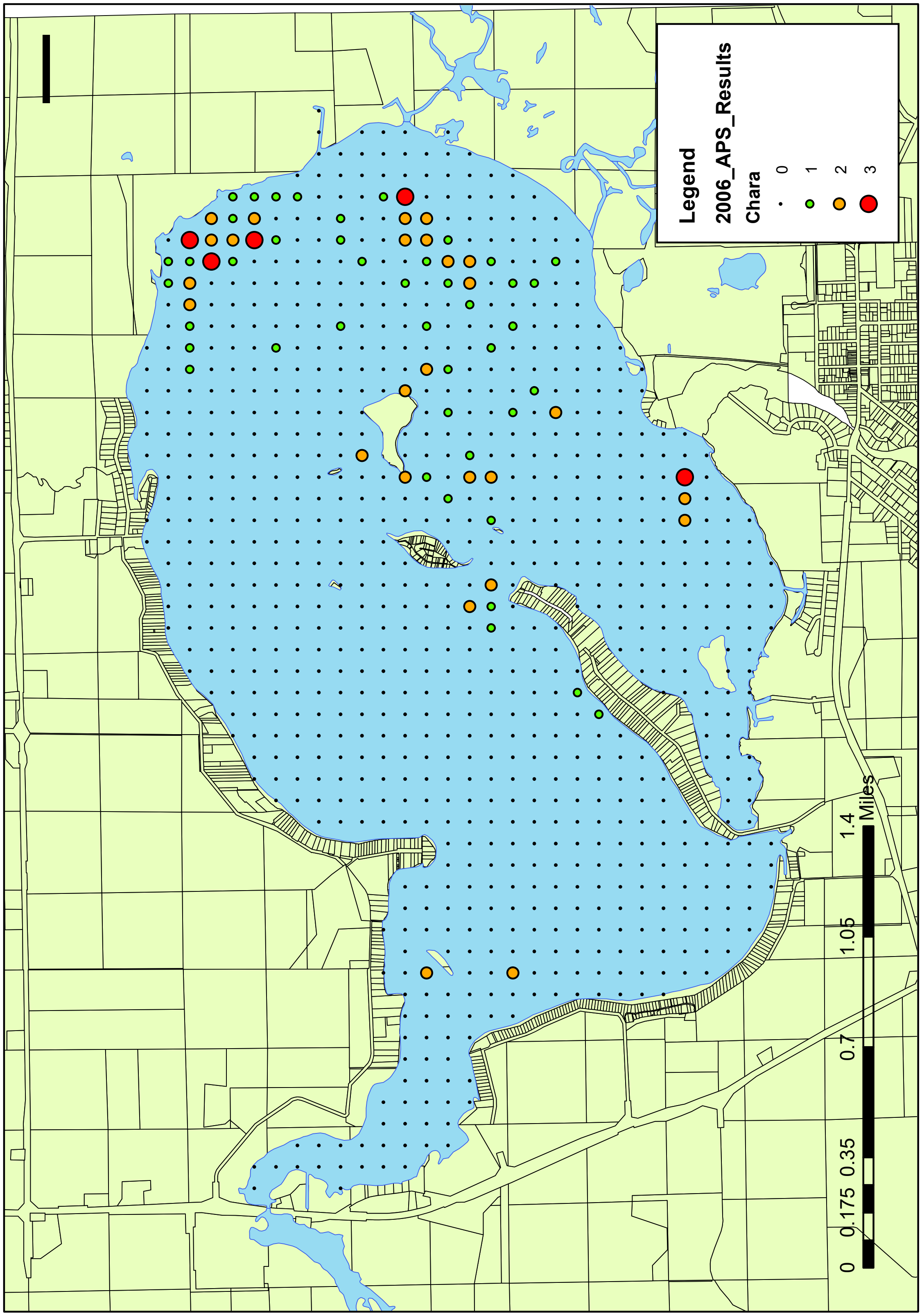
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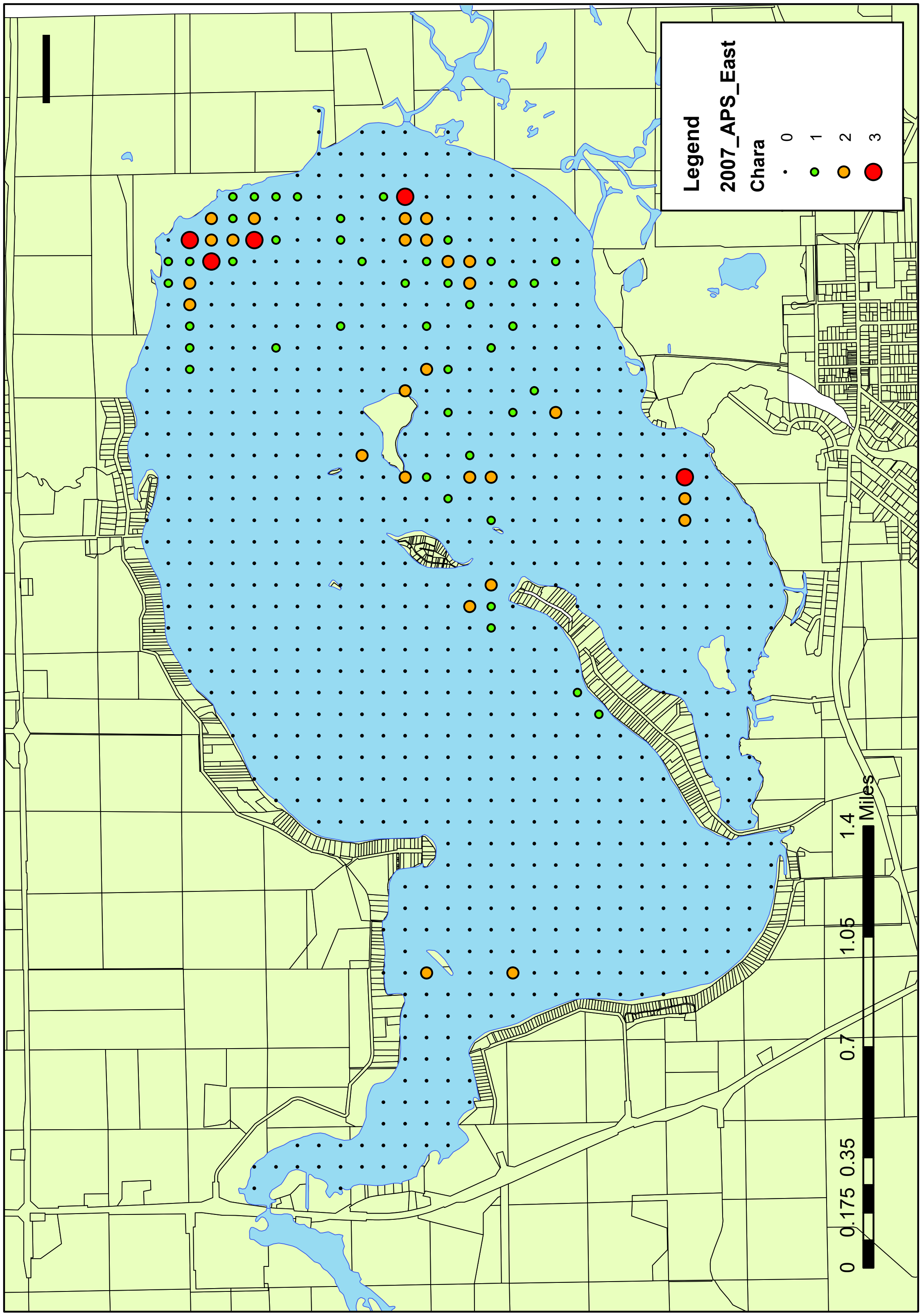
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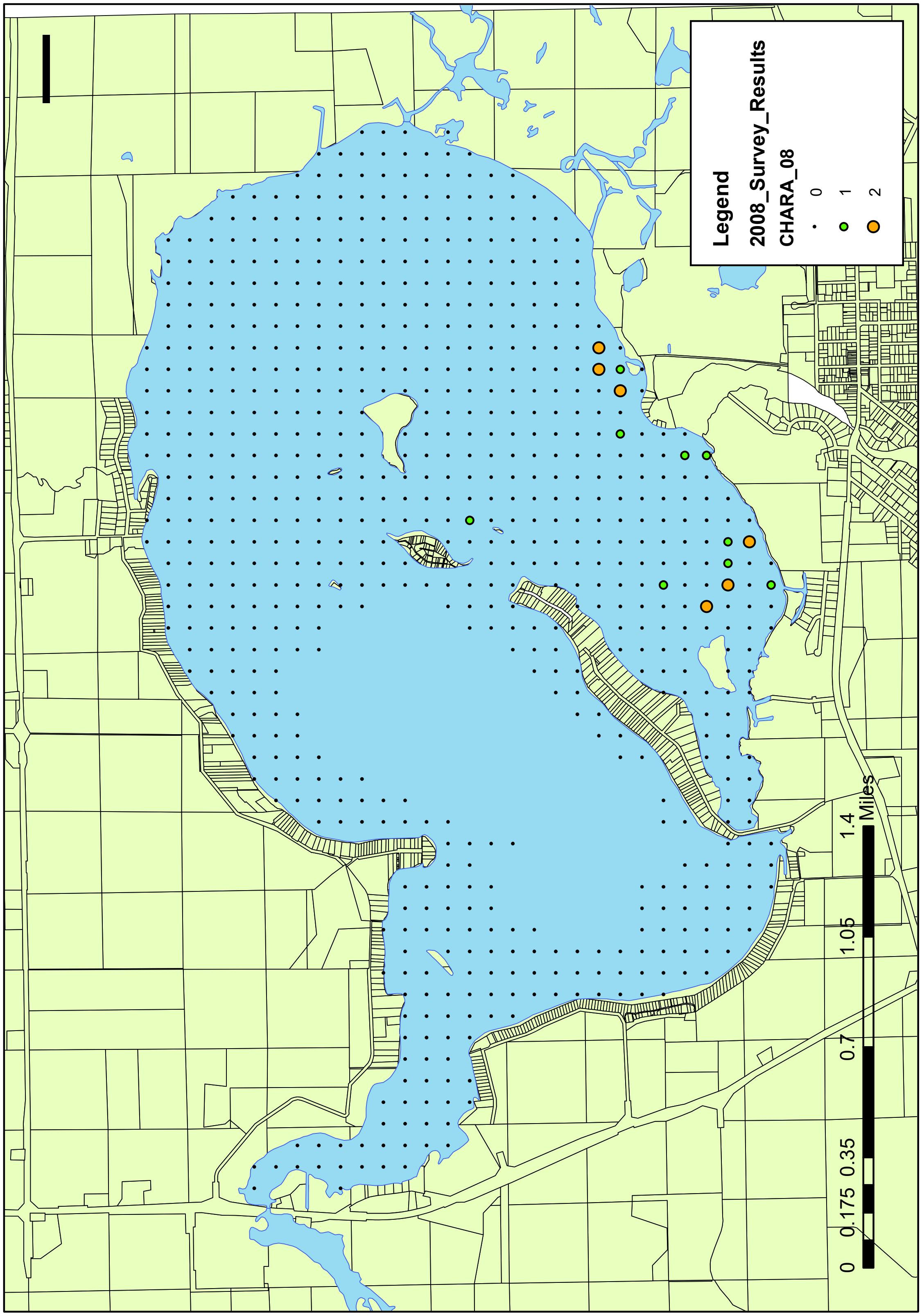
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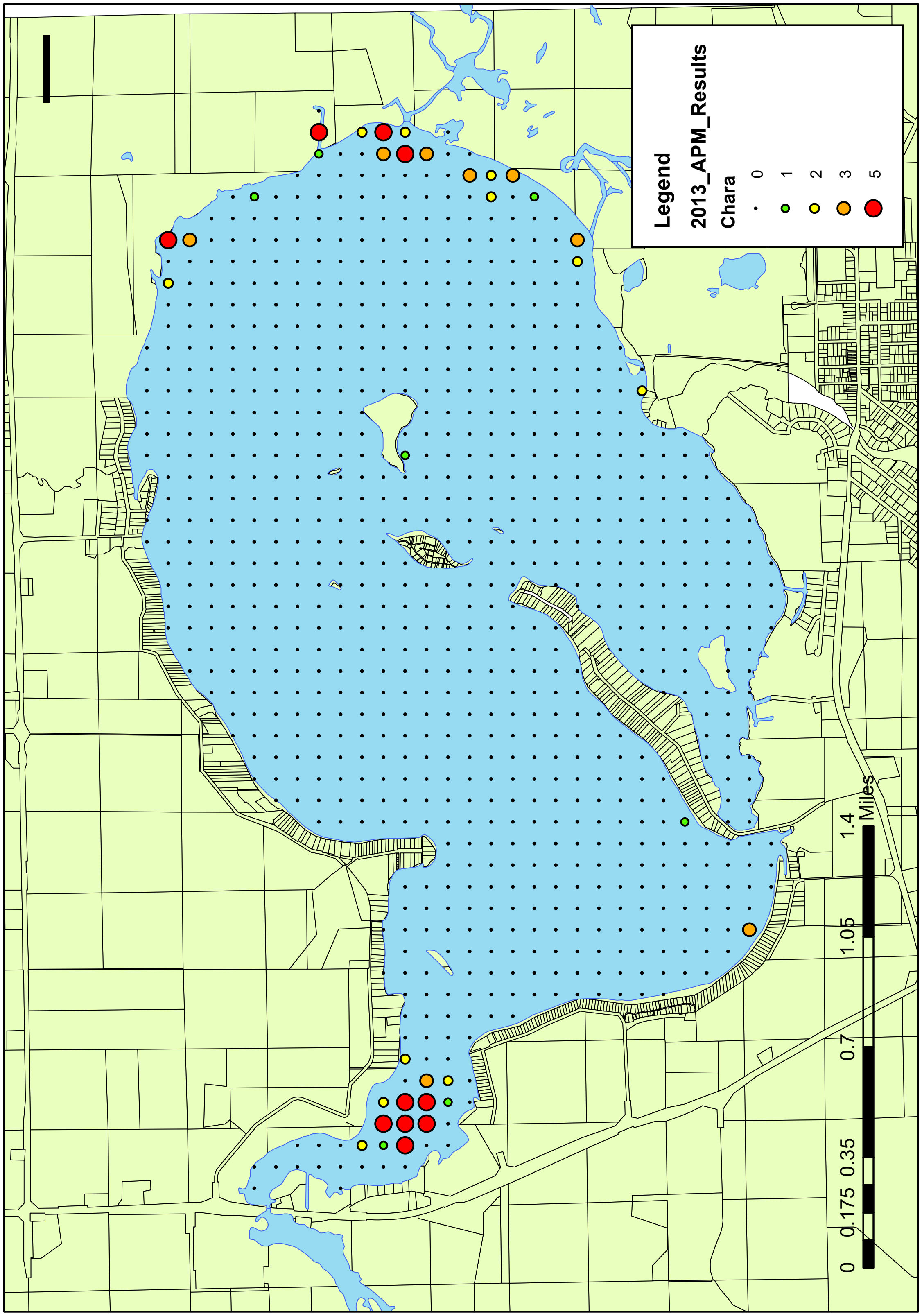
