Littoral Zone Aquatic Plant Community Assessment of the Ross Barnett Reservoir, MS in 2008: A Four Year Evaluation

An Annual Report to the Pearl River Valley Water Supply District

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Executive Summary

1. The three objectives of this project for 2008 were to 1) monitor the aquatic plant community in the Ross Barnett Reservoir by mapping the distribution of aquatic plants in the littoral zone (water depths ≤ 10 feet); 2) monitor and assess the current hydrilla populations as well as document the presence of new populations; and 3) assess the effectiveness of hydrilla management.

2. We have found a total of 26 species of aquatic and riparian plant species in the reservoir, indicating good aquatic habitat diversity.

3. Species richness, a measure of biodiversity, has been unaffected by the aggressive management of invasive species (alligatorweed, hydrilla, and waterhyacinth), and is more sensitive to water levels than aquatic plant management.

4. Native aquatic plants are very widespread in the lake, providing food and habitat for waterfowl and fish. American lotus is the dominant native plant, and covers 24.8% of the littoral zone (water less than 10' deep).

5. The occurrence of all the nonnative, invasive plant species is less than 10%, and continues to decline. Alligatorweed distribution has declined significantly over the period from 2005 to 2008, from 21.2% to 7.3%. Waterhyacinth is also significantly less, declining from 4.9% in 2005 to 4% in 2008. While not statistically significant, hydrilla distribution was 1.2% in 2007 and 0.6% in 2008. Active management has succeeded in reducing the distribution of alligatorweed and waterhyacinth, and is preventing the spread of hydrilla.

6. Hydrilla was treated at 11 sites in 2007, and was found at only three of those sites in 2008. Progress is being made in reducing the distribution of hydrilla in the reservoir. Sampling for hydrilla tubers, a major source of reinfestation, has found very few tubers to date. Active treatment may be reducing tuber production, as well.

7. In two separate trips, we surveyed for hydrilla and other invasive plants from hydrilla site 11 upstream to the low head dam, and from the low head dam to Carthage, MS. While we did not find additional populations of hydrilla, alligatorweed and waterhyacinth were both found along the river, which will serve as a continuing source of these plants.

Recommendations

1. Apply fluridone to Sites 1, 4, 5, 7, and 11 in May 2009.
2. Increase the area as proposed of sites 5 and 7 to encompass new hydrilla sightings.
3. If fluridone applications in site 11 are unsuccessful, use contact herbicides such as copper, diquat, or endothall.
4. Continue herbicide applications to waterhyacinth and alligatorweed, especially in the Pearl River to prevent re-infestations of the Reservoir.
5. Ensure that accurate locations of species, especially hydrilla, are being recorded.
6. Continue monitoring aquatic plant populations and assessing management activities.

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INTRODUCTION

The fraction of non-native plants that are harmful to a community does not have to be large to inflict significant damage to an ecosystem (Pimentel et al. 2000). Therefore, the development and refining of methods to rapidly detect, monitor and ultimately control these species to mitigate negative impacts is critical. Non-native plants affect aesthetics, drainage, fishing, water quality, fish and wildlife habitat, flood control, human and animal health, hydropower generation, irrigation, navigation, recreation, and ultimately land values (Pimentel et al. 2000, Rockwell 2003). The Ross Barnett Reservoir, near Jackson, Mississippi is the largest surface water impoundment in the state (33,000 acres) and is managed by the Pearl River Valley Water Supply District (PRVWSD). The Ross Barnett Reservoir supplies the city of Jackson with potable water, provides fish and wildlife habitat, recreation, and is experiencing substantial urban and economical development.

However, waterhyacinth [*Eichhornia crassipes* (Mart.) Solms] and alligatorweed [*Alternanthera philoxeroides* (Mart.) Griseb.] have invaded large portions of the Reservoir, negatively impacting navigation, recreation, and aesthetics of the Reservoir. Furthermore, in 2005 the submersed non-native plant hydrilla [*Hydrilla verticillata* (L.F.) Royle] was found for the first time. Hydrilla is a Federal Noxious Weed and is also listed on the Mississippi Noxious Weed List. The adverse impacts of these species on the Reservoir prompted the PRVWSD to develop a long term strategic management plan to address the control of these non-native species.

Waterhyacinth and alligatorweed have been under active management for almost a decade, primarily through the use systemic herbicides such as 2,4-D and imazapyr. Hydrilla has been aggressively managed through the use of the systemic herbicide fluridone and the contact herbicide endothall since 2006. The use of fluridone has been largely successful, reducing the initial hydrilla population to a few individual plants scattered in the northern portion of the Reservoir. To ensure the effectiveness of management techniques, regular assessments are a significant component of successful long-term maintenance management programs (Madsen 2007). Pursuant to this, intensive surveying has been cited as the only effective way to determine a program's success and when to terminate a management program (Simberloff 2003).

OBJECTIVES

Our objectives for 2008 were to 1) continue monitoring the aquatic plant community in the Ross Barnett Reservoir by mapping the distribution of aquatic plants in the littoral zone (water depths ≤ 10 feet; 2) continue to monitor and assess the current hydrilla populations as well as document the presence of new populations; and 3) assess the effectiveness of hydrilla management. The results of this assessment are included in detail in this report.

MATERIALS AND METHODS

Vegetation Survey

Aquatic plant distribution was evaluated using the point intercept survey method on a 300 meter grid in July 2008 (Madsen 1999). Only those points occurring in water depths of ≤ 10 feet were sampled. Sampling points in this manner allowed for a more rigorous survey of the littoral zone, the portion of the Reservoir most likely to be inhabited with aquatic plants (Figure 1). In general, we attempted to survey the same points that were sampled in 2005, 2006, and 2007 surveys so that quantifiable changes in the plant community could be determined (Figures 2 to 4). However, there were areas within the littoral zone that were inaccessible by boat due to low water levels at the time of the survey. Points that were located in those areas were not sampled. The southern portion of the Reservoir was excluded due to greater water depths and the low likelihood of observing plant growth. For the purposes of recording sampling data, the Reservoir was divided into seven sections: Upper Reservoir, Middle Reservoir 5, Middle Reservoir 4, Lower Reservoir 3, Lower Reservoir 2, Lower Reservoir 1, and Pelahatchie Bay.

A Trimble AgGPS106^{tm} (Sunnyvale, California) receiver coupled with a Panasonic C-29 Toughbook^{tm} (Secaucus, New Jersey) computer was used to achieve 3-10 foot (1-3 m) survey accuracy. A total of 627 points were surveyed in 2008. At each survey point, a weighted plant rake was deployed to determine the presence of plant species. Additionally, the depth at each point was recorded using a Lowrance LCX-28C depth finder (Tulsa, Oklahoma) or with a sounding rod in water depths of less than 10 feet. Spatial data were recorded electronically using FarmWorks Site Mate® software version 11.4 (Hamilton, Indiana). Site Mate® allowed for navigation to specific survey points as well as visual display and collection of geographic and attribute data while in the field, thus eliminating data entry errors and post processing time. Collected data were recorded in database templates using specific pick lists constructed exclusively for this project. Similar studies using this technology are described in Wersal and others (2006a, 2007, 2008a) and Madsen and Wersal (2008).

Plant species presence was averaged over all points sampled and multiplied by 100. Total species richness was calculated and presented as the mean (± 1 SE) of all species observed at each point. Changes in the occurrence of plant species was determined using McNemar's Test for dichotomous response variables that assesses differences in the correlated proportions within a given data set between variables that are not independent (Stokes et al. 2000, Wersal et al. 2006a). A pairwise comparison of species occurrences was made between years using the Cochran-Mantel-Haenszel statistic (Stokes et al. 2000, Wersal et al. 2006b).

Invasive Species Management

Waterhyacinth and Alligatorweed Assessment: Management assessments of these plant species were made at the Reservoir scale using data obtained from the point intercept surveys. These data allowed for a quantitative comparison of changes in the frequency of occurrence of each species between years.

Hydrilla Assessment: Similar to waterhyacinth and alligatorweed, a Reservoir scale analysis was conducted on the occurrence of hydrilla throughout the Reservoir.

A tuber survey was conducted on March 28, 2008 to assess the current density of hydrilla tubers in the Ross Barnett Reservoir. Hydrilla typically produces tubers in the fall and early winter after plant senescence; therefore spring is generally a good time to sample tubers for estimating hydrilla recruitment in the coming year. During this survey we sampled sites 6, 7, 8, 9, 10, and 11 (Figure 1). We chose these sites because they were relatively new sites and have not had repeated herbicide treatments. A PVC coring device was used to collect 30 sediment samples at each site (Madsen et al. 2007). The sediment was rinsed through a pail with a wire mesh bottom to separate the sediment from plant material. Samples were transported to Mississippi State University where they were sorted, dried to a constant mass, and weighed to assess tuber biomass and density.

Pearl River Assessment: On July 10, 2008 a boat survey was conducted from Low Head Dam to hydrilla Site 11 to document and map additional hydrilla locations that may be in areas along the Pearl River that are not routinely surveyed during the littoral survey. Also, as part of a statewide survey and mapping project, Robles et al. (2009) surveyed the Pearl River from Low Head Dam to Carthage, MS in August 2008 to document and map potential hydrilla populations that could be sources of infestation to the Ross Barnett Reservoir.

