Lake Waccamaw Vegetation Survey Report

October 2024

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Submitted To:

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Introduction

Lake Waccamaw is a shallow 9,000-acre lake located in Columbus County, North Carolina. This waterbody is one of the few naturally formed bay lakes in the state and is valued for the unique aquatic habitat it provides. Lake Waccamaw is well known for having high ecological diversity, including rare and endemic species such as the Waccamaw killifish (*Fundulus waccamensis*) and Waccamaw darter (*Etheostoma perlongum*), that depend on a delicate balance of critical aquatic habitat.

In the fall of 2012 approximately 960 acres of monoecious hydrilla (*Hydrilla verticillata*), a federally listed invasive noxious weed, were first reported within Lake Waccamaw. A task force was immediately formed to discuss control options for hydrilla management which took into consideration the control of a nuisance species and impacts to endemic species. A slow-release granular fluridone herbicide was chosen as the most suitable management strategy and treatments began in the fall of 2013, targeting all 960 reported hydrilla acres. This management protocol continued until 2018 when hydrilla acreage was reduced to an estimated 455 acres. The hydrilla management program was then concluded following the 2019 treatment season. Simultaneous to management actions, system-wide surveys were conducted to monitor shifts within both native and non-native submersed aquatic vegetation (SAV) populations. These surveys were conducted through a collaboration of multiple agencies, but North Carolina State University Aquatic Plant Management Program (NCSU APM) began monitoring the distribution and abundance of these communities in 2012.

Following the directed management efforts, the distribution and abundance of hydrilla was greatly reduced in Lake Waccamaw and has not been identified within the system since 2017. However due to this species' ability to remain viable in hydrosoils in North Carolina reservoirs for 7 to 10 years (Nawrocki et al. 2016), continued monitoring has occurred up to the present date. This report details the findings from 2024 monitoring efforts by North Carolina State University.

Methods

The 2024 whole-lake aquatic vegetation survey at Lake Waccamaw occurred on the 9th and 10th of October. In 2012, a 300 x 300-meter grid of 362 georeferenced survey sites were determined for SAV monitoring efforts at Lake Waccamaw. These sites have been maintained as pre-determined site locations for point-intercept sampling during annual survey efforts. At each point, a double-sided rake was tossed from the boat towards the shoreline and the collected vegetation was recorded by species. Species abundance was measured on a rating scale of 0 to 4 (0 = no plants present on the rake; 1 = plants present at low densities, < 25% cover (*trace*); 2 = plants present at moderate densities, 25-50% cover (*sparse*); 3 = plants present a moderate to high densities, 50-75% cover (*moderate*); 4 = plants present at extremely high densities, 75-100% cover (*dense*)).

Concurrently, water column biovolume (%) was measured via boat-mounted hydroacoustic sonar technology. Data were recorded on micro-SD cards and uploaded to BioBase C-Map, a cloud-based post-processing service, to extract bathymetry and biovolume (quantity of the water column occupied with SAV; 0 to 100%) estimates. All processed data were exported as tabular data for further post-processing in ArcPro (V.3.2.1).

Results and Discussion

In total, 346 of the 362 proposed survey points were monitored at Lake Waccamaw in fall 2024. Like the 2023 survey, low water levels limited sampling access along the southeast shoreline. Of the surveyed points, aquatic vegetation was recorded at 180 (52%) sites in varying abundances (Table 1 and 2; Figure 1). Interpolated sonar data determined that vegetation covered 6.6% of the lake; mean biovolume was 15.9% where vegetation was present and 1% throughout the entire lake (Figure 2). Depth averaged 6.7 feet in the surveyed area while the deepest recording measured 9.64 feet (Figure 3).

Nine vegetation species were documented during the 2024 survey of Lake Waccamaw. Submersed vegetation species included slender pondweed (*Potamogeton pusillus*), macroalgae (*Chara* spp and *Nitella* spp.), slender naiad (*Najas flexilis*), southern naiad (*Najas guadalupensis*), spikerush (*Eleocharis palustris*), and lyngbya (*Microseria wollei*). Emergent and shoreline plants included narrow-leaf spatterdock (*Nuphar sagittifolia*), maidencane (*Panicum hemitomon*), and water willow (*Justicia americana*) (Table 1 and 2; Figures 4 to 12). Hydrilla was not found during the 2024 survey and has remained absent since 3 instances were recorded in 2017 (Table 1 and 2).

The 2024 survey results showed a decline in abundance among most aquatic plant species, although overall diversity remained comparable to years prior (Table 1; Figure 13). In this year's survey, water willow was the only species documented for the first time in NCSU's survey efforts. Slender naiad and macroalgae remain the dominant species within Lake Waccamaw but have decreased in abundance when compared to the 2023 survey (-36% and -78% respectively, Table 1; Figure 13).

Lyngbya was detected at three survey sites during the 2024 survey of Lake Waccamaw (Figure 6). This is the first detection of lyngbya since the 2021 survey when it represented 9% of the overall abundance for the aquatic plant community (Table 1). Lyngbya is a problematic, free-suspension filamentous cyanobacterium that has the ability to form dense mat-like formations along both the benthos and on the water's surface. Of the three sites where lyngbya was present in 2024, two were classified as having 'trace' benthic mat density and one was categorized as 'sparse' in density. All three instances were within close proximity of the NC Wildlife Boat Ramp on the northwest edge of the lake (Figure 6) where lyngbya was detected previously at low densities in 2013, 2014, 2016, and 2017. A spline interpolation estimated lyngbya to cover 48.79 acres of Lake Waccamaw in 2024 (Figure 14).

Thread-leaf naiad was previously found in 2022 and 2023, but was not documented during the 2024 survey effort (Table 1 and 2). Thread-leaf naiad is typically found in the Northern US and is characterized by its thin, flexible, and toothed leaves. It closely resembles the non-native brittle naiad (*Najas minor*) but does not exhibit recurve in its leaves. In North Carolina, thread-leaf naiad has been documented in waterbodies in the Mountains region and

throughout the Piedmont, but is considered rare in the Coastal Plain. The plant is listed as a Watch List species in North Carolina (LeGrand et. al., 2023). Watch List species are those that are, "rare or otherwise threatened with serious decline but for which current information does not justify placement on the main [state status] list" (LeDegrand et. al., 2023).

During previous survey years, bladderwort and maidencane were most commonly found at shallow shoreline points. The decrease in these two species' occurrence during the 2023 and 2024 survey is most likely due to sampling limitations (i.e., too shallow to survey) rather than a decline in plant presence.

Conclusion and Management Implications

- Hydrilla remains absent from sampling sites at Lake Waccamaw during the 2024 survey. The subterranean turions (tubers) of monoecious hydrilla have been shown to remain viable in hydrosoils in North Carolina reservoirs for 7 to 10 years (Nawrocki et al. 2016). Because hydrilla has not been documented at Lake Waccamaw in >10 years, it is likely the original plant population has been fully managed in the system.
- Continued monitoring of the SAV community at Lake Waccamaw will be beneficial to managers to document change over time and to provide early detection for potential introductions of non-native species.

References

LeGrand, H., B. Sorrie, and T. Howard. 2023. Vascular Plants of North Carolina [Internet]. Raleigh (NC): North Carolina Biodiversity Project and North Carolina State Parks. Available from https://auth1.dpr.ncparks.gov/flora/index.php.

Nawrocki JJ, RJ Richardson, ST Hoyle. 2016. Monoecious hydrilla tuber dynamics following various management regimes on four North Carolina reservoirs. Journal of Aquatic Plant Management. 54: 12 – 19.

Table 1. Relative abundance of all macrophytes surveyed by NCSU between 2012 and 2024.