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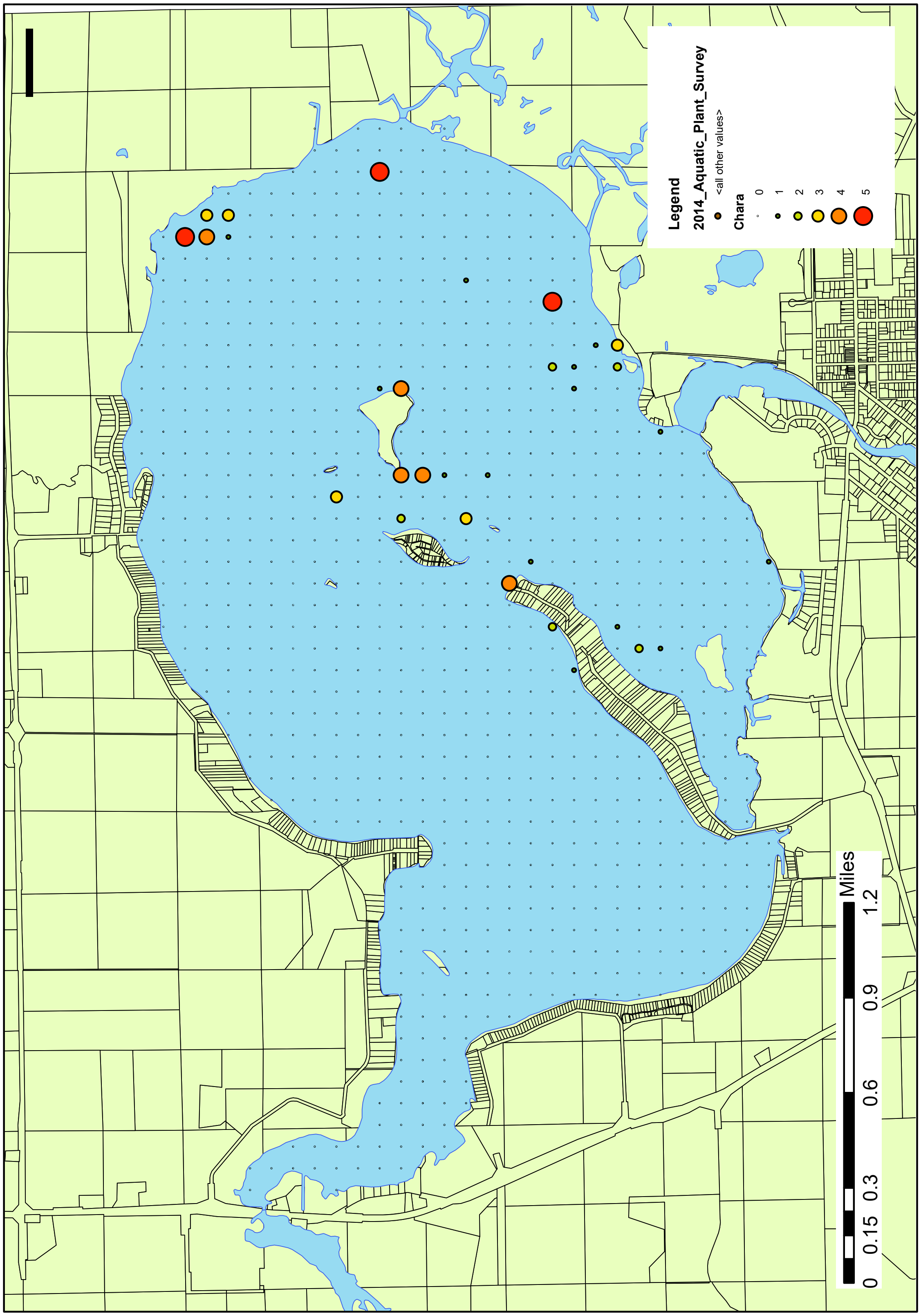
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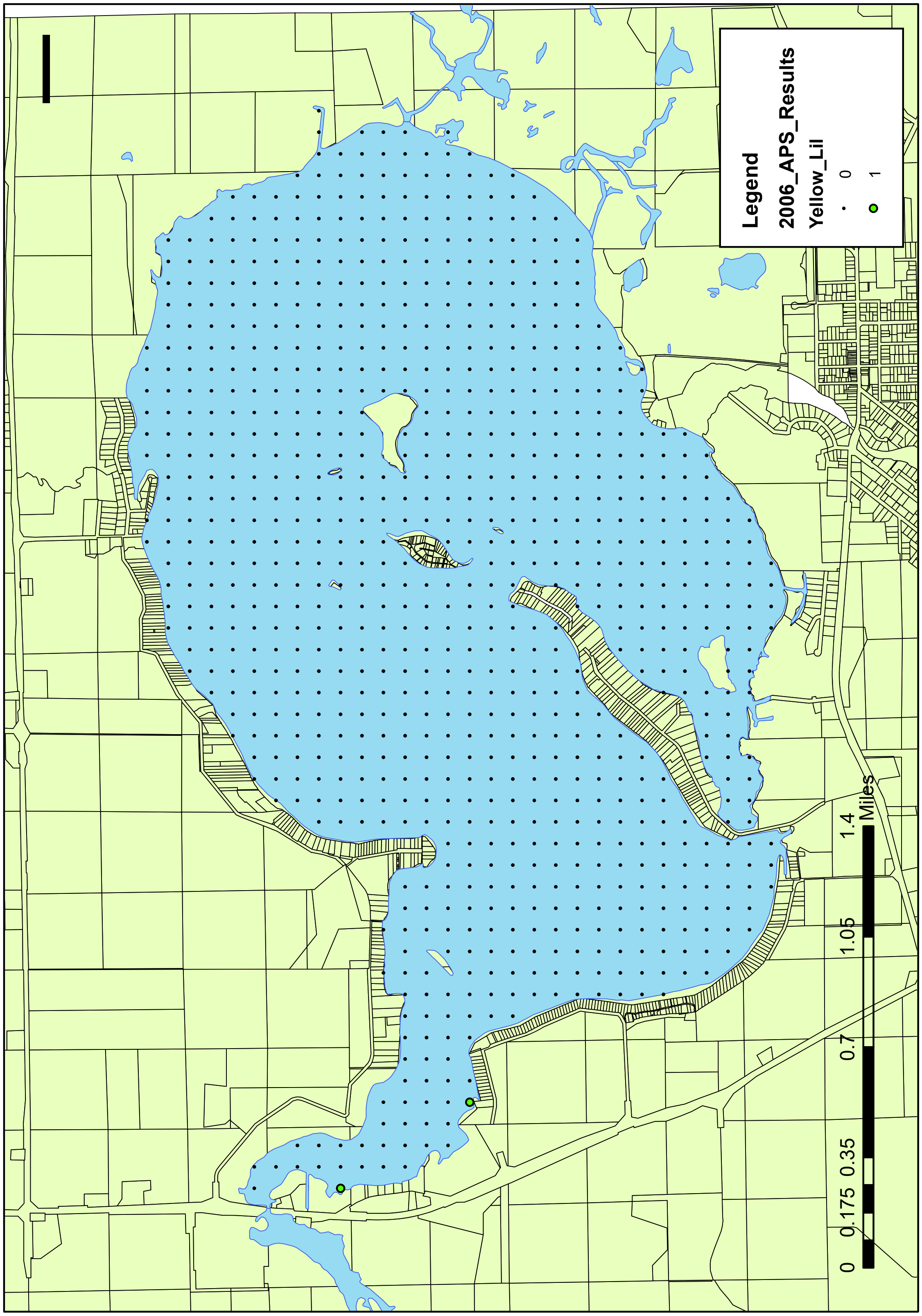
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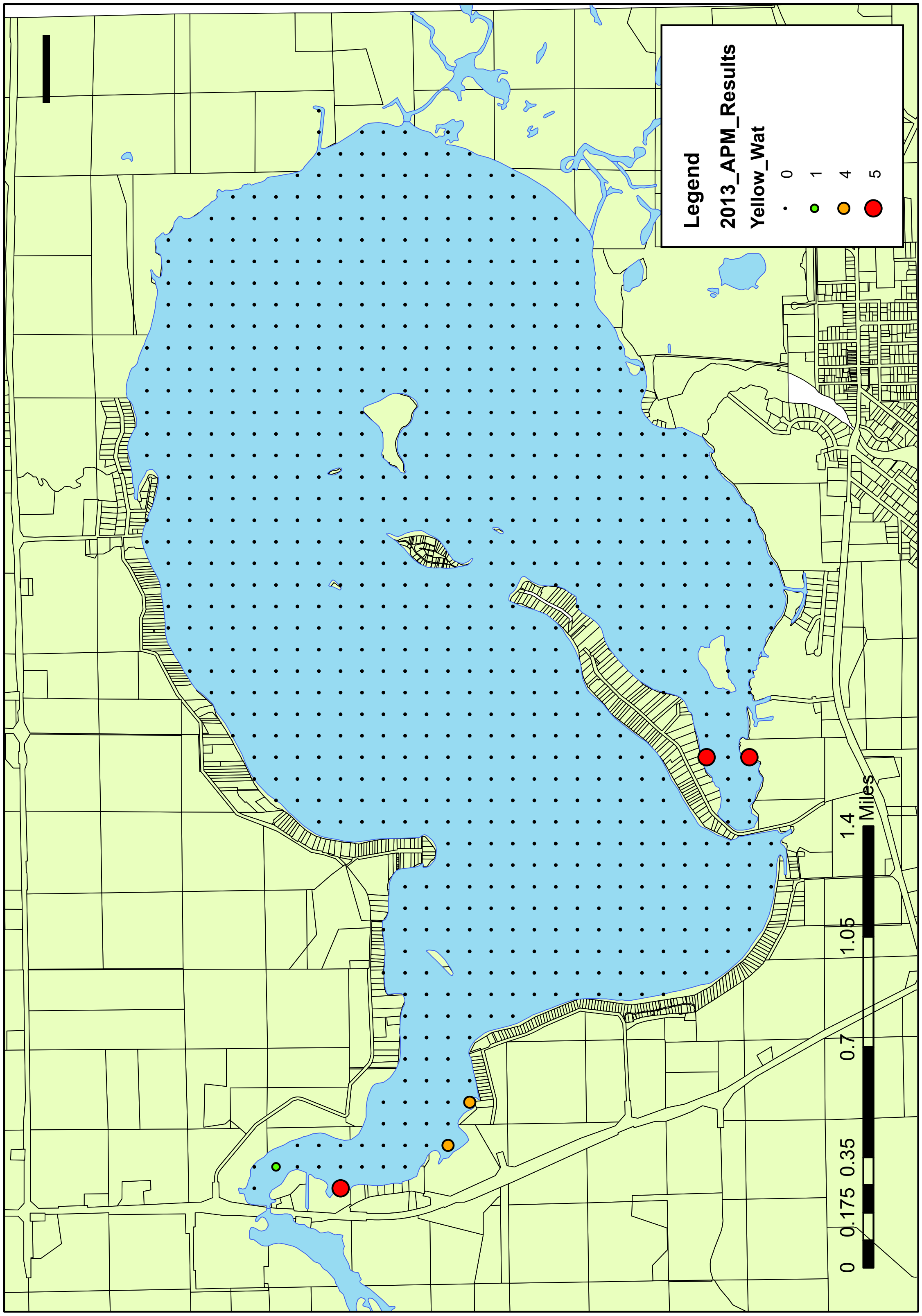