RESULTS AND DISCUSSION

Littoral Survey

The 2008 survey of the Ross Barnett Reservoir yielded 22 aquatic or riparian plant species (Table 1). After 4 years of surveying, a total of 26 species of aquatic or riparian plant species have been observed. The dominant species was the native plant American lotus (*Nelumbo lutea* Willd.) which increased in occurrence from 17% in 2005 to 25% in 2008. Other commonly occurring native species include coontail (*Ceratophyllum demersum* L.) which increased in occurrence from 2005 to 2008 and white waterlily (*Nymphaea odorata* Aiton) which remained stable over the 4 survey years. Water depths of 0 to 8 ft. appear to be the optimum range for aquatic plant species in the Reservoir, as greatest species richness occurred within this depth range (Figure 6). There were species observed beyond 10 ft. however these were species growing along the navigation channel where the position of the boat would influence water depth readings, and or floating species being moved to other locations by wave action. Species richness was greatest in 2005 and 2008 (Figure 7). The greater number of species located per point is a result of water depth during the year of the survey. In 2005 and 2008, the two years with the highest species richness, there were also higher water levels that allowed access to more areas of the reservoir (Figure 8). The higher water also may have allowed for greater germination of annual plant species that need the disturbance of drawdown and were then detected in subsequent surveys. Typically, draw-downs favor the establishment of mud-flat annual and emergent plants such as American lotus (van der Valk 1981).

The occurrence of all non-native species, alligatorweed, waterhyacinth, hydrilla, parrotfeather (*Myriophyllum aquaticum* (Vell.) Verdc.), and brittle naiad (*Najas minor* All.) was below 10%

for all survey years (Table 1). Alligatorweed was the non-native species observed most often in all years, followed by waterhyacinth, hydrilla, brittle naiad, and parrotfeather. The occurrence of alligatorweed is depicted in figures 9 through 12. Waterhyacinth distribution is depicted in figures 13 through 16 and hydrilla distribution is shown in figures 17 through 19. Generally, the occurrence of all aquatic plant species including non-native species were in Pelahatchie Bay and the northern portion of the Reservoir where shallow water depths favor the growth of rooted plants.

Invasive Species Management

Waterhyacinth and Alligatorweed Assessment: The frequency of occurrence for alligatorweed has decreased significantly ($p \leq 0.01$) from 2005 to 2008. The frequency of occurrence for waterhyacinth in 2005 was 4.9% and declined to 2.9% and 1.2% in 2006 and 2007, respectively; however in 2008 waterhyacinth was found at 4% of the sample points and was similar to 2005 levels. Estimated acreages of non-native plants are displayed in Table 2. The estimated acreage for alligatorweed has decreased from approximately 3100 acres in 2005 to 1000 acres in 2008. These reductions in species occurrence may be attributed to the use of the systemic herbicide 2,4-D for control of waterhyacinth, and the use of 2,4-D and imazapyr for alligatorweed control.

Our surveys suggest that the aggressive management of waterhyacinth and alligatorweed has been successful in reducing these weeds in the Ross Barnett Reservoir. If the survey team had better information on the locations of management activities in the Reservoir, a more direct approach at assessing management of these two species could be achieved and would provide more definitive information. Similarly, since the detection of these species is largely dependent upon water depth and accessibility to areas in the Reservoir, alternative spatial technologies such as remote sensing should be explored to better estimate the extent of these species in back water areas of the Reservoir. For example, during the July 10, 2008 survey of the Pearl River from Low Head Dam to the Reservoir, alligatorweed was present along both shorelines the entire length of the Pearl River. Also during that survey, several areas were found containing large beds of both alligatorweed and waterhyacinth in channels and pools off of the main river channel. Since both species can be spread by water movement, these populations in the river would serve as a continuous source for new infestations into the Reservoir.

Hydrilla Assessment: Hydrilla was observed at sites 1, 4, and 11 during the littoral survey. Sites 1 and 4 had been treated with fluridone in 2006 and 2007 which indicates that a small tuber bank may still be allowing re-infestation of these areas; and applications should continue to control new plants and deplete the tuber bank. Site 11 was treated with fluridone in 2007; however, it appears that this treatment was not effective due to the number of plants found during the survey. Water movement at this site may be an issue and repeated applications of a contact herbicide may be a better alternative than fluridone. In general, fluridone treatments appear to be successful as hydrilla has been reduced to less than 100 acres. In most areas hydrilla populations are represented by a few scattered plants. However, these scattered plants that will be increasingly hard to locate, so repeated surveys and intensive monitoring should continue to ensure herbicide efficacy and identify new infestations.

Following the littoral survey, 5 new sites of hydrilla were found by the PRVWSD's contracted applicator, Applied Aquatics (Figure 20). After projecting the points in ArcMap software the accuracy of the locations was equivocal. Two of the points were located on dry land and three of the points were near other treatment areas. Based on these new hydrilla locations and to reduce the total number of sites, we propose that site 5 be expanded from 37 acres to 37.8 acres to encompass the new location along Pipeline Road (Figure 21). Site 7 should be expanded from 47 acres to 59.4 acres to encompass the new hydrilla location (Figure 22). Site 11 had been expanded from 8 to 11 acres by Applied Aquatics during an herbicide treatment, but this new boundary file had not been supplied to us, and the new location in figure 20 near site 11 is on dry land. Therefore, the 5 new sites would actually be 1 if the unknown point in figure 20 was actually in the Reservoir. Accuracy in recording new locations is critical for a successful management program therefore adequate equipment and training are required to provide site specific information.

Hydrilla Tuber Assessment: The frequent tuber surveys from 2006 to 2008 have yielded very few hydrilla tubers (Table 3). Tubers were found at site 4 in 2006, explaining why new plants were discovered in 2008. The tuber survey conducted in March 2008 did not result in any tubers, but hydrilla was found actively growing at site 11where plants were topped out at the water surface (Figures 23 and 24). It appears that the hydrilla may be overwintering and regrowing from root crowns with little tuber production. Plants that were found during the March 2008 tuber survey had well developed root crowns and new shoots growing from these root crowns as well as from nodes of already developed shoots. The low density of tubers may reduce the year to year recruitment of hydrilla, possibly reducing the number of herbicide treatments necessary for eradication. If herbicide treatments were reduced, minimizing fragmentation and transport by boats within the Reservoir would become more critical. The use of fluridone may also further inhibit the production of tubers as well as remove standing biomass (MacDonald et al. 1993).

RECOMMENDATIONS

- Apply fluridone to Sites 1, 4, 5, 7, and 11 in May 2009.
- Increase the area as proposed of sites 5 and 7 to encompass new hydrilla sightings.
- If fluridone applications in site 11 are unsuccessful use contact herbicides such as copper and diquat.
- Continue herbicide applications to waterhyacinth and alligatorweed, especially in the Pearl River to prevent re-infestations of the Reservoir.
- Ensure that accurate locations of species, especially hydrilla, are being recorded.

RECOMMENDED FUTURE WORK

- Continue monitoring plant distribution to assess spread in nuisance species populations.
- Continue monitoring of hydrilla populations and herbicide treatments at all sites.
- Request GPS locations be provided for all herbicide applications in the Reservoir on invasive plant species, as well as rate and other information on the herbicides applied.
- Assess herbicide treatments on other nuisance species, provided that the applicator supplies the appropriate location information.

- Assess techniques to control the new hydrilla populations located in 2008.
- Assess techniques to control nuisance species and promote the growth of more desirable native plants.
- Accurately estimate coverage of nuisance aquatic plant species (particularly waterhyacinth and alligatorweed) using remote sensing (e.g., aerial or satellite imaging) technology.

ACKNOWLEDGEMENTS

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Table 1. Percent frequency of occurrence for aquatic plant species observed in the littoral zone during the Ross Barnett Reservoir Surveys 2005-2008. The percent frequency of occurrence reported for the 2005 data (n=677) and 2006 data (n=508) are from those points that where sampled in 10 feet of water or less during the time of that survey. The letter 'n' refers to the total number of points sampled in a given year. Letters in a row for a given species denotes a significant difference among years at a p = 0.05 level of significance. Analyses were conducted within species.

Species Name	Common Name	Native (N) or Exotic (E), Invasive (I)	2005 % Frequency (n = 677)	2006 % Frequency (n = 508)	2007 % Frequency (n = 423)	2008 % Frequency (n = 627)
Alternanthera philoxeroides	Alligatorweed	E I	21.1a	3.9	4.0	7.3a
Azolla caroliniana	mosquito fern	N	0.0	0.2	0.4	0.0
Cabomba caroliniana	Fanwort	N	2.2a	0.0	0.5	1.3a
Ceratophyllum demersum	Coontail	N	4.4	4.9	3.5	7.6a
Colocasia esculenta	wild taro	E I	0.0a	0.9	0.7	2.4a
Eichhornia crassipes	waterhyacinth	E I	4.9a	2.9	1.2	4.0a
Hydrilla verticillata	hydrilla	E I	0.0	0.6a	1.2a	0.6a
Hydrocotyle ranunculoides	pennywort	N	6.4a	0.5	1.4	2.8a
Juncus effuses	common rush	N	0.0	0.0	0.0	0.2
Lemna minor	common duckweed	N	3.1	2.5	1.9	1.4a
Limnobium spongia	American frogbit	N	1.5	0.8	0.7	1.3
Ludwigia peploides	waterprimrose	N	4.9	7.4	4.3	10.2a
Myriophyllum aquaticum	parrotfeather	E I	0.7	0.0	0.2	1.0a
Najas minor	brittle naiad	EI	0.0	0.0	1.9a	1.0a
Nelumbo lutea	American lotus	N	17.1	17.7	21.2	24.8a
***Nitella* sp.**	stonewort	N	0.1	0.0	0.0	0.0
Nymphaea odorata	white waterlily	N	4.4	3.4	4.9	5.4
Potamogeton foliosus	leafy pondweed	N	0.0	0.0	0.0	0.6
Potamogeton nodosus	American pondweed	N	2.7	2.7	2.4	3.0
Sagittaria latifolia	arrowhead	N	1.0	1.2	0.0a	0.5
Sagittaria platyphylla	arrowhead	N	0.0a	1.8	0.8	0.3a
Scirpus validus	softstem bulrush	N	1.2a	0.2	0.0	0.0
Spirodella polyrhiza	giant duckweed	N	0.0	0.0	0.0	0.16
***Typha* sp.**	cattail	N	1.3	2.4a	0.7	1.1
Utricularia vulgaris	bladderwort	N	0.0	0.4	0.0	0.5
Zizaniopsis miliacea	giant cutgrass	N I	1.5a	3.5	1.9a	4.1

Table 2. Estimated acreage of the non-native aquatic plant species occurring in the Ross Barnett Reservoir from 2005 to 2008. Acreage was calculated based on the total number of points for which a given species was observed. Each point of the survey represents approximately 22.2 acres.

