Aquatic Plant Survey of Ross Barnett Reservoir for 2005

An Annual Report to the Pearl River Valley Water Supply District

Ryan M. Wersal, John D. Madsen, and Mary Love Tagert
Mississippi State University
GeoResources Institute
Box 9652
Mississippi State, MS 39762-9652

GeoResources Institute Report 5003
April 10, 2006

Aquatic Plant Survey of Ross Barnett Reservoir for 2005

Ryan M. Wersal, John D. Madsen, and M.L. Tagert
GeoResources Institute, Box 9652 Mississippi State, MS 39762-9652

INTRODUCTION

Invasive aquatic plants are an increasing problem to water resources in Mississippi and most other states around the country (Madsen 2004). These plants generally are introduced from other parts of the world, some for seemingly beneficial or horticultural uses (Madsen 2004). Invasive aquatic plants affect aesthetics, drainage, commercial and sport fishing, drinking water quality, fish and wildlife habitat, flood control, human and animal health, hydropower generation, irrigation, navigation, recreation, and ultimately land values (Madsen 1997). An estimated $100 million are spent annually in the United States for the control of aquatic weeds (Rockwell 2003). The Ross Barnett Reservoir is the largest surface water impoundment in Mississippi (33,000 acres) and serves as the primary drinking water supply for the city of Jackson, Mississippi's capital city. It is surrounded by approximately 50 residential subdivisions and over 4,600 homes. The reservoir provides recreational opportunities in the form of 5 campgrounds, 16 parks, 22 boat launches, 3 handicapped-accessible trails, and 2 multi-purpose trails. In recent years, invasive species have become an increasing problem on this reservoir by clogging navigation channels, reducing recreational fishing opportunities, and reducing access for users of the reservoir.

OBJECTIVES

Our overall objective was to begin the initial phases of a five-year study to develop an aquatic plant management plan for the Ross Barnett Reservoir. The first step in the development of a long-term aquatic plant management plan was to assess the reservoir's plant community by mapping the current distribution of aquatic macrophytes throughout the reservoir. The detailed results of this assessment are included in this report.

METHODS AND MATERIALS

Macrophyte distribution was evaluated using a point intercept survey method using a 300 m grid in June of 2005 (Madsen 1999). Points were surveyed throughout the main body of the reservoir and along the main channel of the Pearl River as far north as Low Head Dam. Figure 1 shows the original boundary of the reservoir and the portion of the Pearl River that was sampled, but there are areas of the original lake that were not accessible by boat in June 2005. These are areas that have silted in since the reservoir opened in 1966, and were not sampled. Also, for the purposes of recording sampling data, the reservoir was divided into four main sections: Upper Reservoir, Middle Reservoir, Lower Reservoir, and Pelahatchie Bay.

A hand-held personal digital assistant (PDA) (Hewlett Packard 2110 iPAQ) outfitted with a GPS receiver (Holux GM-270) was used to navigate to each point. Spatial data were directly recorded in the hand-held computer using Farm Works® Farm Site Mate software for in-field geographic and attribute data collection. Data were recorded in database templates using specific pick lists constructed exclusively for this project. The software provides an environment for displaying geographic and attribute data and enables navigation to specific locations. A total of 1,423 points were sampled during the survey by deploying a rake to determine the presence or absence of aquatic macrophyte species at these points. Percent frequency of occurrence was calculated using the total number of points sampled (Table 1).

Environmental parameters (e.g., depth, turbidity, dissolved oxygen, pH, and water temperature) were recorded using a Manta multi-probe (Eureka Environmental Laboratories) in Pelahatchie Bay, the Lower Reservoir, and the Upper Reservoir. Light intensity was recorded at Pelahatchie Bay, Lower Reservoir (2 sites), Middle Reservoir (2 sites), and Upper Reservoir sites using a LiCor light meter enabled with a submersible photosynthetically active radiation (PAR, 400-700 nm) sensor as well as an incident PAR sensor. All measurements were taken in 0.5-meter intervals from the water surface to the reservoir bottom. Light extinction coefficients (K_d) were calculated for each site as an index of how rapidly light is attenuated in the water column.

$$K_d = [\ln (I_{z1}) - \ln (I_{z2})] / (z_2 - z_1) \qquad (1)$$

Where z = the water depth at a given point and I = the light intensity at that point. The greater the coefficient indicates the more rapidly light is attenuated.