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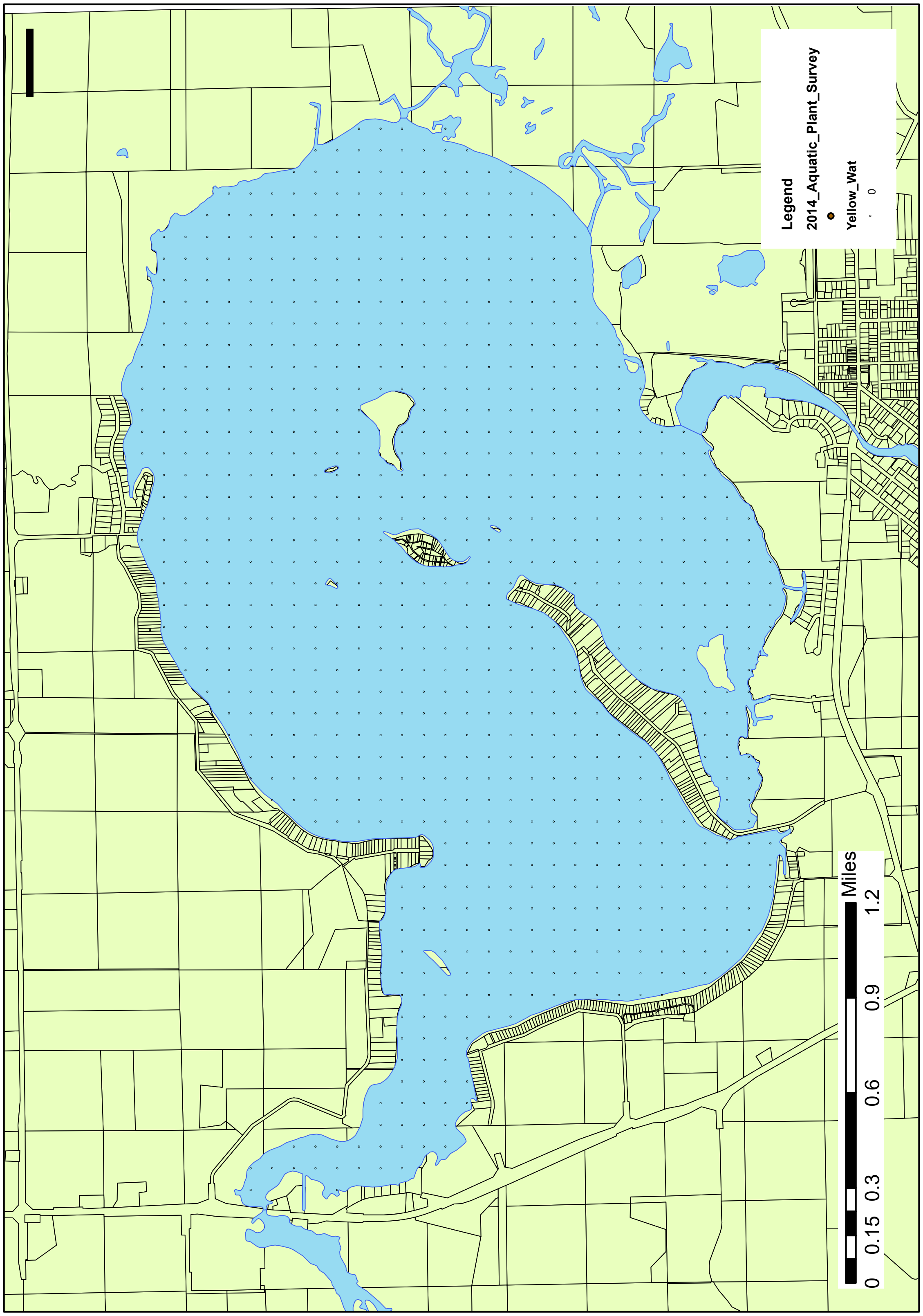
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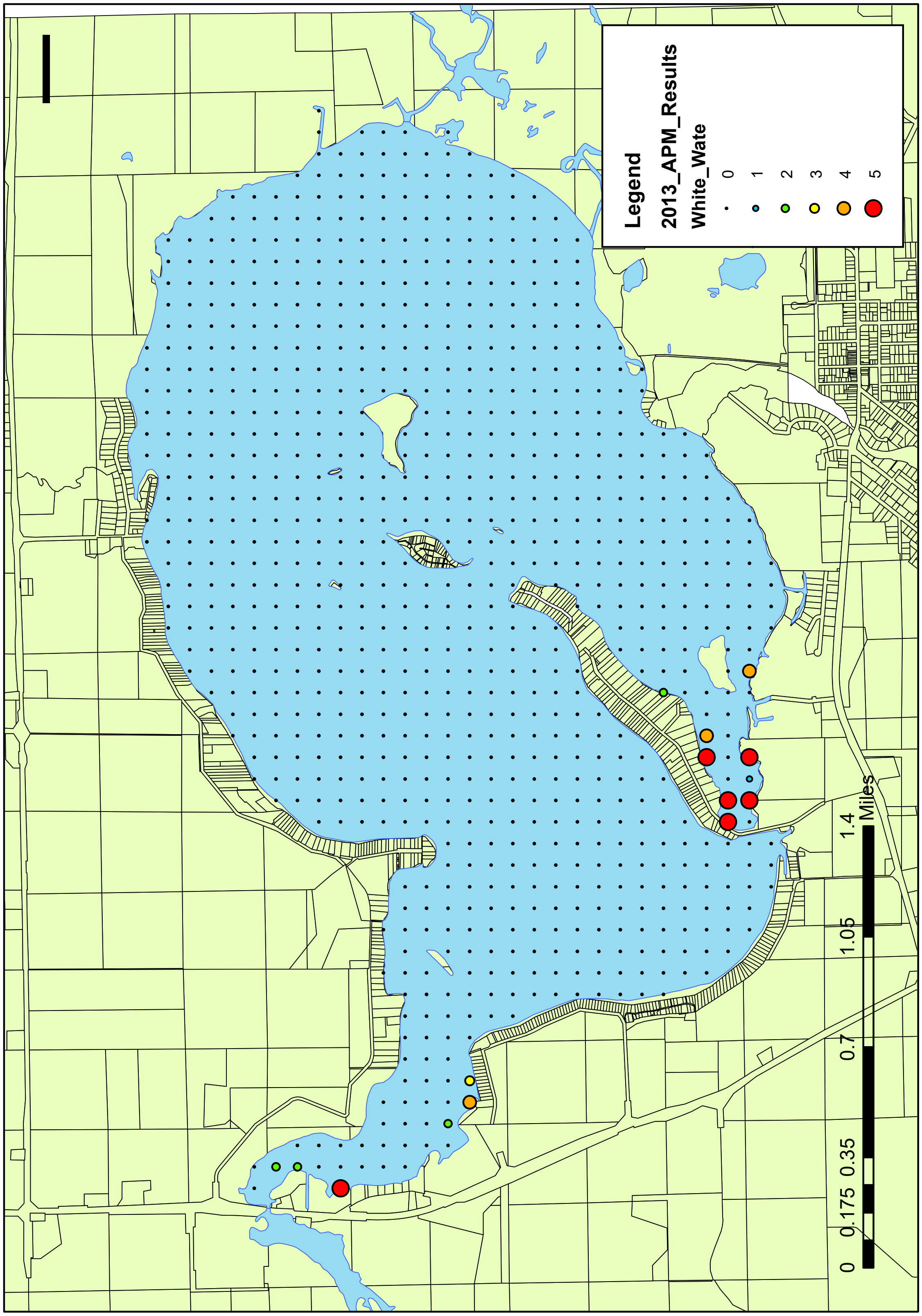
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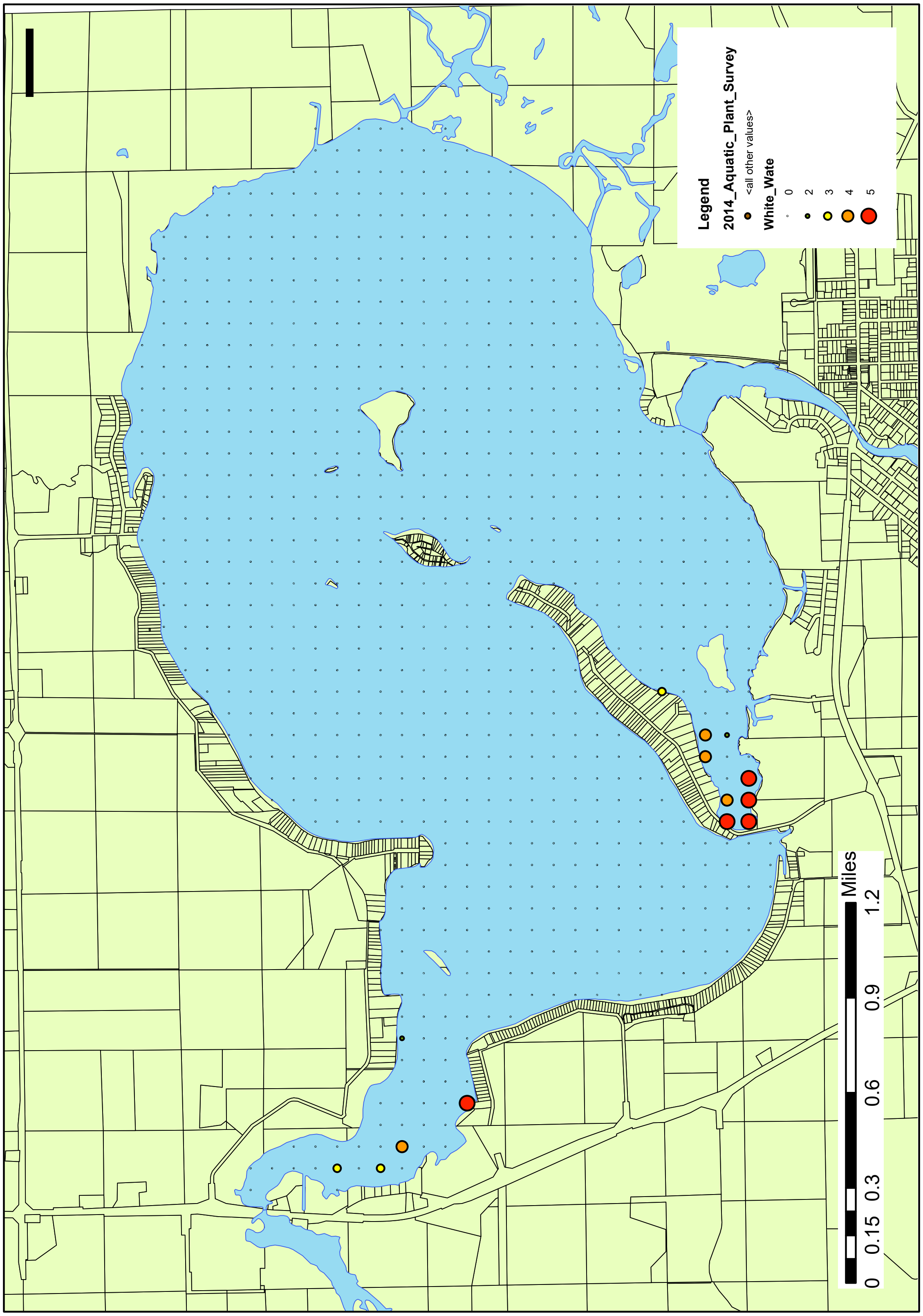