Species	2005 Estimated Acreage	2006 Estimated Acreage	2007 Estimated Acreage	2008 Estimated Acreage	2008 Acreage Treated[1]
Alligatorweed	3175	444	377	1021	339
Brittle naiad	0	0	178	111	-
Hydrilla	120	67	111	89	275
Parrotfeather	111	111	22	133	-
Waterhyacinth	733	333	111	555	167

[1]Acreage treated refers to the total surface area of water treated, it does not necessarily refer to the extent of plant infestation.

Table 3. Mean tuber number (± 1 SE), mean tuber density (± 1 SE), mean tuber biomass (± 1 SE), and mean shoot biomass (± 1 SE) of hydrilla found during the tuber survey conducted in 2008.

Site Name	Tuber Number	Tuber Density (n m^{-2})	Tuber Biomass (g m^{-2})	Shoot Biomass (g m^{-2})
Site 1	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0
Site 2	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0
Site 3	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0
Site 4	0.1 ± 0.0	0.0 ± 0.0	0.1 ± 0.1	0.0 ± 0.0
Site 5	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0
Site 6	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0
Site 7	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0
Site 8	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0
Site 9	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0
Site 10	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0
Site 11	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0	4.2 ± 2.2[c]

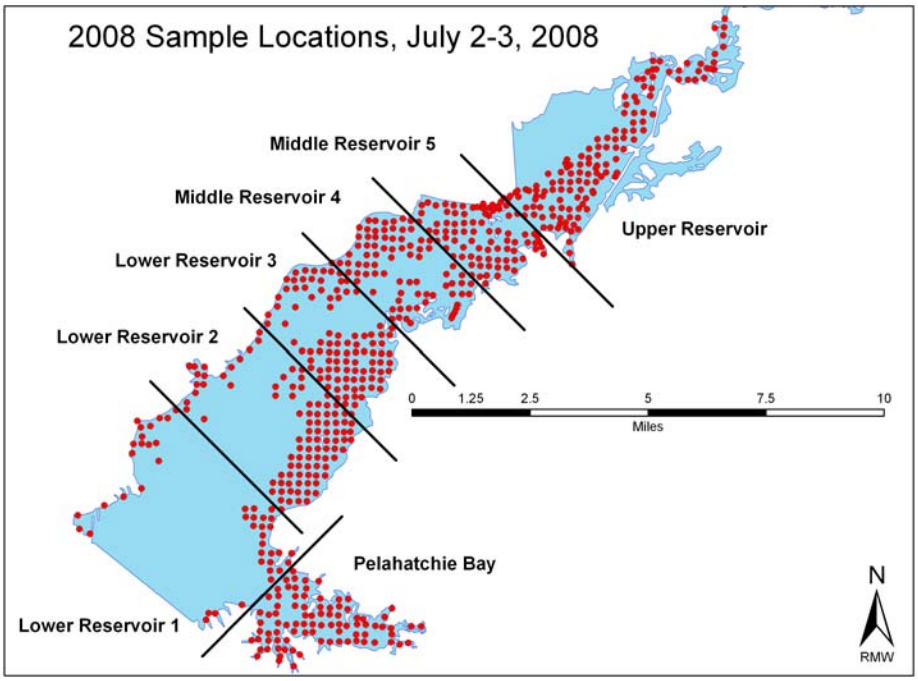

Figure 1. Littoral zone sampling locations for the 2008 survey of the Ross Barnett Reservoir.

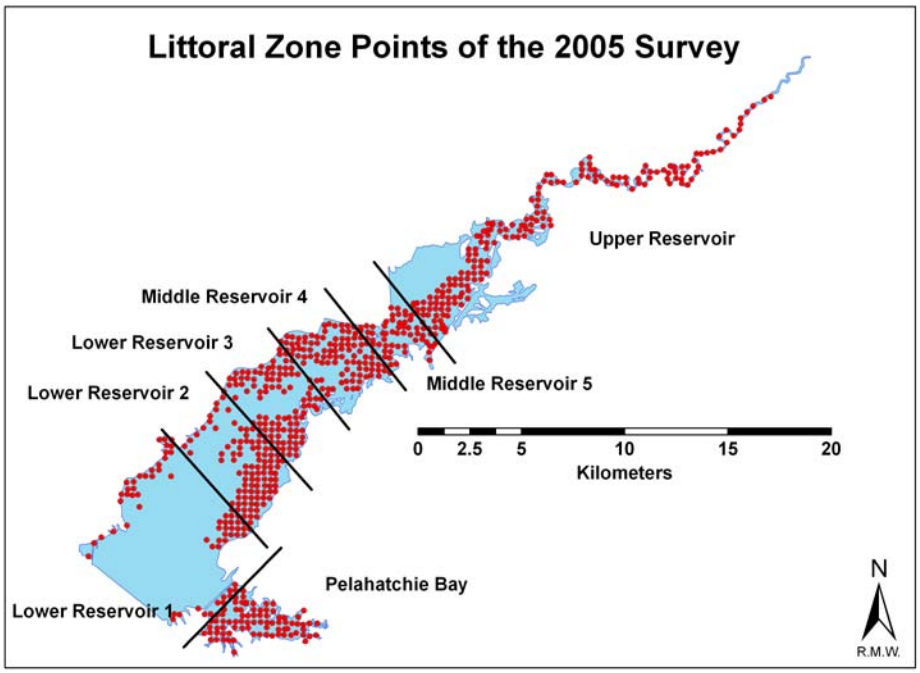

Figure 2. Littoral zone sampling locations for the 2005 survey of the Ross Barnett Reservoir.

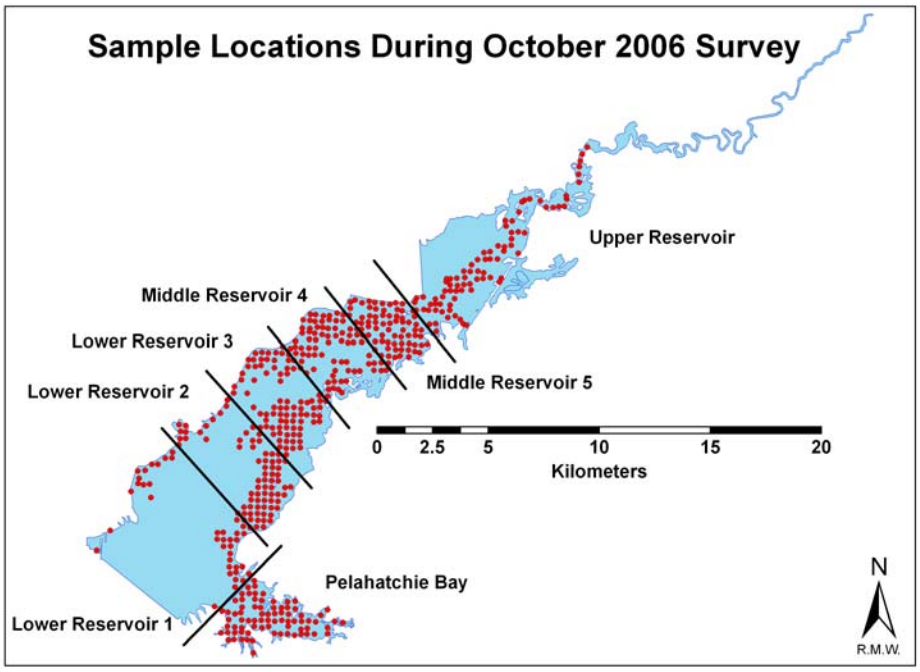

Figure 3. Littoral zone sampling locations for the 2006 survey of the Ross Barnett Reservoir.

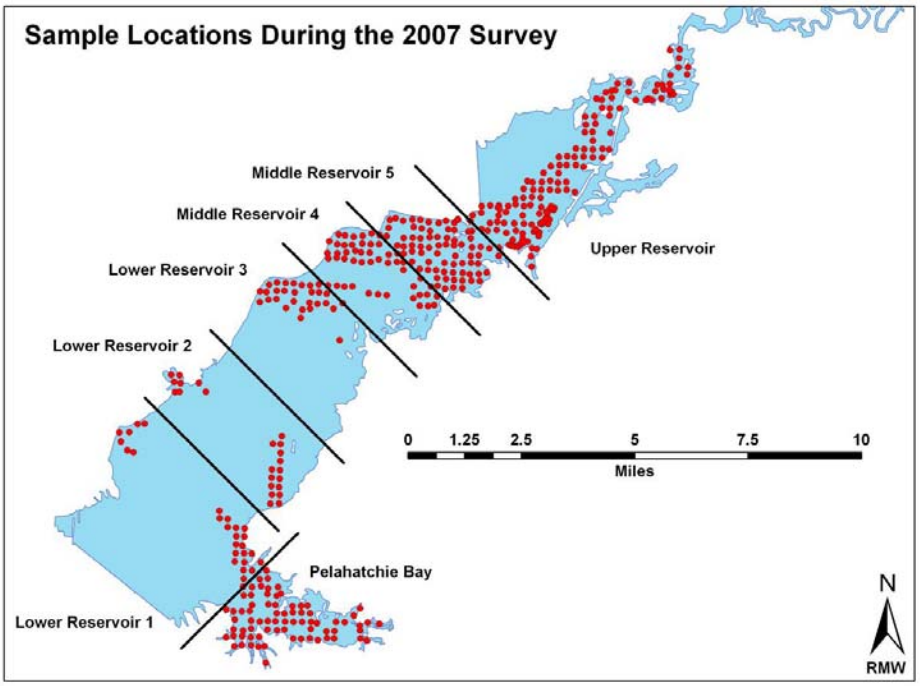

Figure 4. Littoral zone sampling locations for the 2007 survey of the Ross Barnett Reservoir.