Species	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Hydrilla	12%	0%	0%	0%	0%	1%	0%	0%	0%	0%	0%	0%	**0%**
Slender Pondweed	61%	5%	0%	0%	0%	1%	0%	3%	1%	4%	2%	7%	**1%**
Slender/Southern Naiad	72%	6%	0%	1%	0%	0%	2%	6%	0%	2%	53%	81%	**46%**
Thread-leaf Naiad	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	17%	3%	**0%**
Proliferating Spikerush	0%	0%	0%	0%	2%	3%	4%	0%	0%	1%	0%	0%	**<1%**
Narrow-leaf Spatterdock	2%	1%	1%	2%	3%	1%	3%	5%	2%	4%	2%	7%	**2%**
Native Floating Heart	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	**0%**
Maidencane	2%	2%	1%	3%	0%	0%	4%	3%	3%	6%	4%	1%	**1%**
Bladderwort	0%	0%	0%	0%	0%	1%	0%	1%	3%	9%	4%	0%	**0%**
Pennywort	0%	0%	0%	0%	0%	0%	0%	0%	0%	1%	0%	0%	**0%**
Nitella/Chara	29%	3%	7%	13%	0%	27%	8%	34%	0%	38%	52%	45%	**9%**
Yellow-eyed Grass	0%	0%	0%	0%	0%	0%	0%	0%	0%	1%	0%	0%	**0%**
Phragmites	0%	0%	0%	0%	0%	0%	0%	0%	0%	1%	0%	0%	**0%**
Lyngbya	0%	1%	6%	0%	1%	2%	0%	0%	0%	9%	0%	0%	**1%**
Filamentous algae	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	3%	**0%**
Water Willow	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	**2%**
Total Vegetated Points	300	-	46	-	23	119	67	155	29	204	276	**246**	**180**
Total Surveyed Points	362	347	352	361	361	372	386	357	363	363	356	**304**	**346**
% Vegetated	83%	-	13%	-	6%	32%	17%	43%	8%	56%	77%	**81%**	**52%**

Table 2. Sampling occurrence of all macrophytes surveyed by NCSU between 2012 and 2024. Percent change calculated represents trends in abundance between 2023 and 2024.

Species	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	Percent Change
Hydrilla	45	0	0	0	0	3	0	0	0	0	0	0	**0**	0%
Slender Pondweed	222	16	1	0	1	3	0	12	4	14	6	22	**4**	-82%
Slender/Southern Naiad	259	21	0	5	0	1	8	23	0	6	188	246	**158**	-36%
Thread-leaf Naiad	0	0	0	0	0	0	0	0	0	0	59	8	**0**	-100%
Proliferating Spikerush	0	0	0	0	9	11	15	0	0	5	0	0	**1**	>100%
Narrow-leaf Spatterdock	7	2	4	7	10	4	12	17	8	14	8	21	**8**	-62%
Native Floating Heart	0	0	0	0	0	0	0	0	0	1	0	0	**0**	0%
Maidencane	8	7	4	10	0	0	15	9	10	20	16	4	**2**	-50%
Bladderwort	0	0	0	0	0	2	0	2	11	34	13	0	**0**	0%
Pennywort	0	0	0	0	0	0	0	0	0	2	0	0	**0**	0%
Nitella/Chara	104	11	26	48	1	101	31	123	0	137	185	137	**30**	-78%
Yellow-eyed Grass	0	0	0	0	0	0	0	0	0	2	0	0	**0**	0%
Phragmites	0	0	0	0	0	0	0	0	0	2	0	0	**0**	0%
Lyngbya	0	2	20	0	2	7	0	0	0	32	0	0	**3**	>100%
Filamentous algae	0	0	0	0	0	0	0	0	0	0	0	9	**0**	-100%
Water Willow	0	0	0	0	0	0	0	0	0	0	0	0	**8**	>100%
Total Vegetated Points	300	-	46	-	23	119	67	155	29	204	276	**246**	**180**	-27%
Total Surveyed Points	362	347	352	361	361	372	386	357	363	363	356	**304**	**346**	14%
% Vegetated	83	-	13	-	6	32	17	43	8	56	77	**81**	**52**	-36%

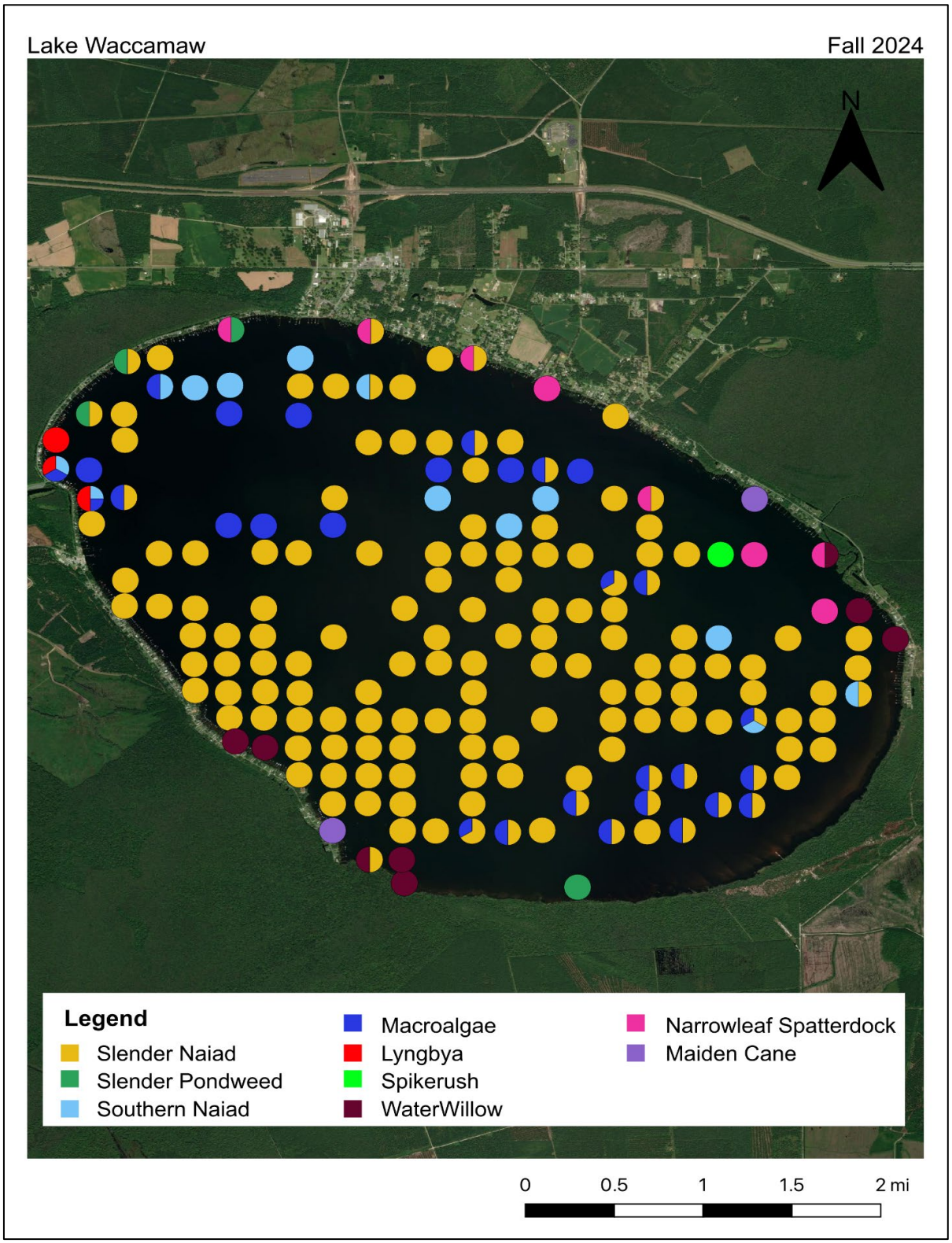

Figure 1: Distribution and relative abundance of aquatic plant species in Lake Waccamaw during the 2024 survey.