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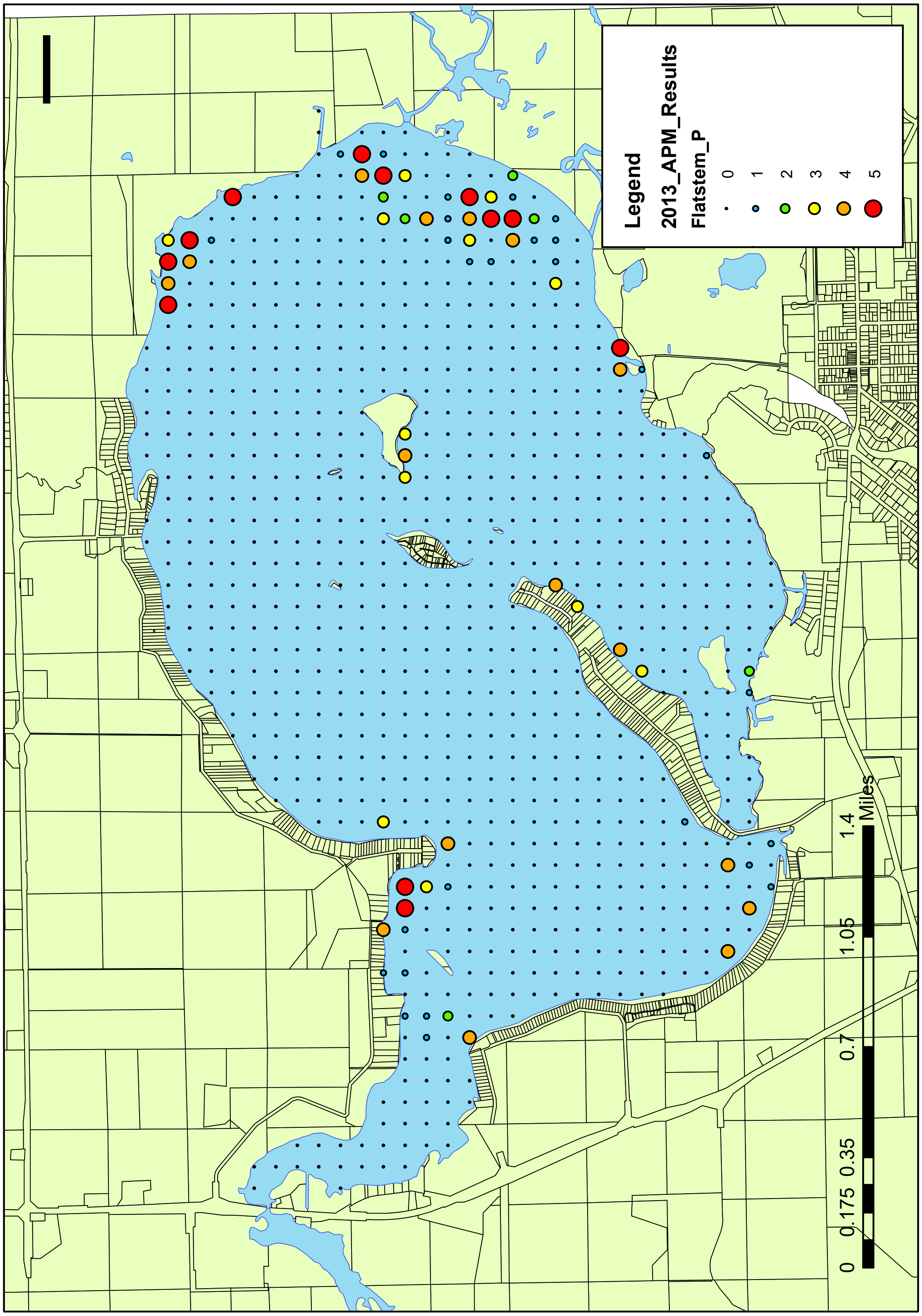
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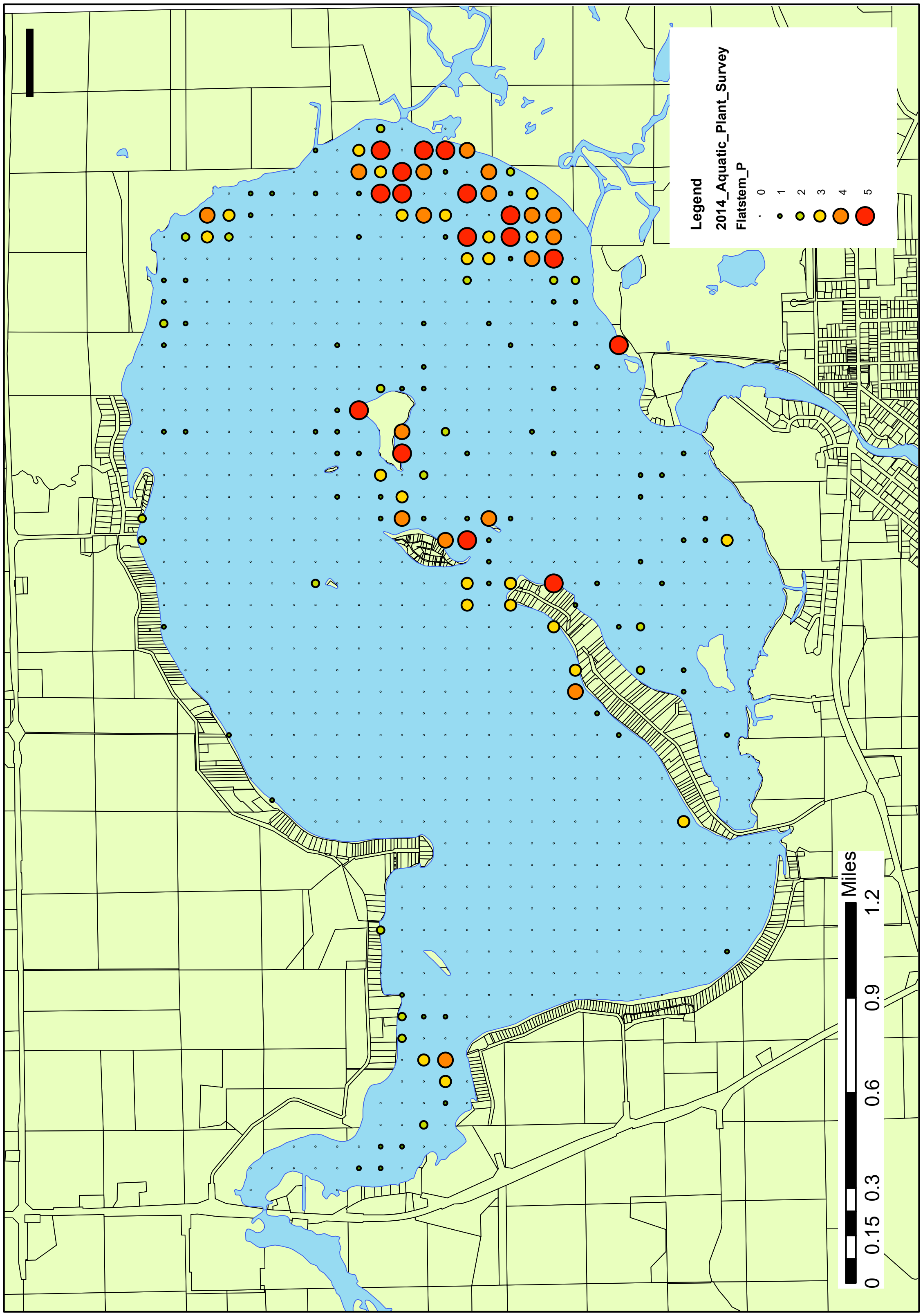
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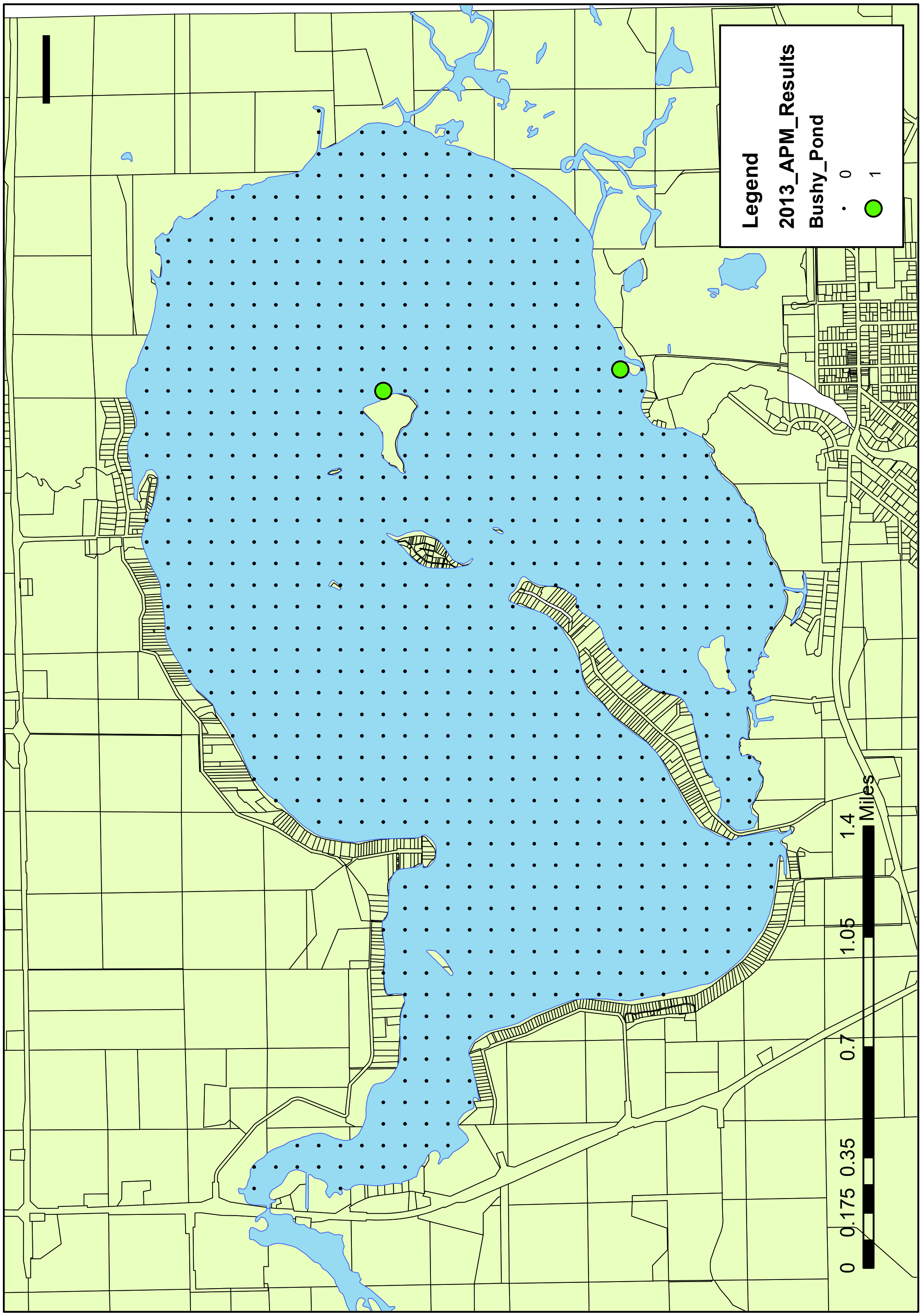