Also, the estimated potential maximum depth of macrophyte colonization (Z_c) (Vant et al. 1986) was calculated using the light extinction coefficients (K_d) for each site.

$$Z_c = 4.34/K_d \qquad (2)$$

RESULTS

A total of 19 species of aquatic or riparian macrophytes were observed during the survey. Of the 19 species, 14 were aquatic species (Table 1). Alligatorweed was located most often, followed by American lotus. The distributions of invasive species were located primarily in the Upper Reservoir, along the eastern shoreline of the Middle and Lower Reservoir, and in Pelahatchie Bay (Figures 2 through 6). Other species found during the survey include coontail, fragrant waterlily, American pondweed, duckweed, American frogbit, cattail, soft-stem bulrush, and arrowhead (Table 1). Coontail was the most common native macrophyte species. In general, the occurrence of aquatic macrophytes increased in the Upper Reservoir and Pelahatchie Bay where water depths were shallow. Species occurrence was low in parts of the Middle and Lower Reservoir where water depths were deeper.

Maximum depth of macrophyte colonization was greatest in a portion of the Middle Reservoir and lowest in Pelahatchie Bay, indicating that water depths of less than 1.5 meters are favorable for rooted aquatic macrophytes (Table 2). Average light profiles for six sites are shown in Figure 7. Light intensity, as shown by the percent of surface light transmitted, decreased rapidly at each site. Light intensities were generally reduced to less than 20 percent of surface light intensity within the upper 100 cm of the water column. The Middle Reservoir 5 site had light intensities reduced to less than 20 percent in the upper 50 cm of the water column. Turbidity levels and other environmental factors are summarized in Table 3.

DISCUSSION

Rooted submersed macrophytes growing in the Ross Barnett Reservoir are limited by water depth and subsequent light extinction in the water column. Light extinction coefficients ranging from 0.5 to 4.0 are considered optimal in an aquatic ecosystem (Madsen et al. 1994). Extinction coefficients in the Reservoir tended to approach the middle to upper threshold of this range, indicating that light availability is limiting the growth of rooted macrophytes. Water depths were shallower in the Upper Reservoir and in Pelahatchie Bay, areas where macrophyte presence was greatest as plants were better able to overcome light deficiencies in the shallower water. Data from this study indicate that light transmittance is less than 20% in the upper 100 cm of the water column. Chambers and Kalff (1985) found that submersed macrophytes are located at depths where 21% of light reaches the bottom. The corresponding mean maximum depth of colonization (Z_c) based on light extinction coefficients for these macrophytes is approximately 1.6 ± 0.1 meters, meaning that rooted macrophytes would be able to colonize 22% or 7,200 acres of the Ross Barnett Reservoir. This relationship is further exacerbated by the presence of floating and mat-forming invasive species such as waterhyacinth and alligatorweed, as they shade out more desirable native species.

The Ross Barnett Reservoir has areas, mainly in the Upper Reservoir and Pelahatchie Bay, which can promote substantial macrophyte growth due to lower water depths and increased light availability. Currently, it appears that infestations of invasive species are confined to these two areas; however, the Middle Reservoir has large areas that could be colonized by nuisance species. Hydrilla (*Hydrilla verticillata*) was detected in July 2005 at three locations in the reservoir (Figure 8). The largest infestation was in the Middle Reservoir just below Highway 43, and a second location was detected around the Goshen Springs boat landing. The third and apparently smallest infestation was located just north of Hwy 43 along the eastern boundary of the Pearl River Wildlife Management Refuge. Again, if control efforts are not implemented the hydrilla infestation could encompass over 7,000 acres of the Ross Barnett Reservoir.

FUTURE RESEARCH

- Continued monitoring of macrophyte distribution to assess changes and spread in nuisance species populations.
- Implement and assess techniques to control nuisance species and promote the growth of more desirable native plants.
- Implement and assess herbicide applications to control the hydrilla infestations.

ACKNOWLEDGMENTS

We would like to thank the Pearl River Valley Water Supply District for funding this project. Thank you to Billy Lester, Bill Gallagher, Josh Cheshier, Bill Warren, and Matt Persaud for help during the survey and Wade Givens for setting up our hand held computers with the appropriate software.

LITERATURE CITED

Chambers, P.A., and J. Kalff. 1985. Depth distribution and biomass of submersed aquatic macrophyte communities in relation to Secchi depth. Canadian Journal of Fisheries and Aquatic Sciences 42:701-709.