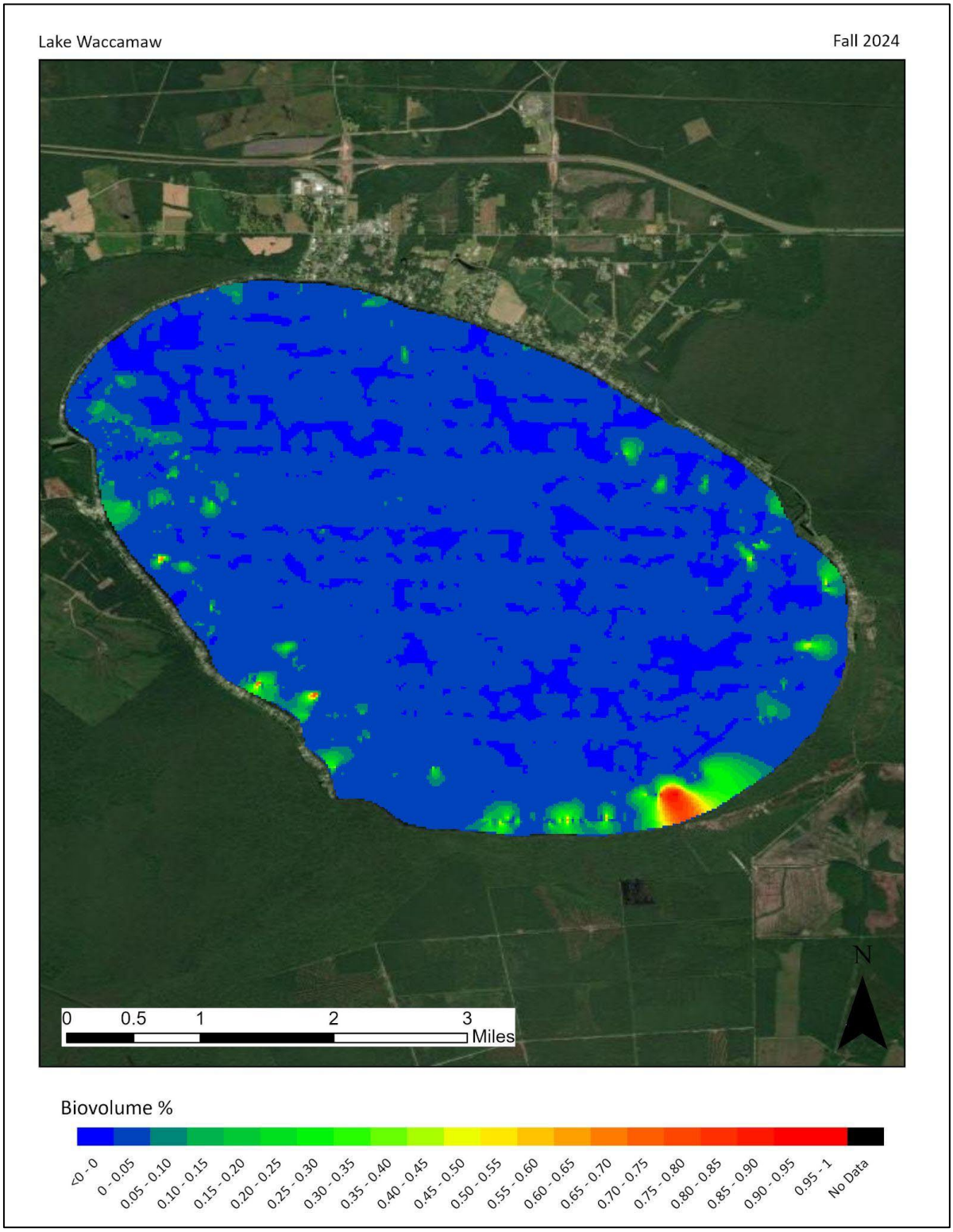

Figure 2: Interpolated biovolume estimates of SAV in Lake Waccamaw during the 2024 survey. Cool (blue) colors represent low biovolume and warm (red) colors represent high biovolume. It should be noted that shallow depths can result in false-positive biovolume estimates. Conversely, the biovolume of sparse, "delicate" species such as naiad and macroalgae is often underrepresented in this hydroacoustically-collected data.

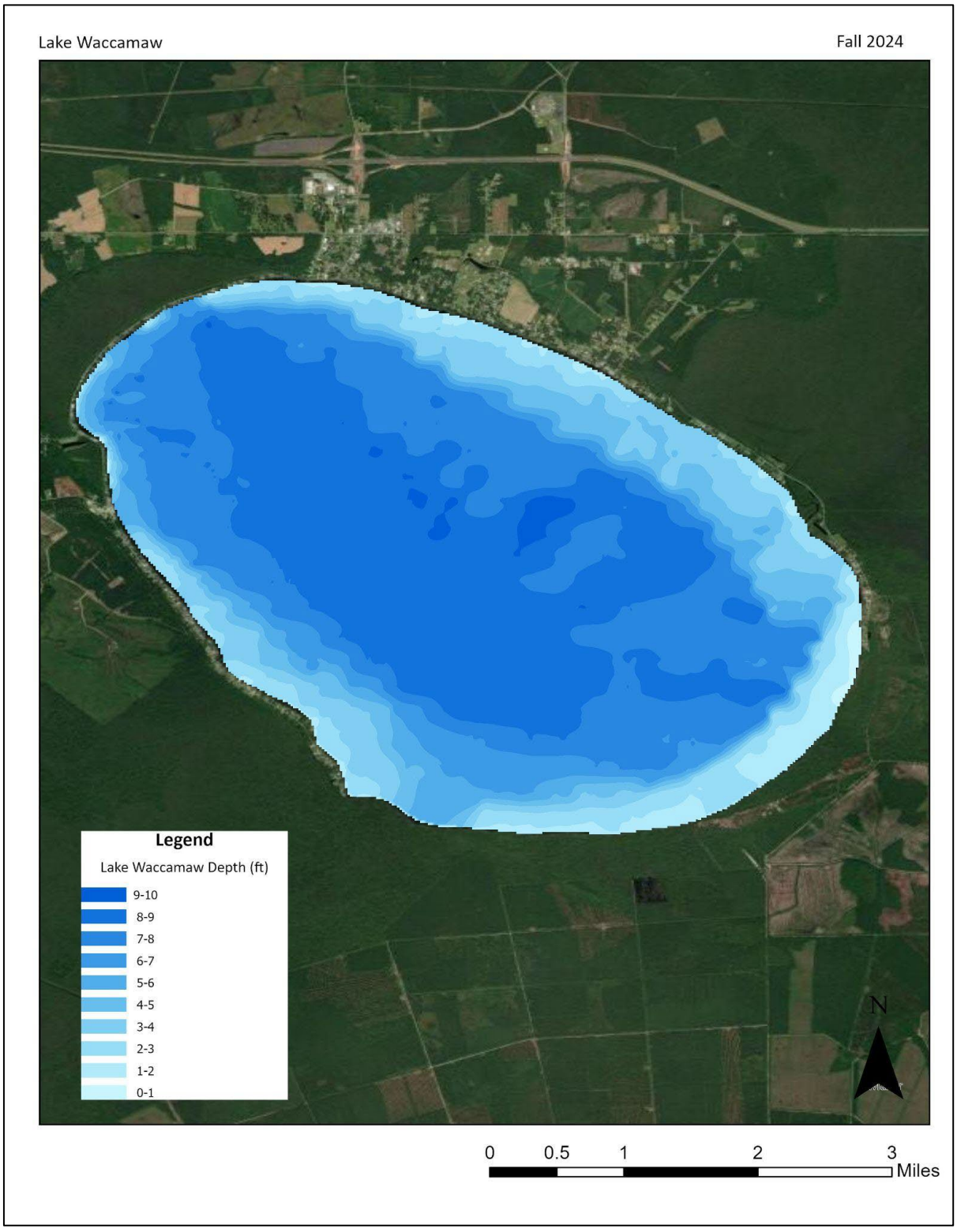

Figure 3: Interpolated depth profile of Lake Waccamaw recorded during the 2024 survey.