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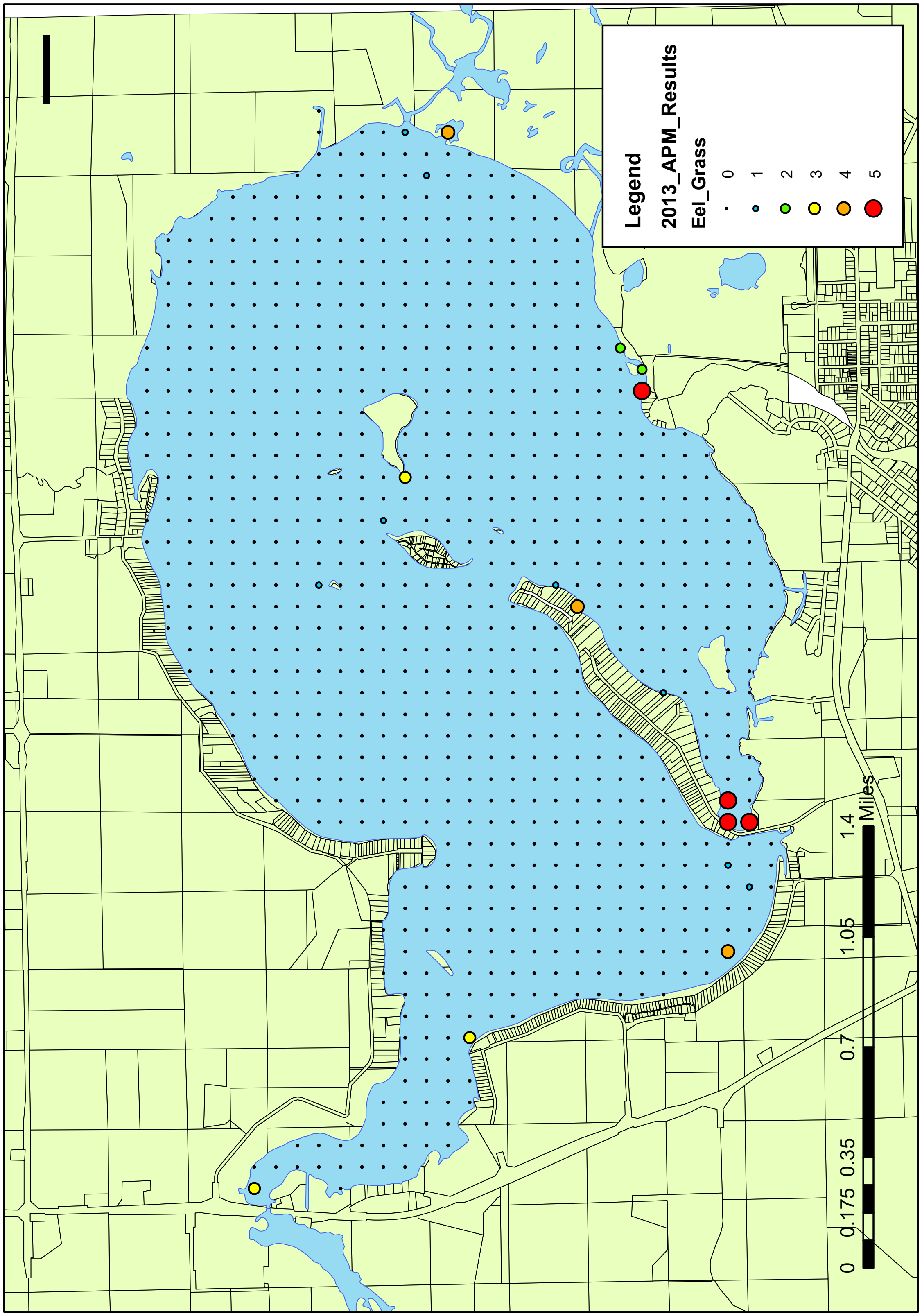
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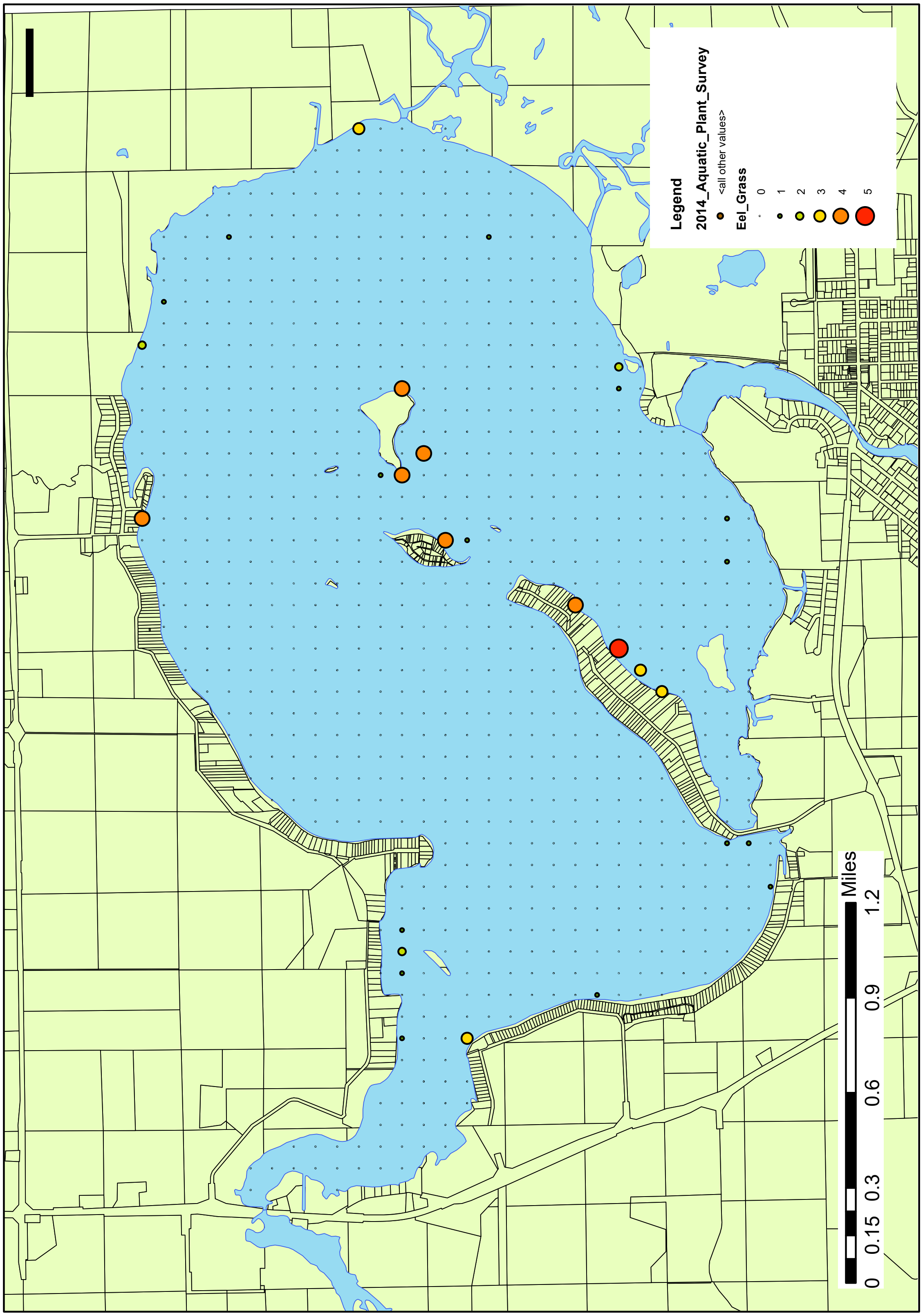
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3
4
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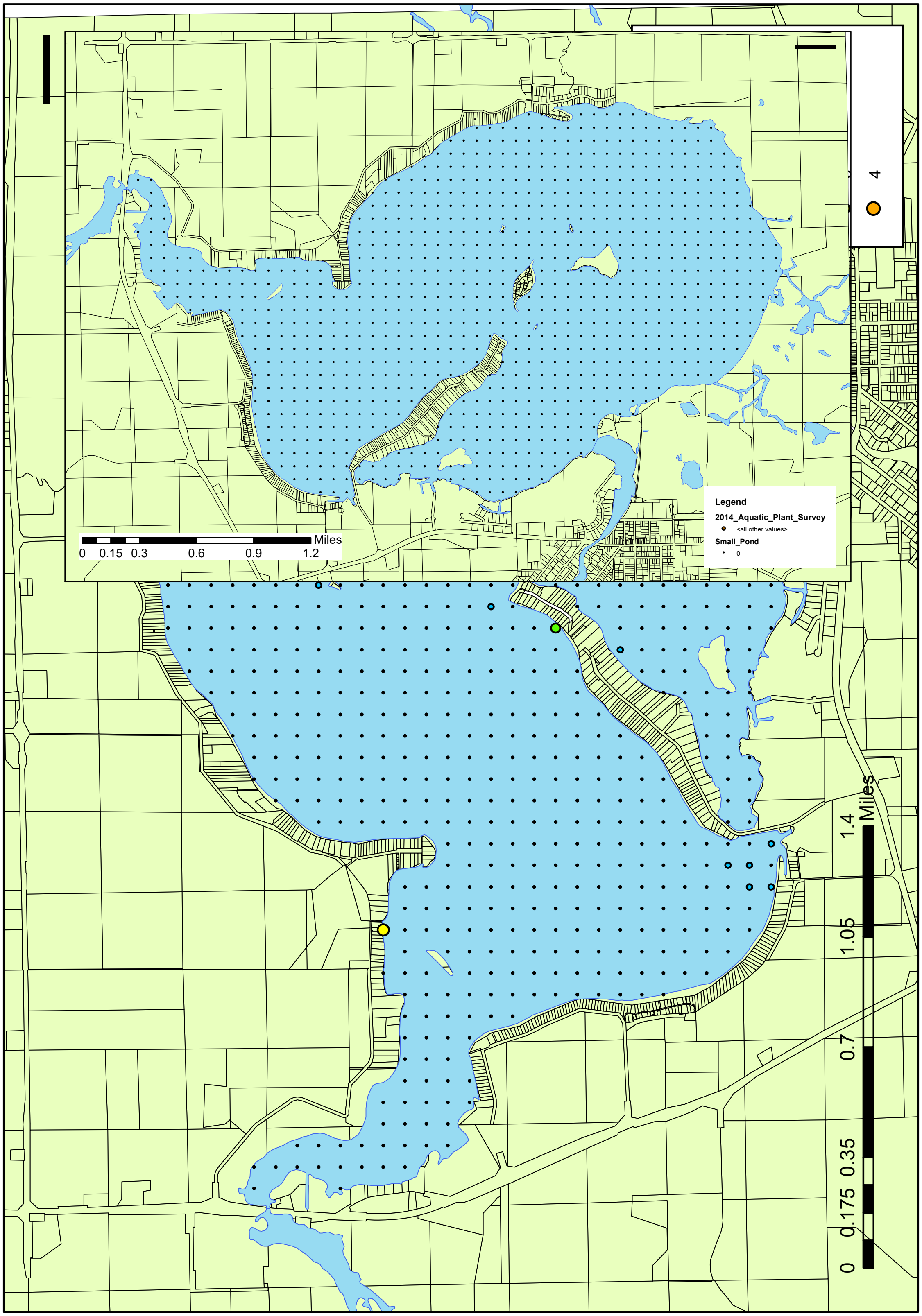