Madsen, J.D. 1997. Ch. 12. Methods for management of nonindigenous aquatic plants. pp. 145-171. In: J.O. Luken and J.W. Thieret, (eds.), Assessment and Management of Plant Invasions Springer, New York. 324pp.

Madsen, J.D. 1999. Point and line intercept methods for aquatic plant management. APCRP Technical Notes Collection (TN APCRP-M1-02), U.S. Army Engineer Research and Development Center, Vicksburg, MS, USA.

Madsen, J.D. 2004. Invasive aquatic plants: A threat to Mississippi water resources. 2004 Proceedings, Mississippi Water Resources Conference, pp. 122-134, Mississippi State University and Water Resources Institute, Mississippi State, MS.

Madsen, J.D., G.O. Dick, D. Honnell, J. Shearer, and R.M. Smart. 1994. Ecological assessment of Kirk Pond. U.S. Army Corp of Engineers, Waterways Experiment Station, Vicksburg, MS, USA. Miscellaneous Paper A-94-1.

Rockwell, H.W. 2003. Summary of a Survey of the Literature on the Economic Impact of Aquatic Weeds. AERF Report August 2003. Aquatic Ecosystem Restoration Foundation, Flint, MI. 18pp. http://www.aquatics.org.

Vant, W.N., R.J. Davies-Colley, J.S. Clayton, and B.T. Coffey. 1986. Macrophyte depth limits in North Island (New Zealand) lakes of differing clarity. Hydrobiologia 137:55-60.

Table 1. Percent frequency of occurrence aquatic plant species mapped within the Ross Barnett Reservoir, June 2005.

Species Name	**Common Name**	**Native (N) or Exotic (E), Invasive (I)**	**% Frequency**
Alternanthera philoxeroides	alligatorweed	E I	10.0
Nelumbo lutea	American lotus	N	8.2
Hydrocotyle ranunculoides	pennywort	N	3.0
Eichhornia crassipes	waterhyacinth	E I	2.4
Ludwigia peploides	waterprimrose	N	2.3
Myriophyllum aquaticum	parrotfeather	E I	0.4
Ceratophyllum demersum	coontail	N	2.2
Nymphaea odorata	fragrant waterlily	N	2.1
Potamogeton nodosus	American pondweed	N	1.5
Lemna minor	common duckweed	N	1.3
Limnobium spongia	American frogbit	N	0.7
Typha sp.	cattail	N	0.6
Scirpus validus	softstem bulrush	N	0.6
Sagittaria latifolia	arrowhead	N	0.5

Table 2. Light extinction coefficients (K_d), estimated maximum depth of macrophyte colonization (Z_c), and maximum observed depth in the Ross Barnett Reservoir, June 2005.

Site	K_d	Z_c (m)	Maximum Depth (m)
Pelahatchie Bay	3.8	1.1	3.0
Lower Reservoir (1)	2.3	1.9	5.5
Lower Reservoir (3)	2.3	1.9	4.0
Middle Reservoir (4)	2.0	2.2	3.5
Middle Reservoir (5)	3.0	1.4	2.5
Upper Reservoir	3.0	1.5	1.5

Table 3. Environmental data collected from selected sites in the Ross Barnett Reservoir, June 2005.

Site Name	Temp. °C	Dissolved Oxygen (mg/L)	Oxygen % Saturation	pH	Turbidity (NTU)	Depth (m)
Pelahatchie Bay	31.1	10.1	136.7	9.3	18.7	0.0
	29.1	10.6	138.3	9.4	21.4	0.5
	27.1	7.6	95.7	8.2	19.5	1.5
	26.2	4.4	54.1	7.6	24.3	2.0
	25.8	2.5	31.3	7.1	30.8	2.5
Lower Reservoir	30.3	8.0	105.9	8.3	34.6	0.5
	27.2	8.4	106.2	8.1	19.2	1.0
	26.2	6.3	78.4	7.5	16.0	2.0
	26.1	5.7	70.2	7.2	17.4	3.0
	26.0	5.5	68.5	7.1	17.2	3.5
	25.0	3.6	43.9	6.9	78.4	4.0
Upper Reservoir	32.8	9.3	129.3	8.5	9.2	0.0
	30.5	10.8	144.9	8.6	12.9	0.5
	28.4	8.3	106.7	7.7	16.7	1.0
	27.8	4.6	58.7	6.9	202.5	1.5