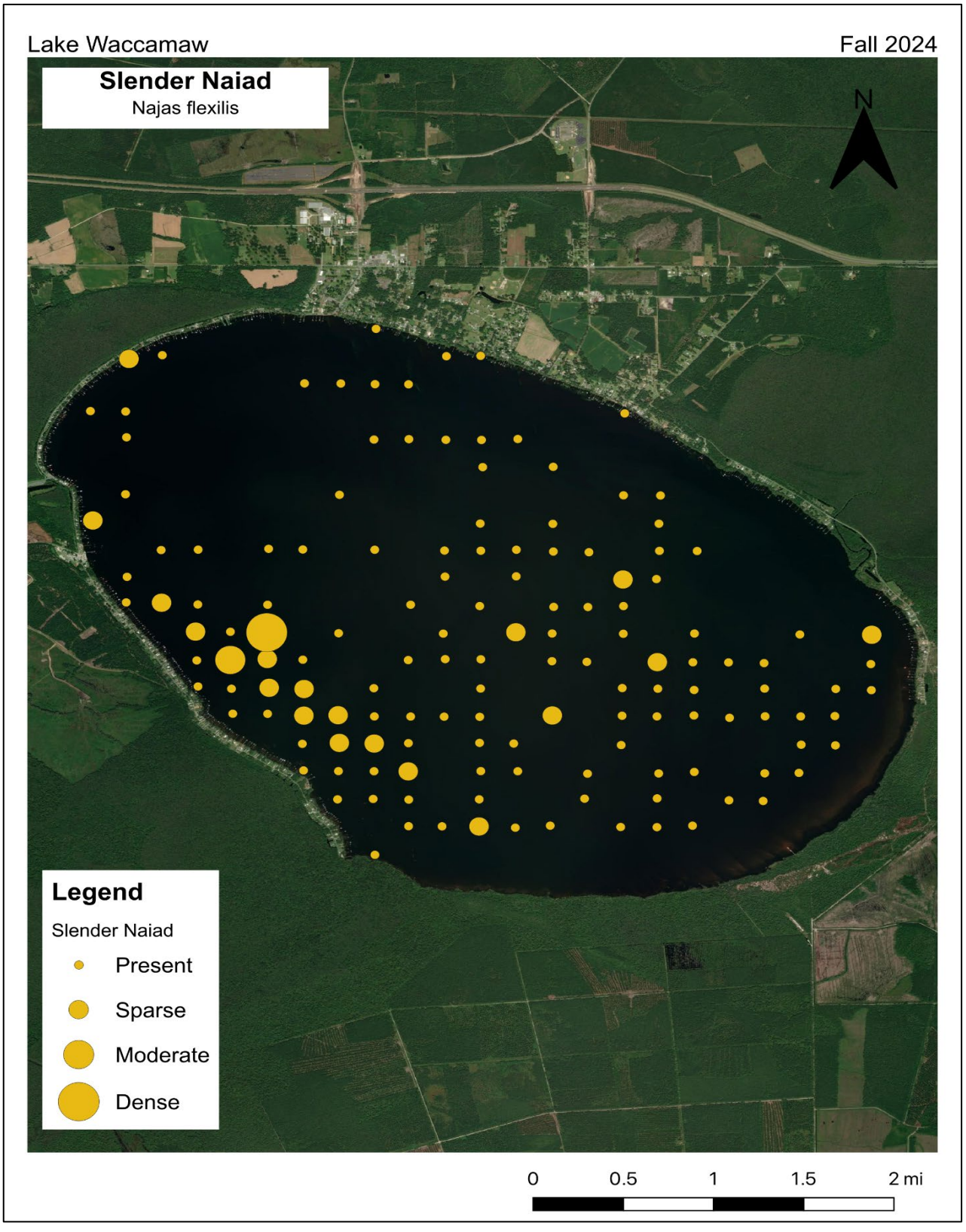

Figure 4: Distribution and abundance of slender naiad (*Najas flexilis*) in Lake Waccamaw during the 2024 survey.

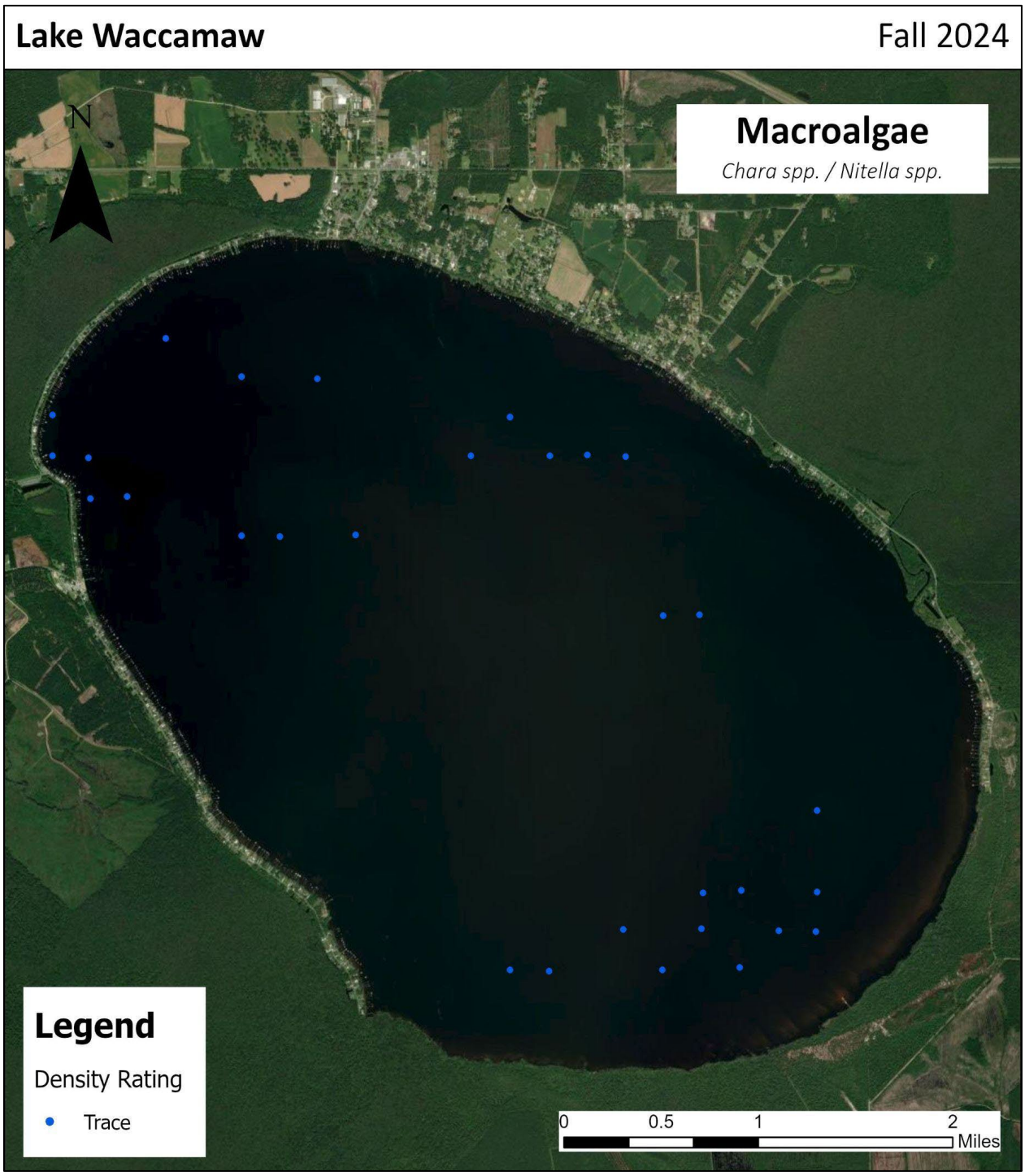

Figure 5: Distribution and abundance of macroalgae (*Chara* spp./*Nitella* spp.) in Lake Waccamaw during the 2024 survey.