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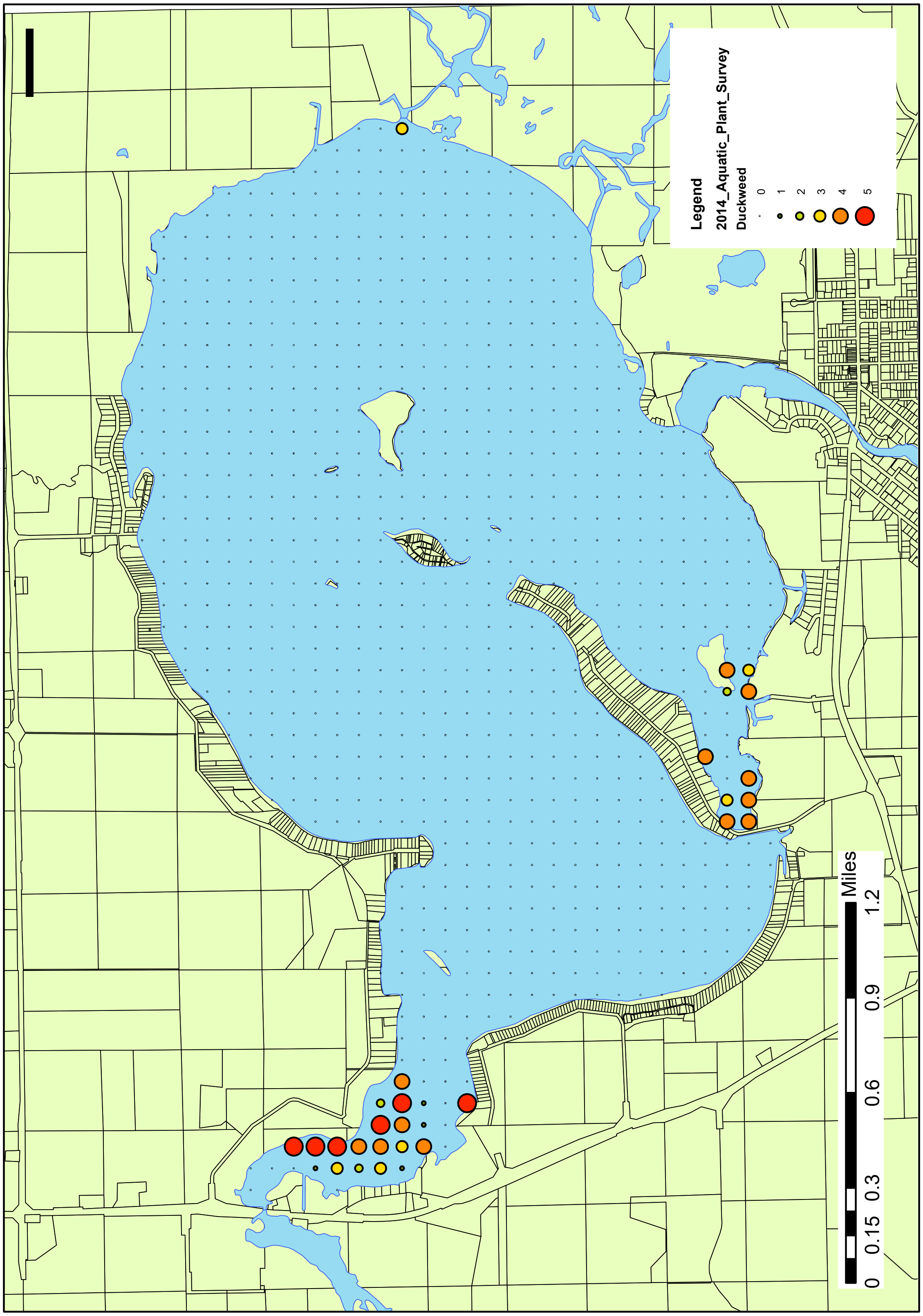
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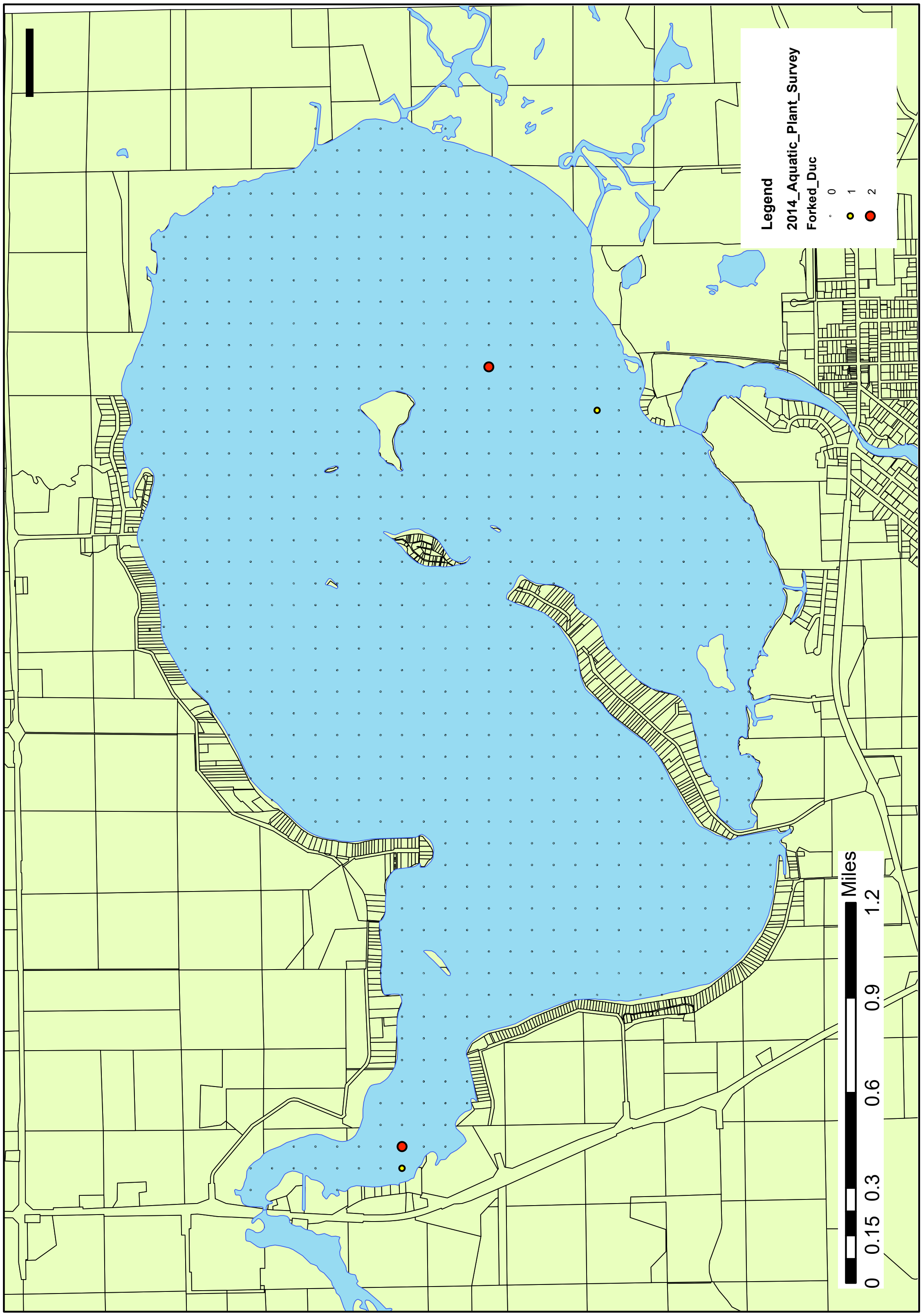
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Forked_Duc
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2