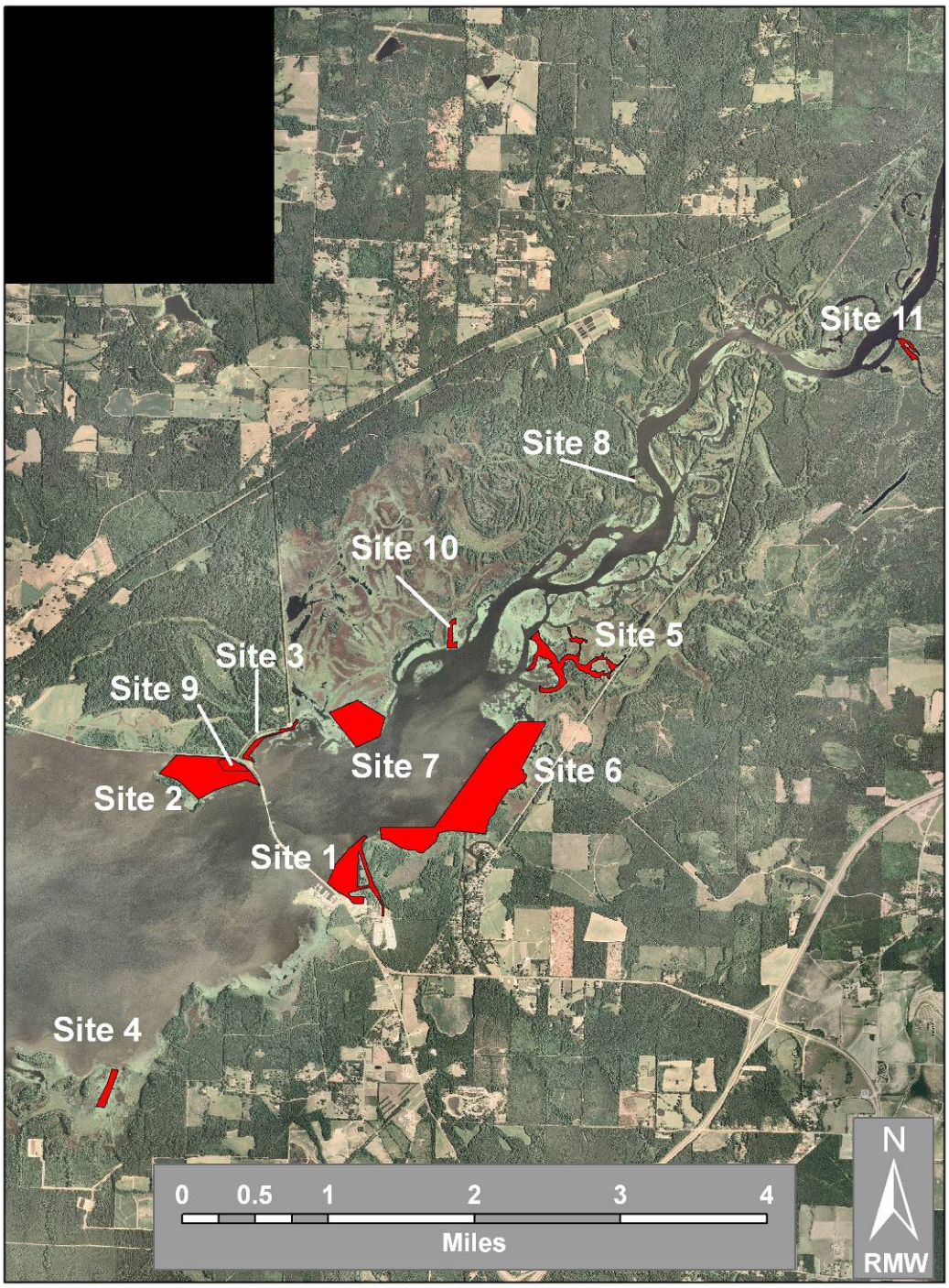

Figure 5. Hydrilla sites in the Ross Barnett Reservoir as of December 2007.

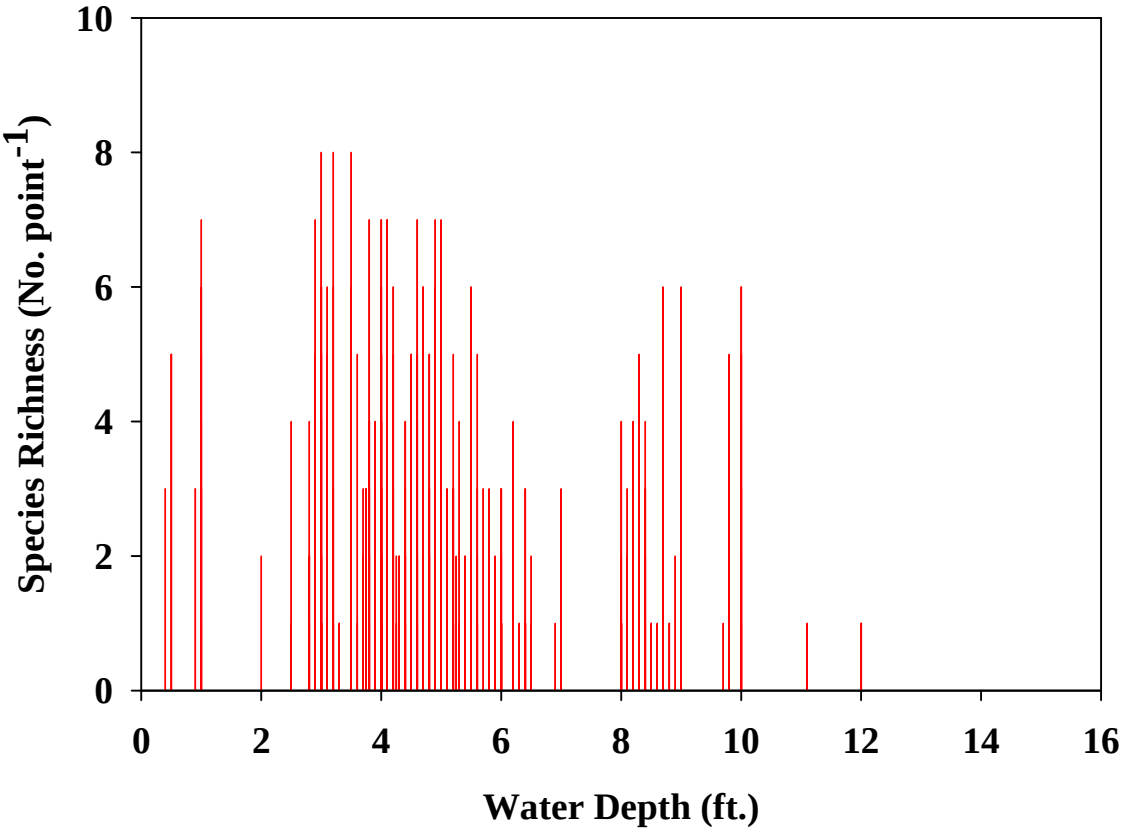

Figure 6. Depth distribution of species richness for the Ross Barnett Reservoir. Species observed in water depths greater than 10 ft. were floating plant species or species observed on the edge of navigation channels and the depth finder read the depth of the channel.

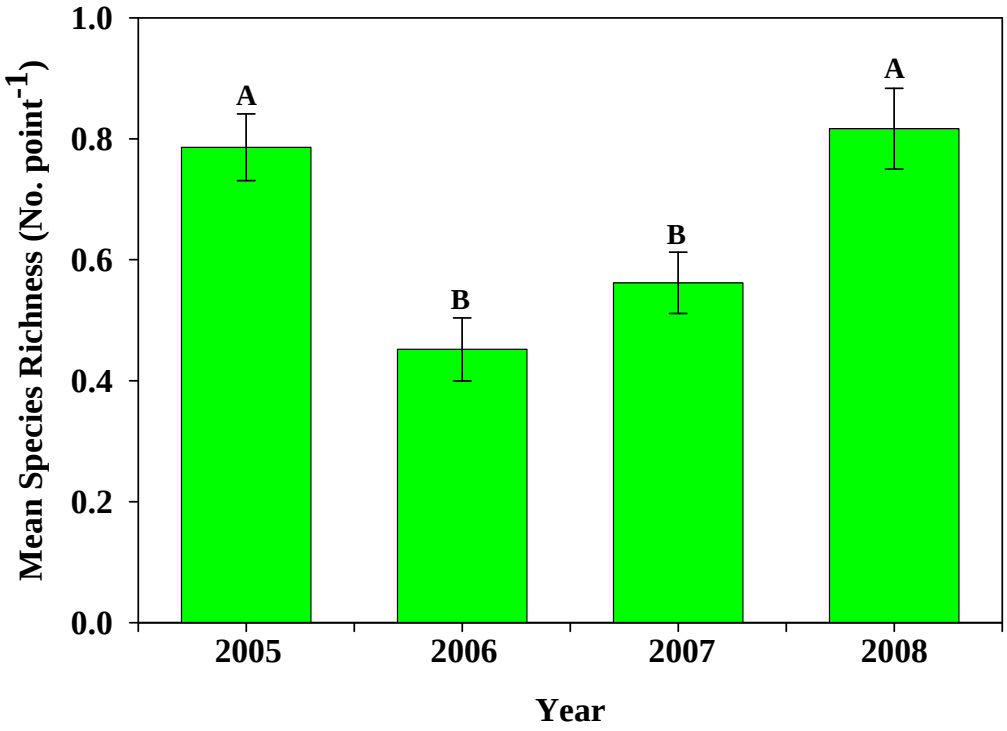

Figure 7. Mean (± 1 SE) species richness during surveys conducted between 2005 and 2008.