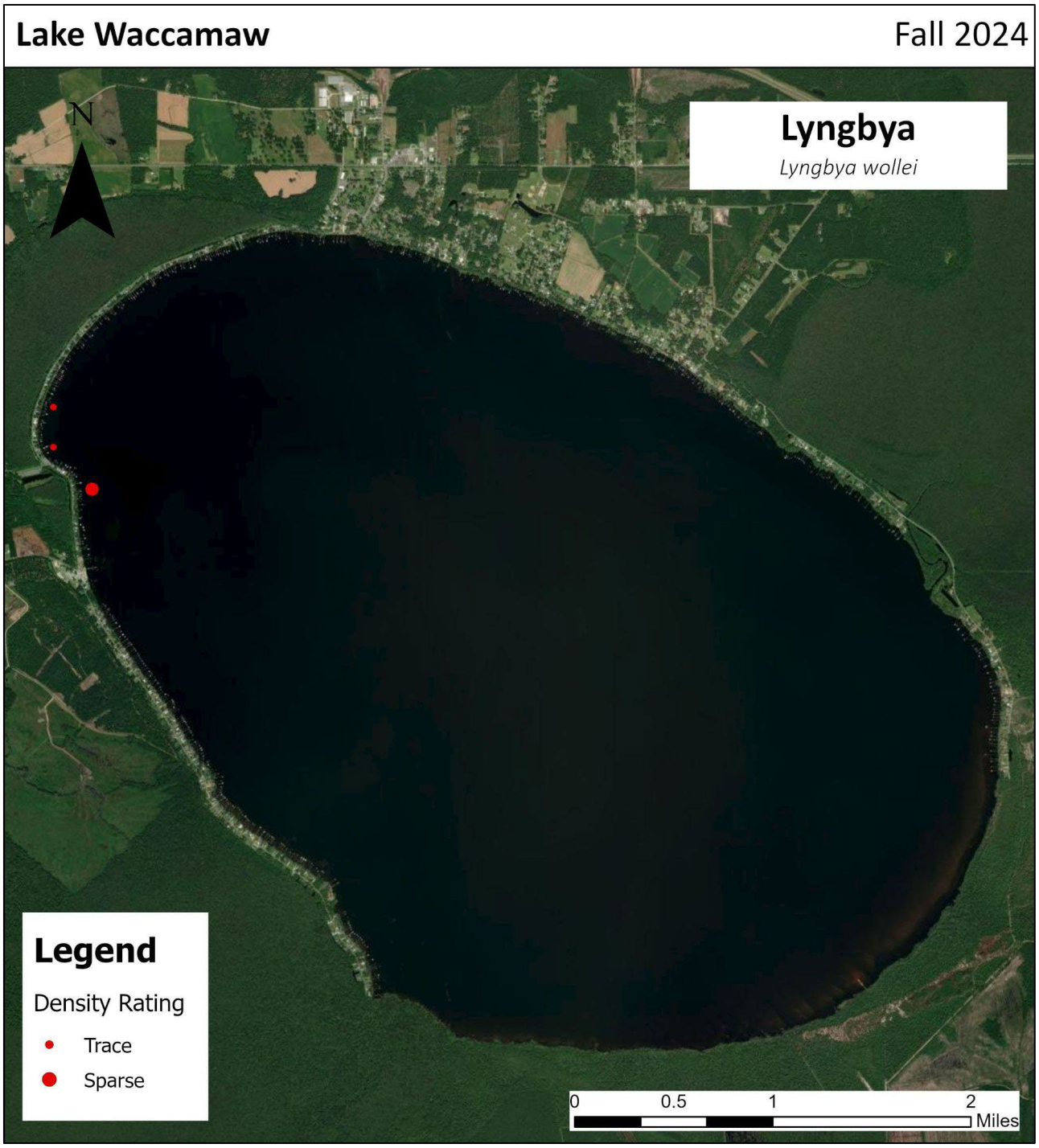

Figure 6: Distribution and abundance of Lyngbya (*Lyngbya wollei*) in Lake Waccamaw during the 2024 survey.

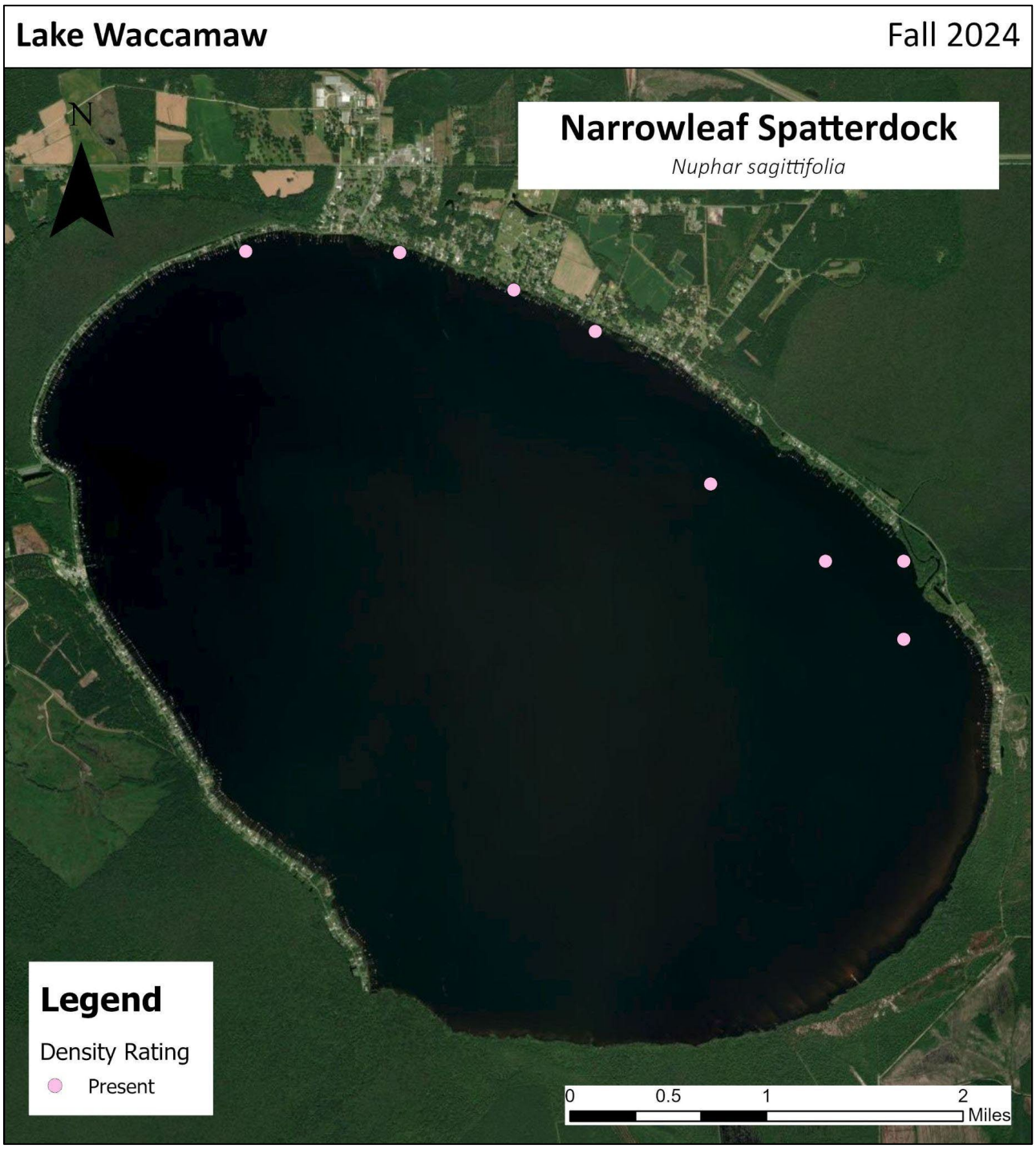

Figure 7: Distribution and abundance of narrow-leaf spatterdock (*Nuphar sagittifolia*) in Lake Waccamaw during the 2024 survey.