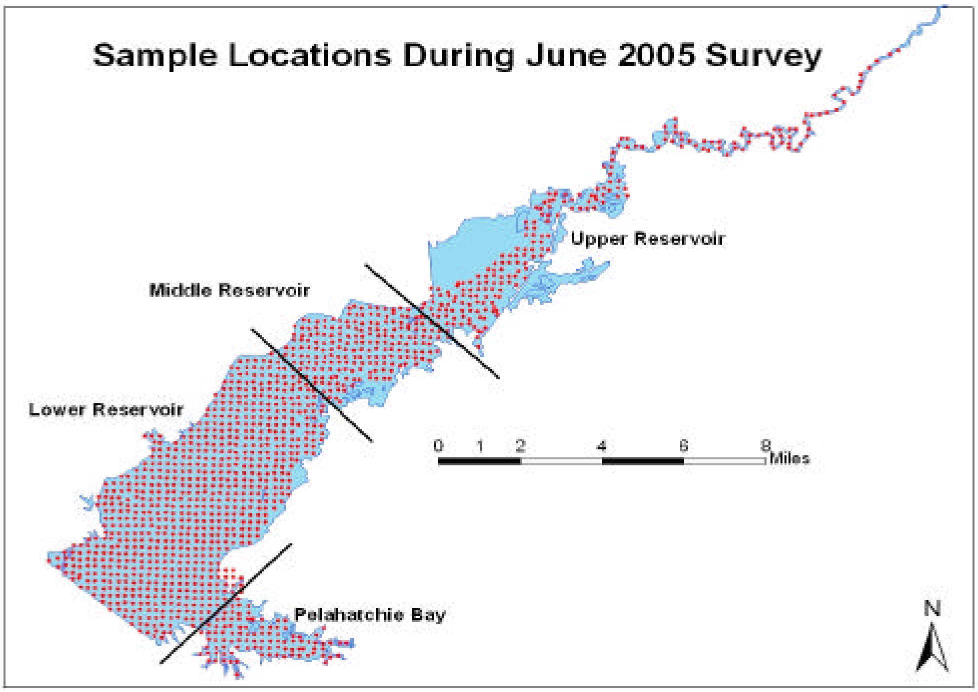

Figure 1. Points sampled on the Ross Barnett Reservoir during the survey conducted in June of 2005.

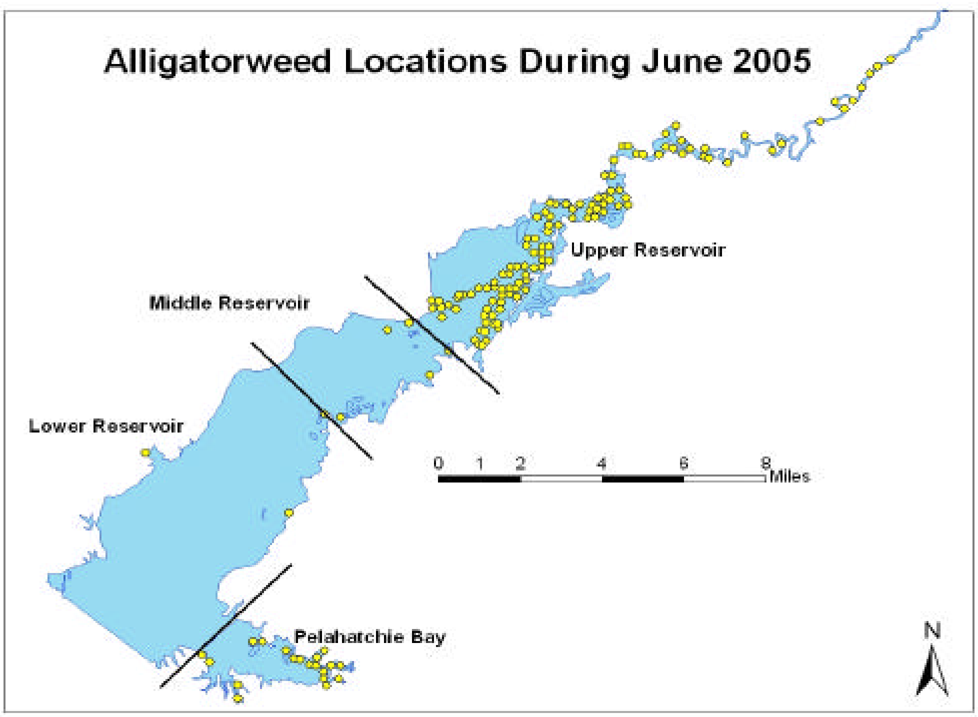

Figure 2. Mapped locations of alligatorweed in the Ross Barnett Reservoir.