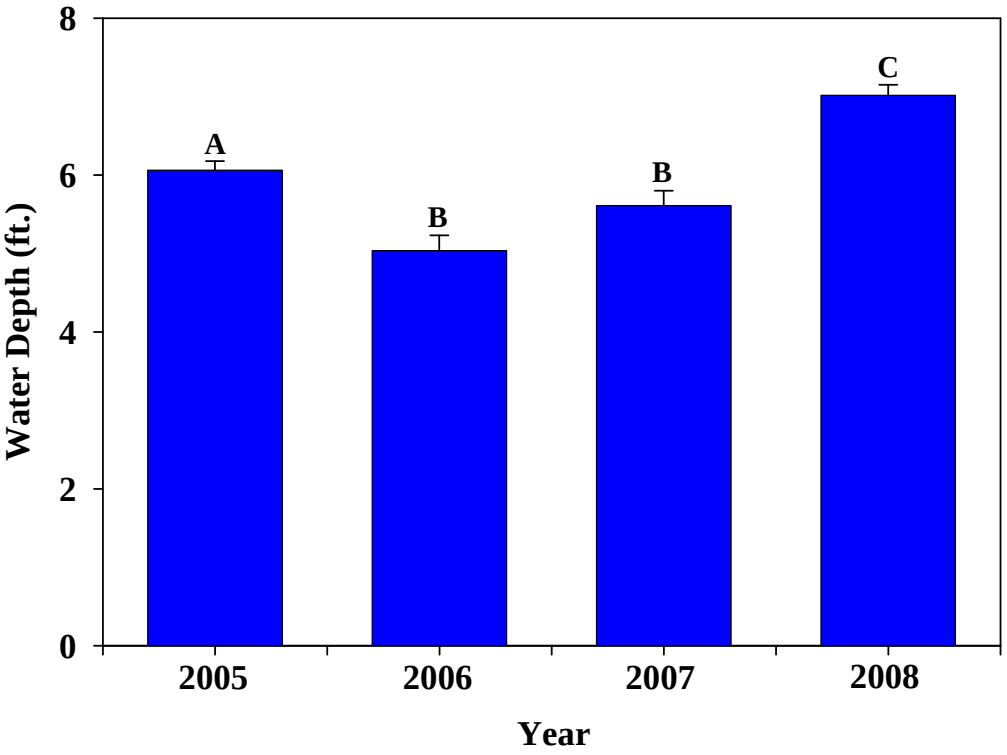

Figure 8. Mean (± 1 SE) water depth for surveys conducted between 2005 and 2007.

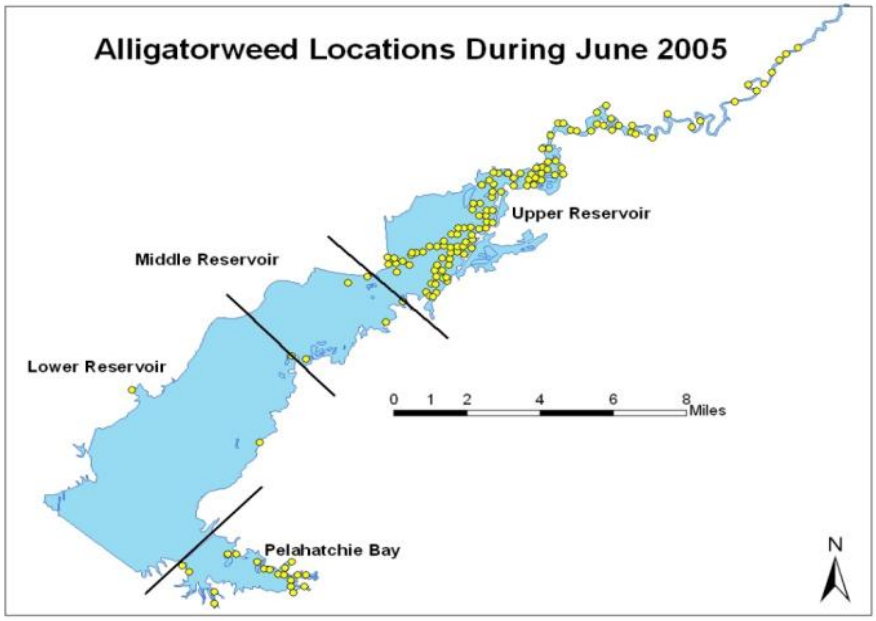

Figure 9. The occurrence of alligatorweed in the Ross Barnett Reservoir during 2005.

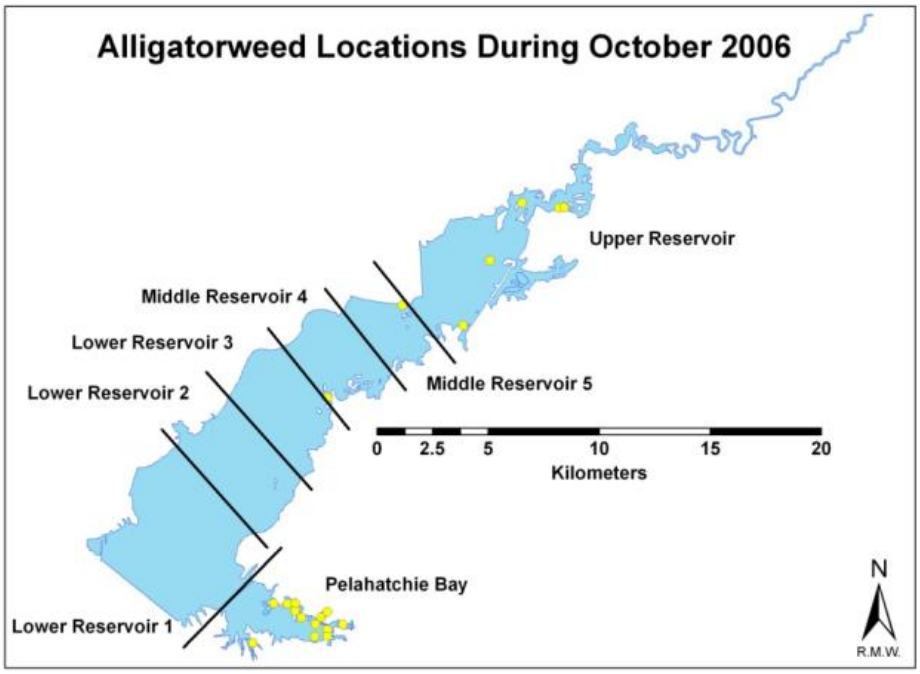

Figure 10. The occurrence of alligatorweed in the Ross Barnett Reservoir during 2006.

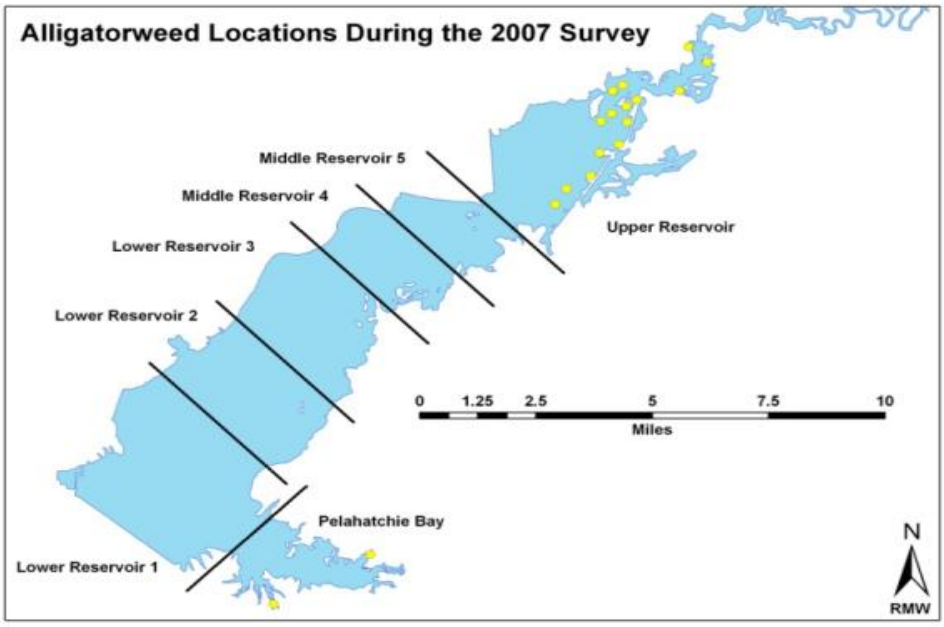

Figure 11. The occurrence of alligatorweed in the Ross Barnett Reservoir during 2007.