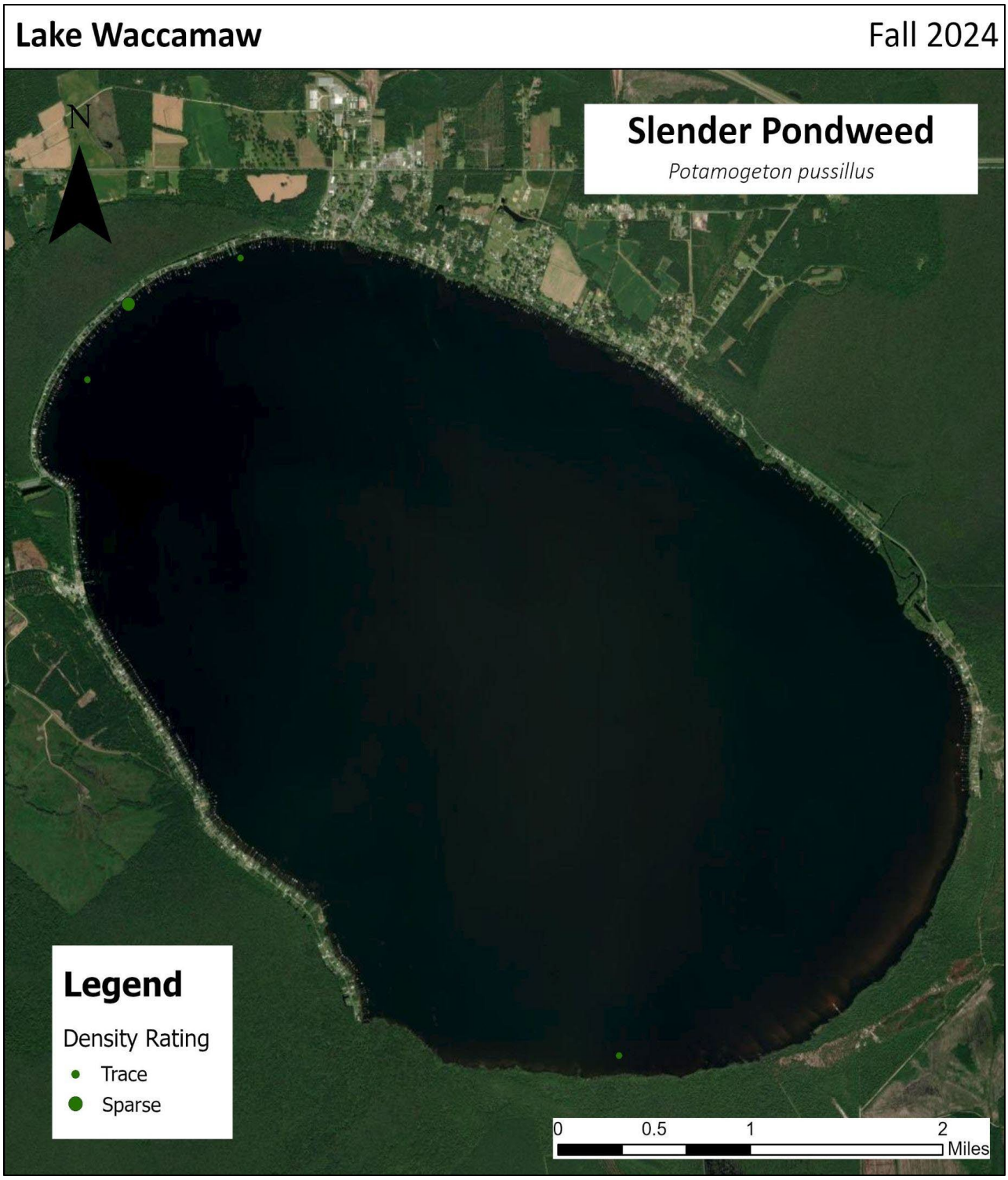

Figure 8: Distribution and abundance of slender pondweed (*Potamogeton pusillus*) in Lake Waccamaw during the 2024 survey.

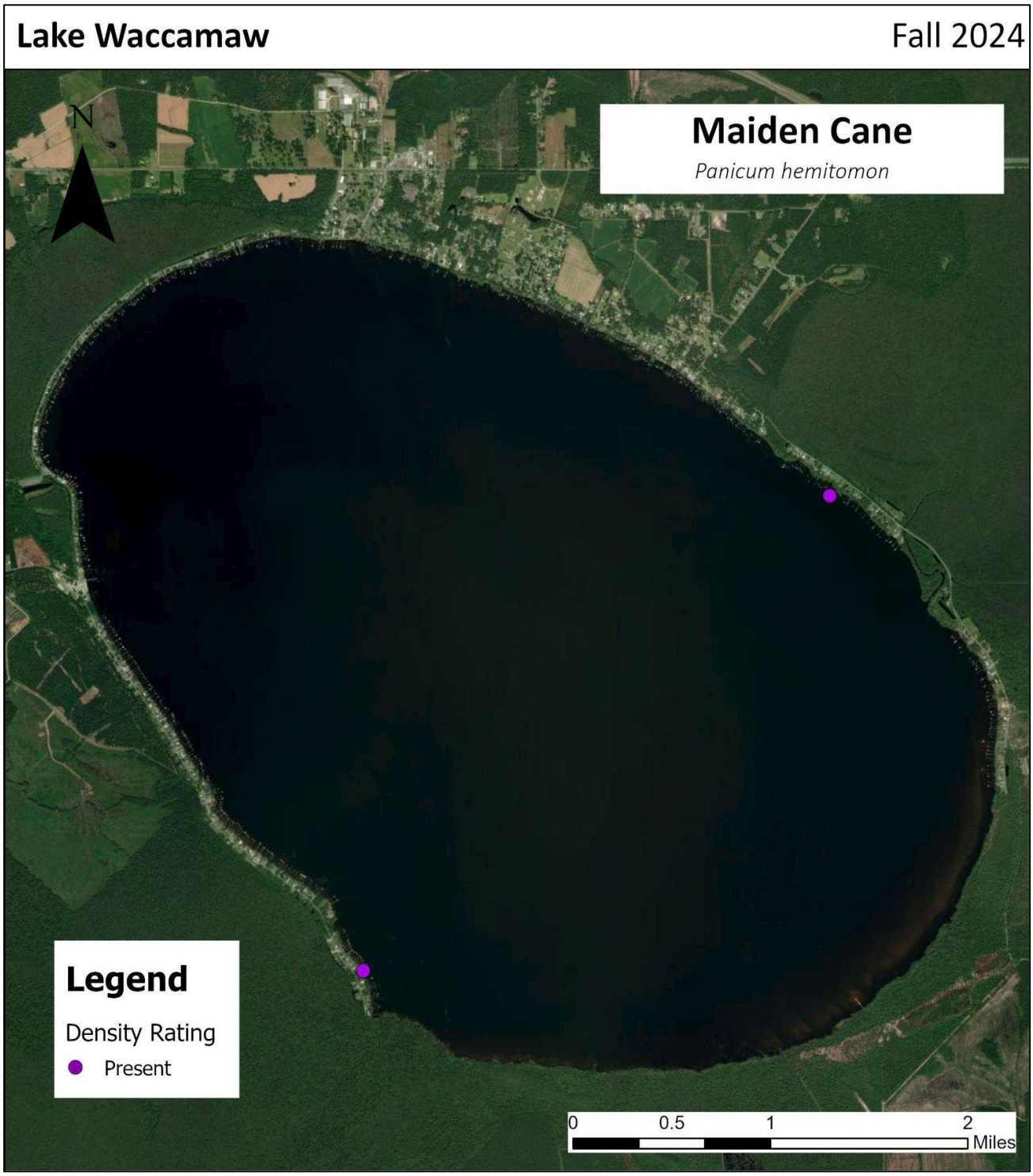

Figure 9: Distribution and abundance of maidencane (*Panicum hemitomon*) in Lake Waccamaw during the 2024 survey.