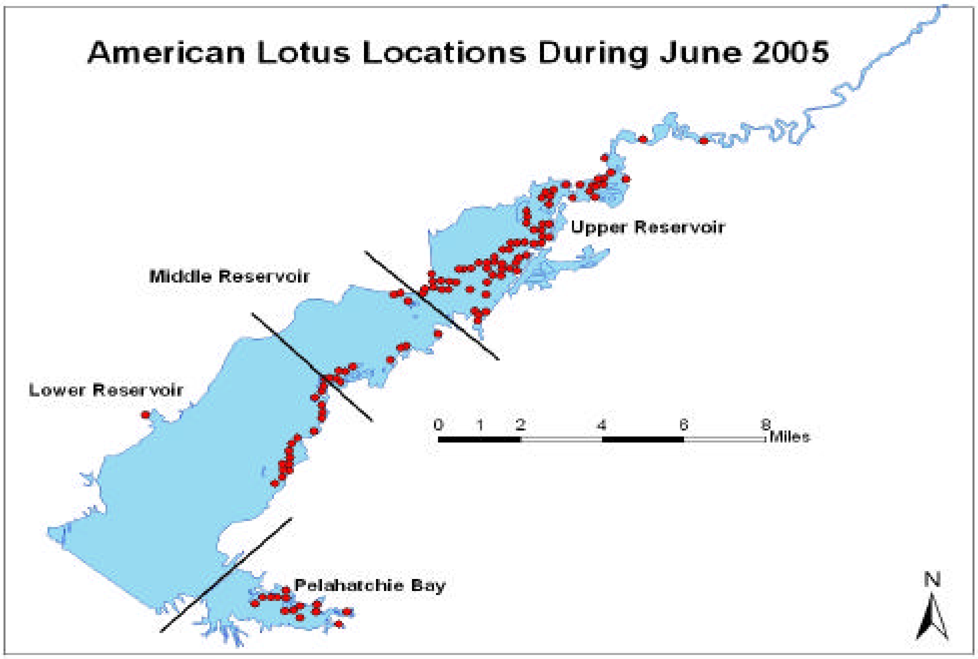

Figure 3. Mapped locations of American lotus in the Ross Barnett Reservoir.

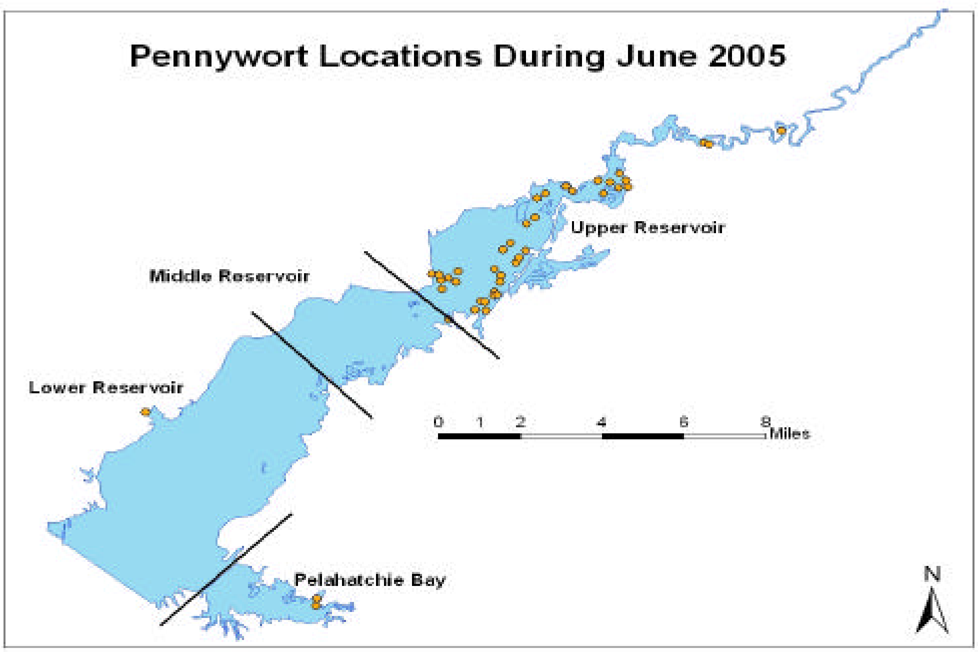

Figure 4. Mapped locations of pennywort in the Ross Barnett Reservoir.