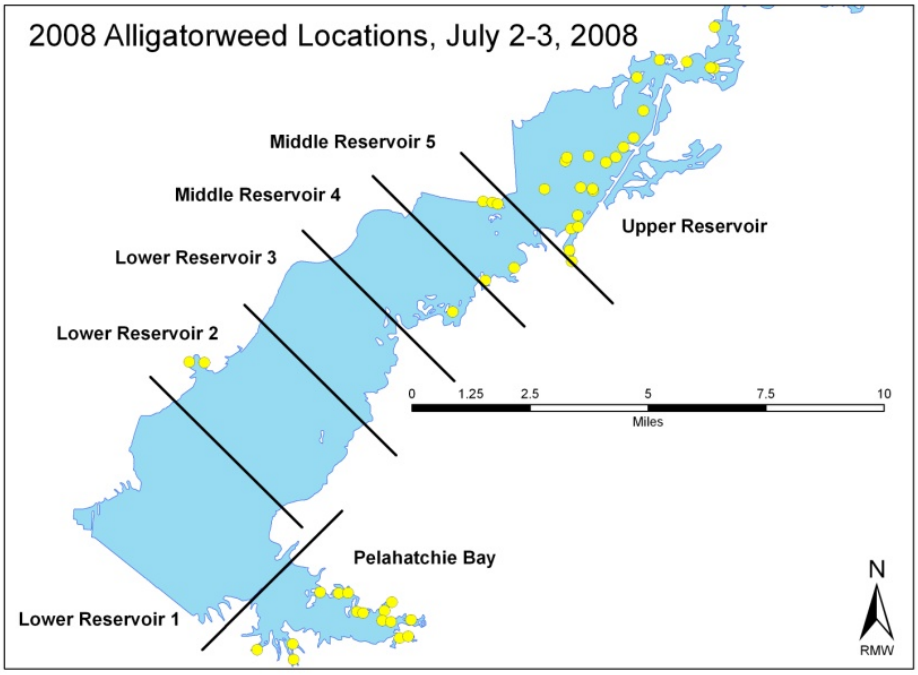

Figure 12. The occurrence of alligatorweed in the Ross Barnett Reservoir during 2008.

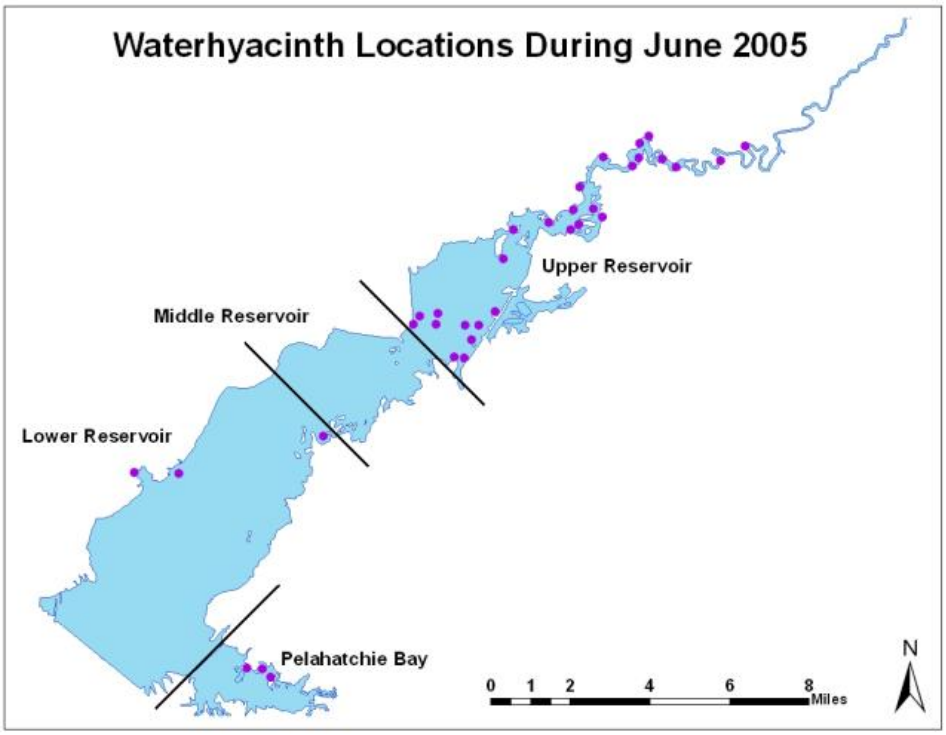

Figure 13. The occurrence of waterhyacinth in the Ross Barnett Reservoir during 2005.

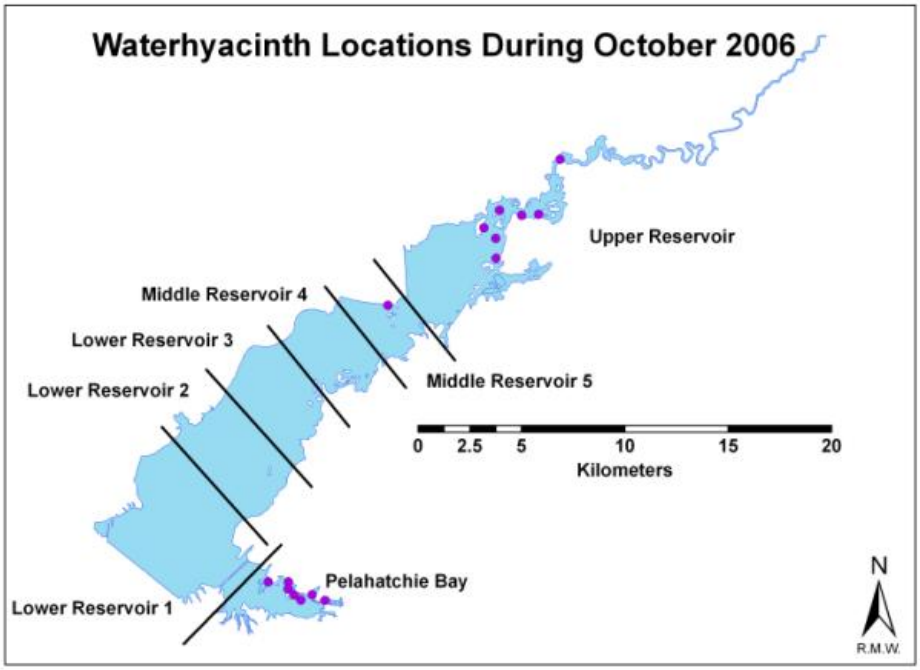

Figure 14. The occurrence of waterhyacinth in the Ross Barnett Reservoir during 2006.

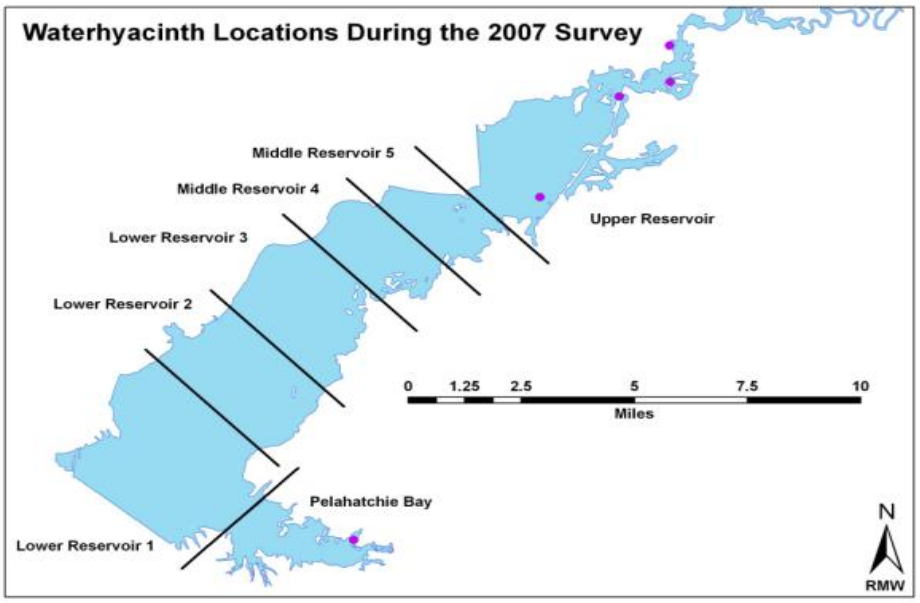

Figure 15. The occurrence of waterhyacinth in the Ross Barnett Reservoir during 2007.

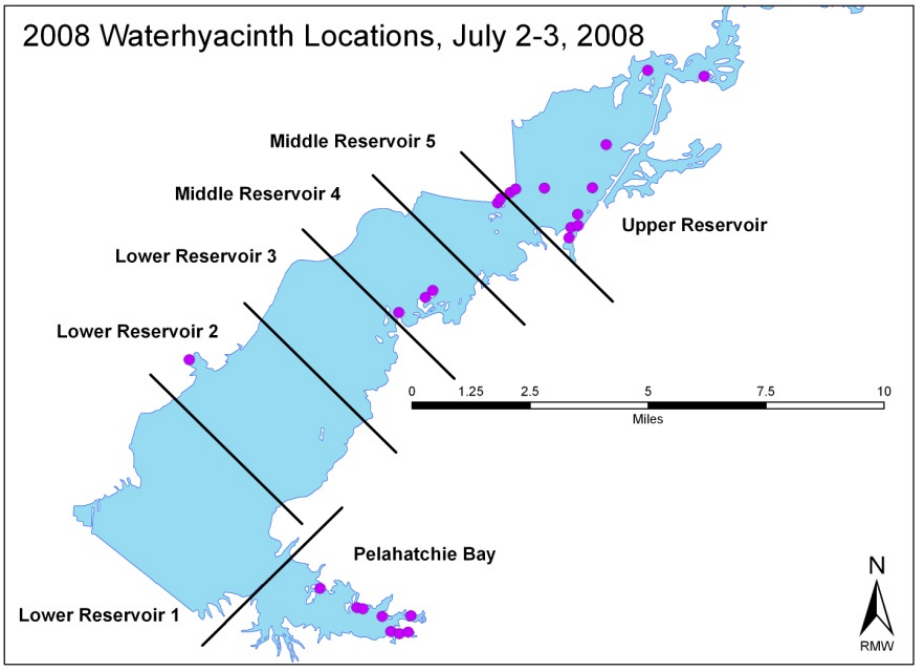

Figure 16. The occurrence of waterhyacinth in the Ross Barnett Reservoir during 2008.