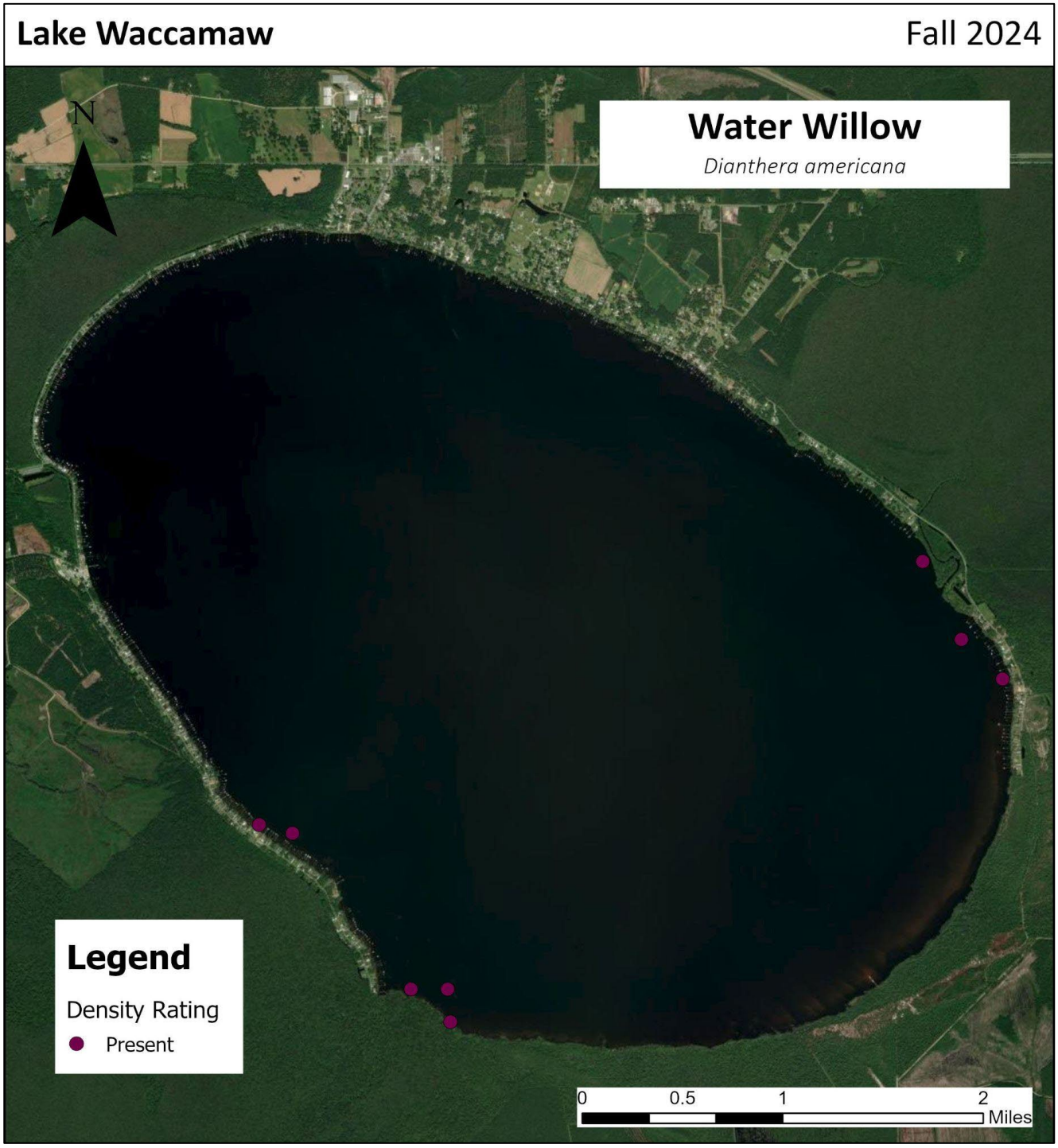

Figure 10: Distribution and abundance of water willow (*Dianthera americana*) in Lake Waccamaw during the 2024 survey.

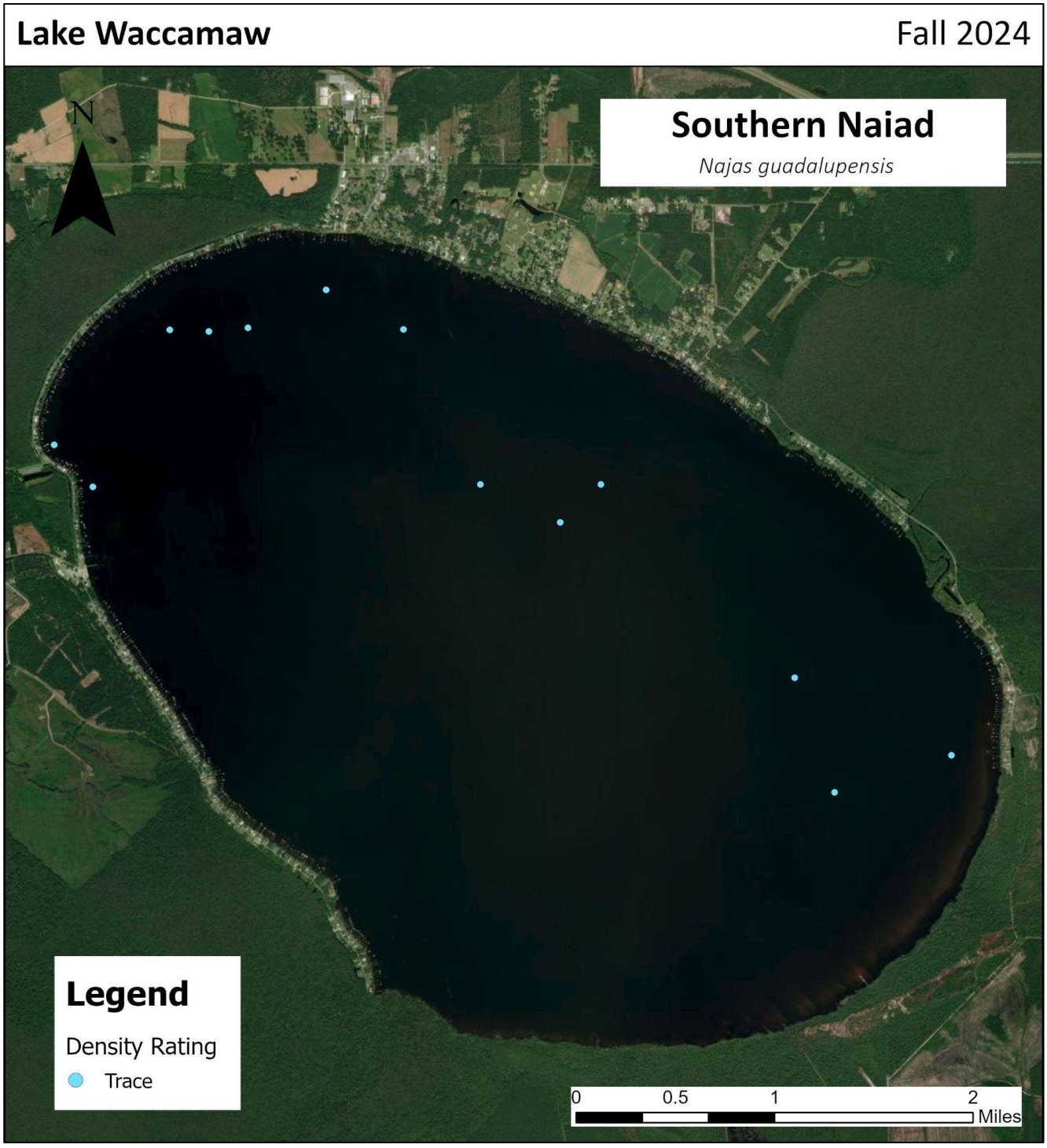

Figure 11: Distribution and abundance of southern naiad (Najas guadalupensis) in Lake Waccamaw during the 2024 survey.