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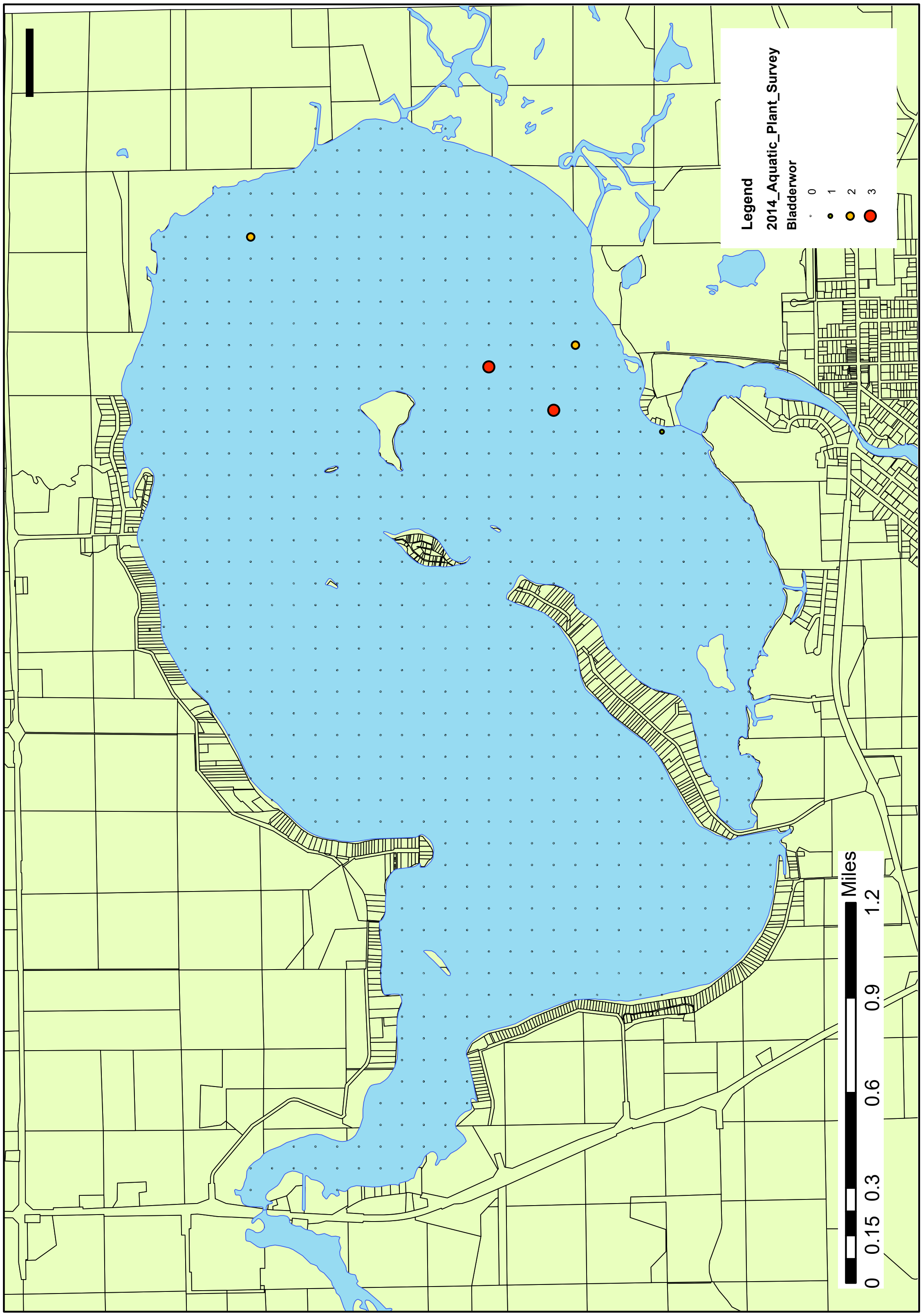
Miles


Legend
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Bladderwor
0
1
2
3
0 0.15 0.3 0.6 0.9 1.2
Miles

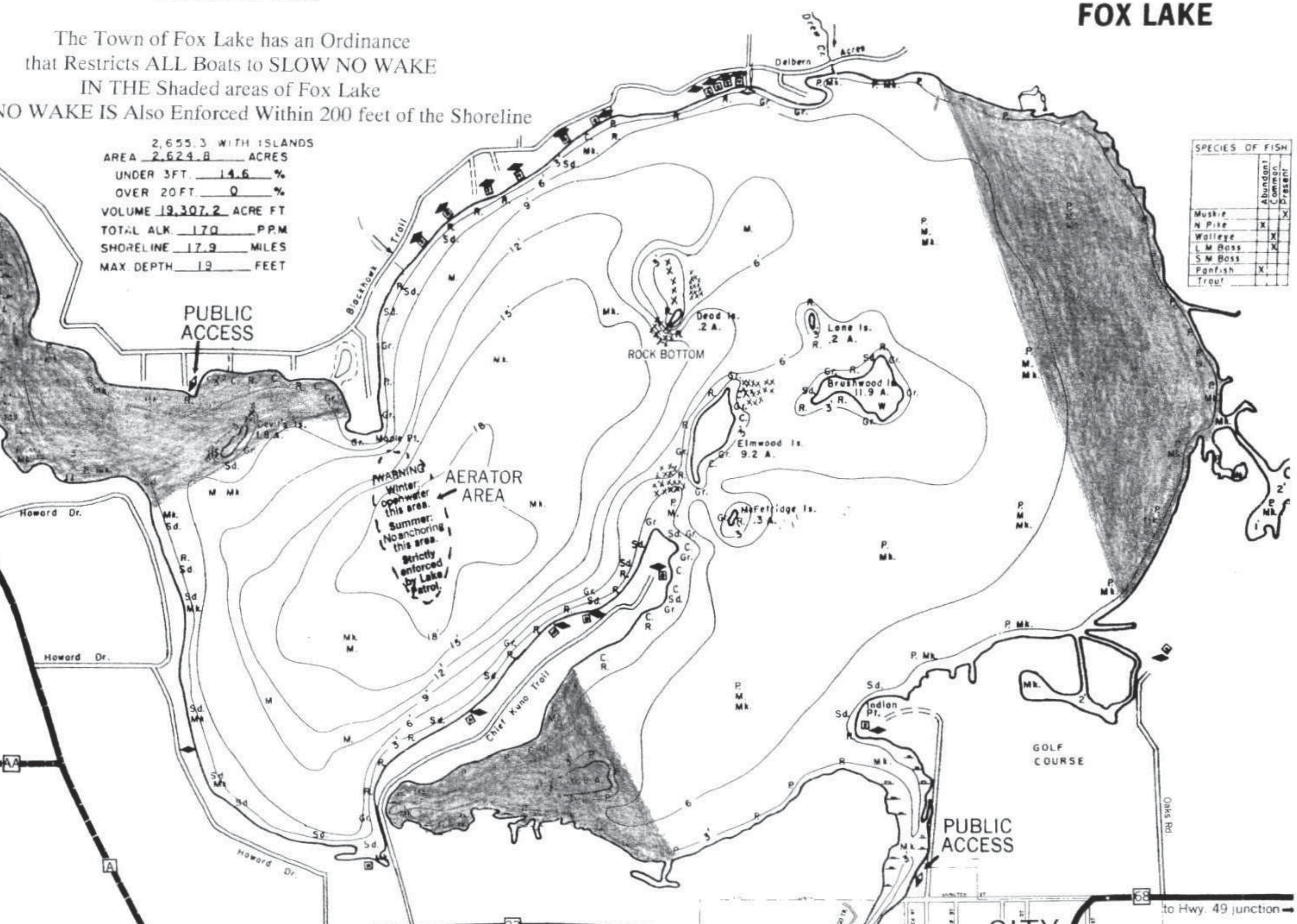
APPENDIX C

Additional Maps

PUBLIC NOTICE

The Town of Fox Lake has an Ordinance
that Restricts ALL Boats to SLOW NO WAKE
IN THE Shaded areas of Fox Lake
NO WAKE IS Also Enforced Within 200 feet of the Shoreline

FOX LAKE



SPECIES OF FISH	Abundant	Common	Present
Muskie			X
N. Pike	X		
Walleye		X	
L.M. Bass		X	
S.M. Bass			
Panfish	X		
Trout			