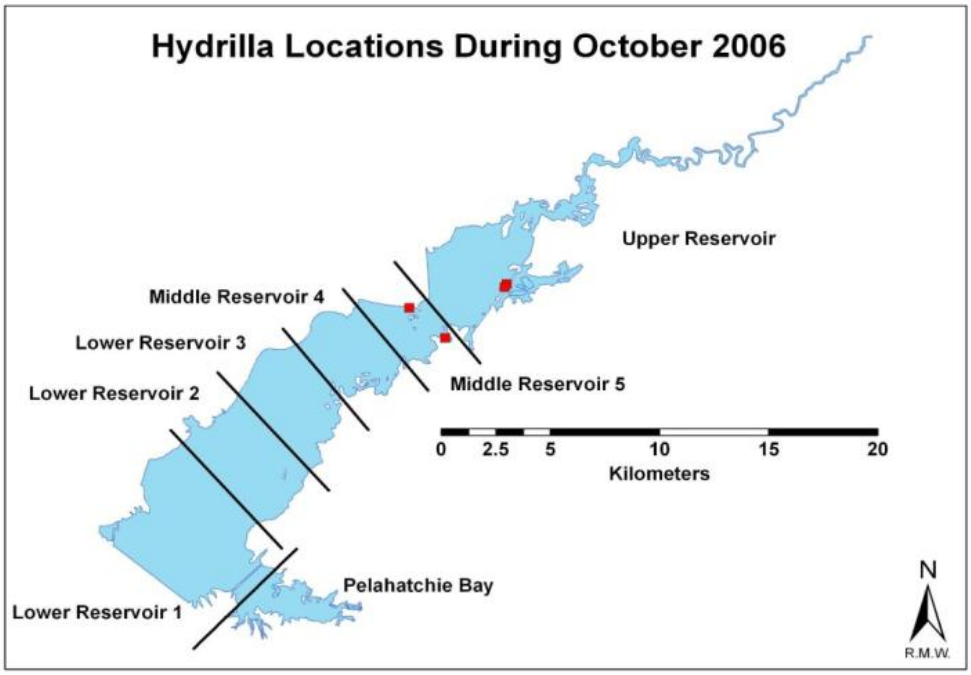

Figure 17. The occurrence of hydrilla in the Ross Barnett Reservoir during 2006.

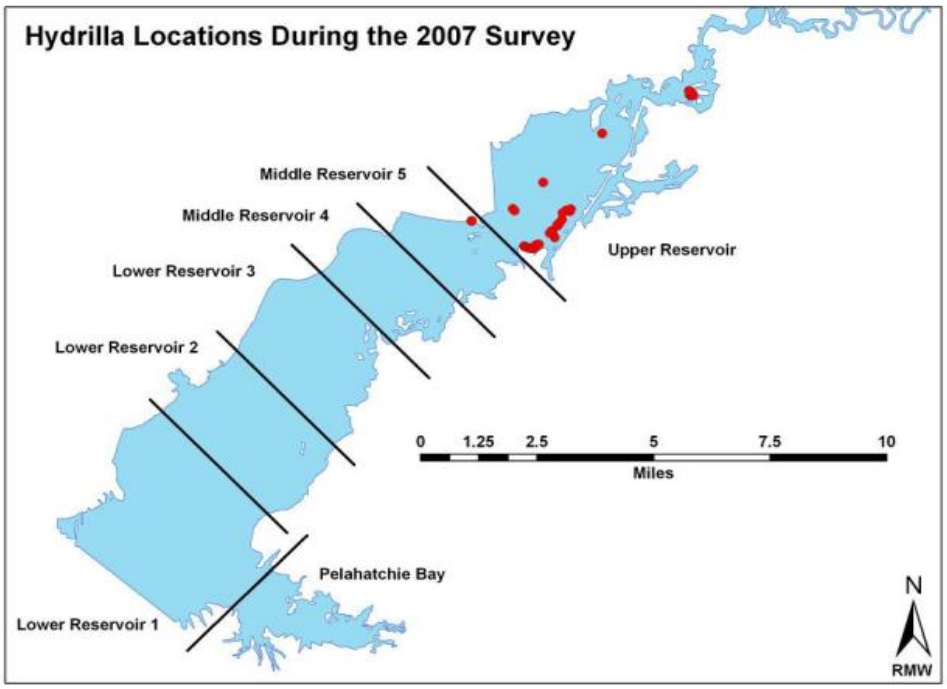

Figure 18. The occurrence of hydrilla in the Ross Barnett Reservoir during 2007.

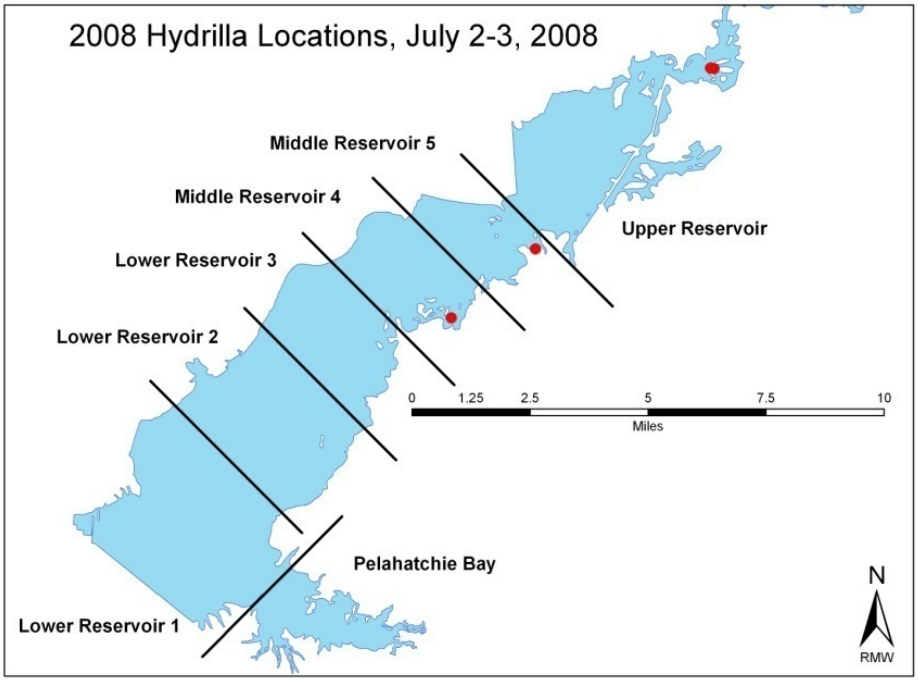

Figure 19. The occurrence of hydrilla in the Ross Barnett Reservoir during 2008.