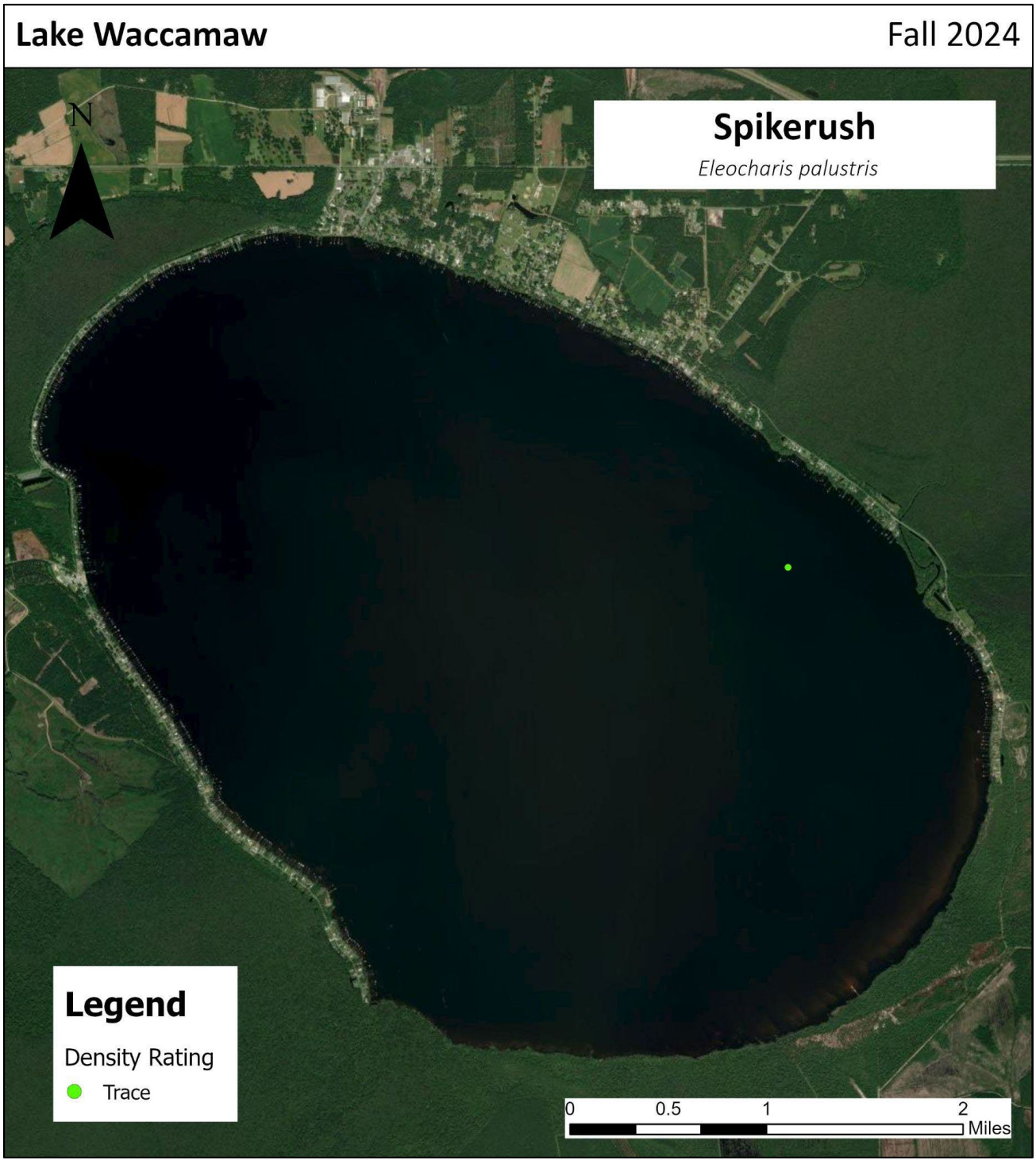

Figure 12: Distribution and abundance of spikerush (*Eleocharis palustris*) in Lake Waccamaw during the 2024 survey.

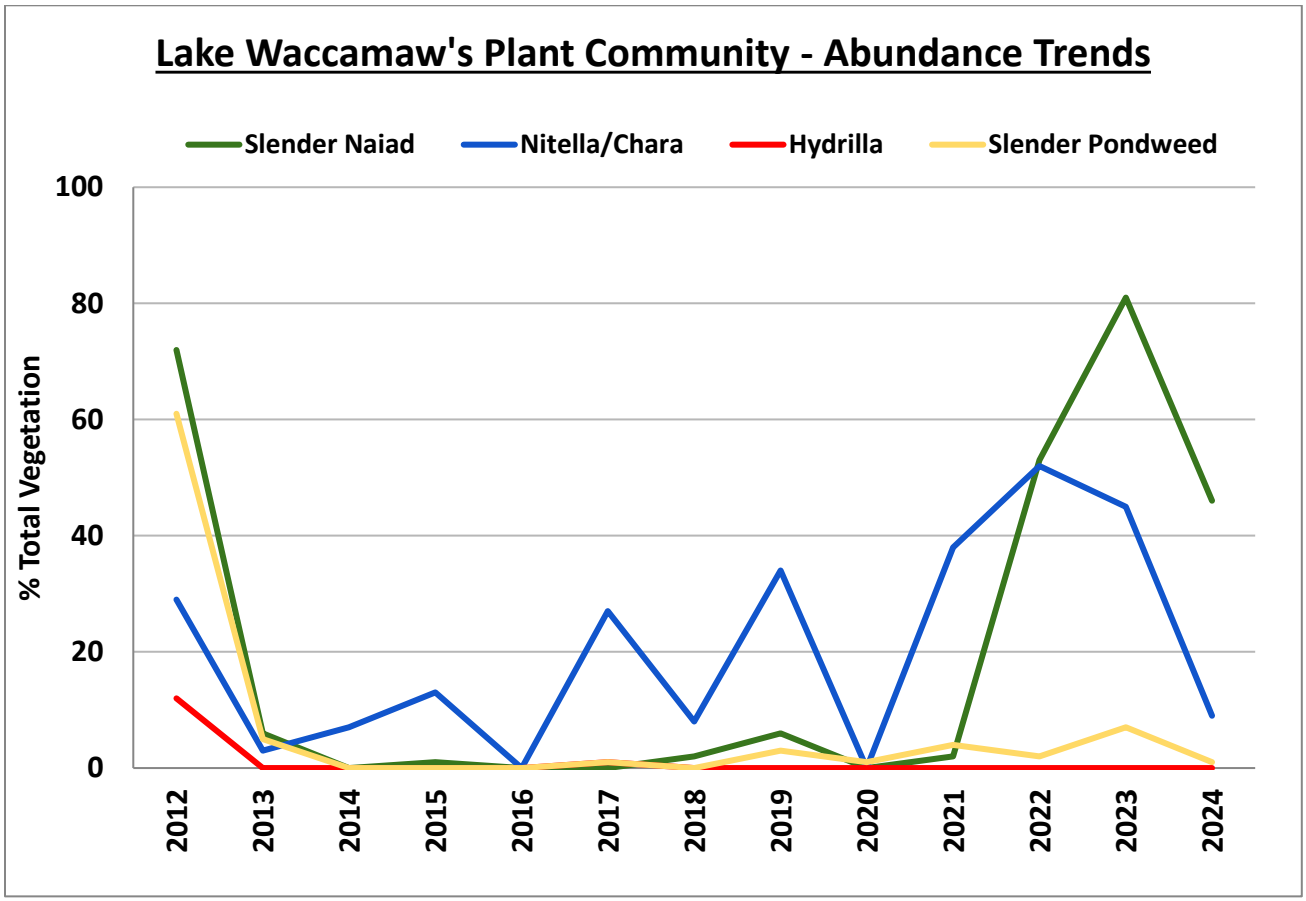

Figure 13: Trends in the relative abundance of aquatic plant species surveyed in Lake Waccamaw from 2012 to 2024. Relative abundance was calculated as the number of sites in which a specific species was present vs. the total number of sites surveyed.

Figure 14: Estimated acreage (69.3 acres) of lyngbya calculated from spline interpolation of point intercept data.