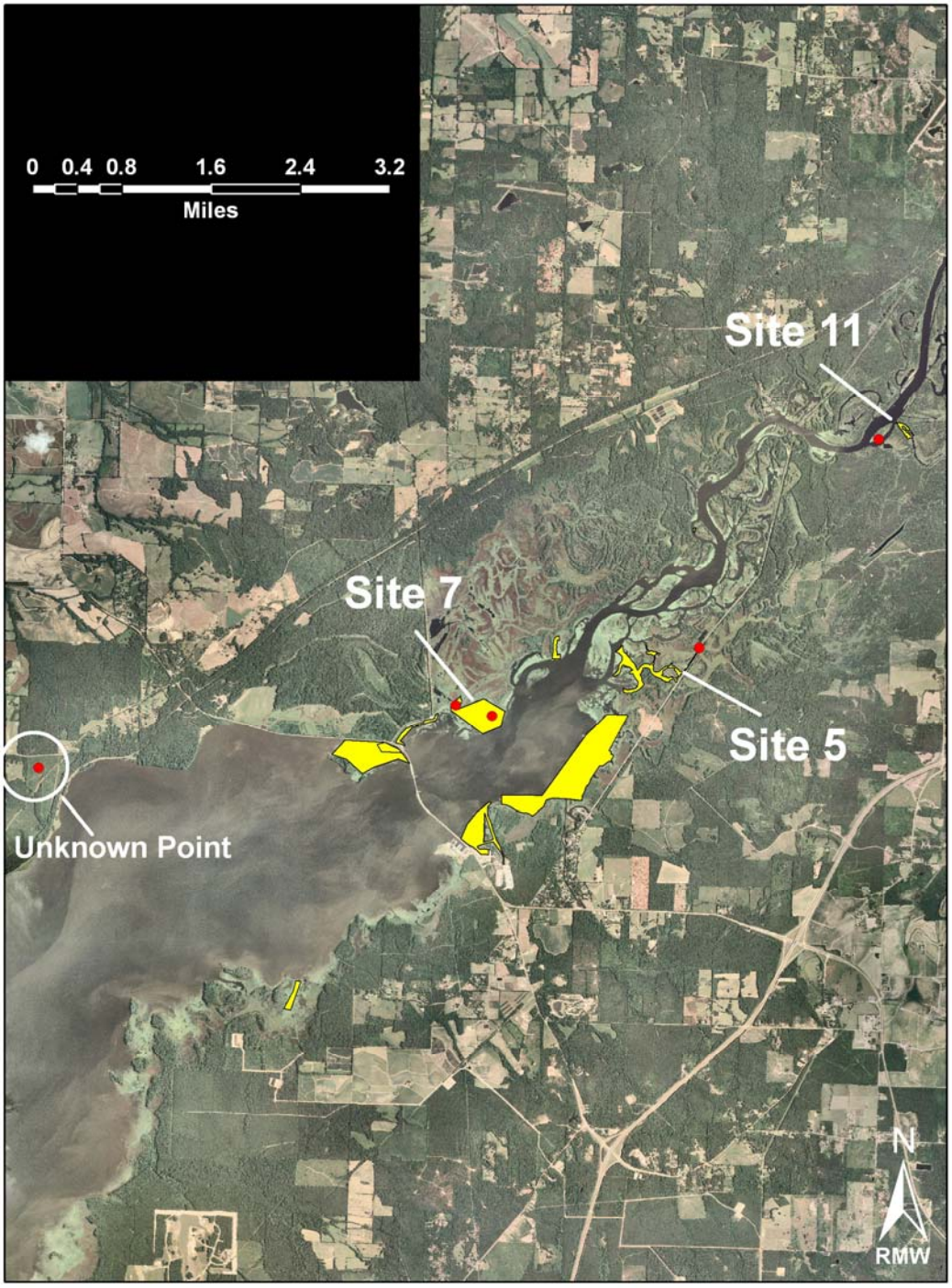

Figure 20. New hydrilla locations found in 2008 (Red Dots) in relation to previous treatment areas (Yellow Polygons).

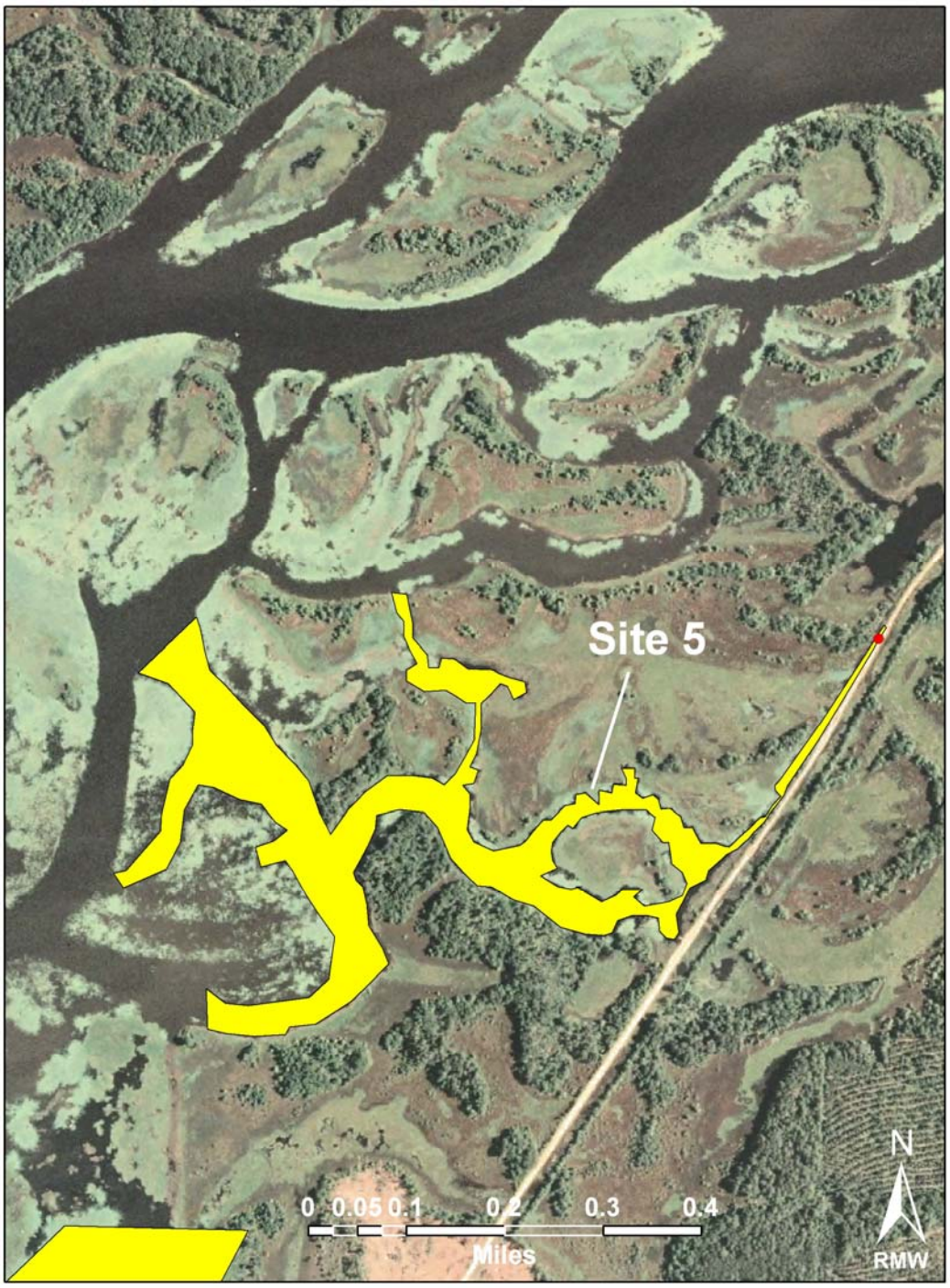

Figure 21. Proposed site 5 expansion to encompass new hydrilla location.

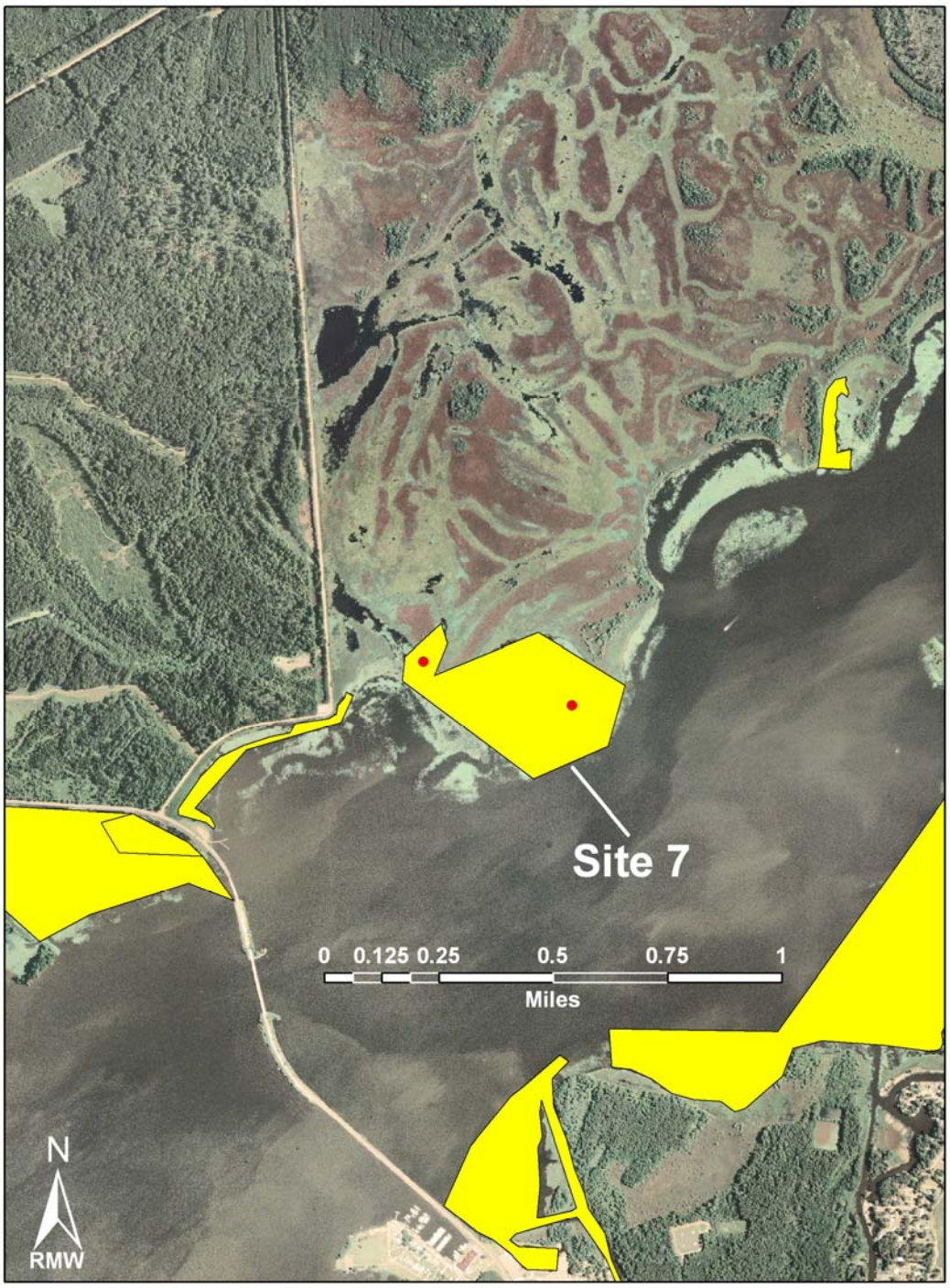

Figure 22. Proposed site 7 expansion to encompass new hydrilla location.

Figure 23. A well developed root crown of a hydrilla plant collected from site 11, March 2008.

Figure 24. A new hydrilla shoot growing from the root crown of an established plant.