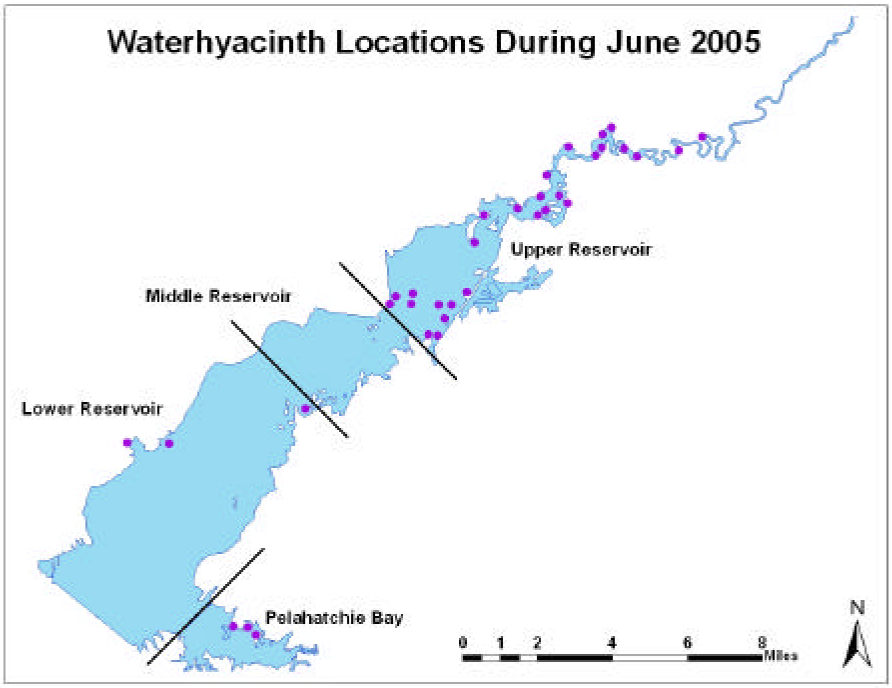

Figure 5. Mapped locations of waterhyacinth in the Ross Barnett Reservoir.

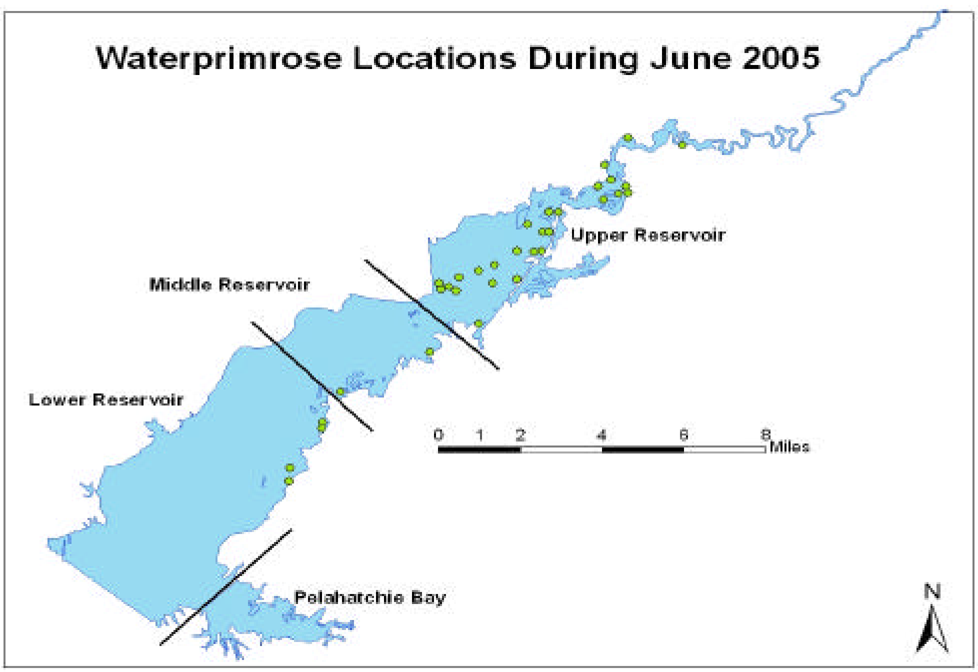

Figure 6. Mapped locations of waterprimrose in the Ross Barnett Reservoir.

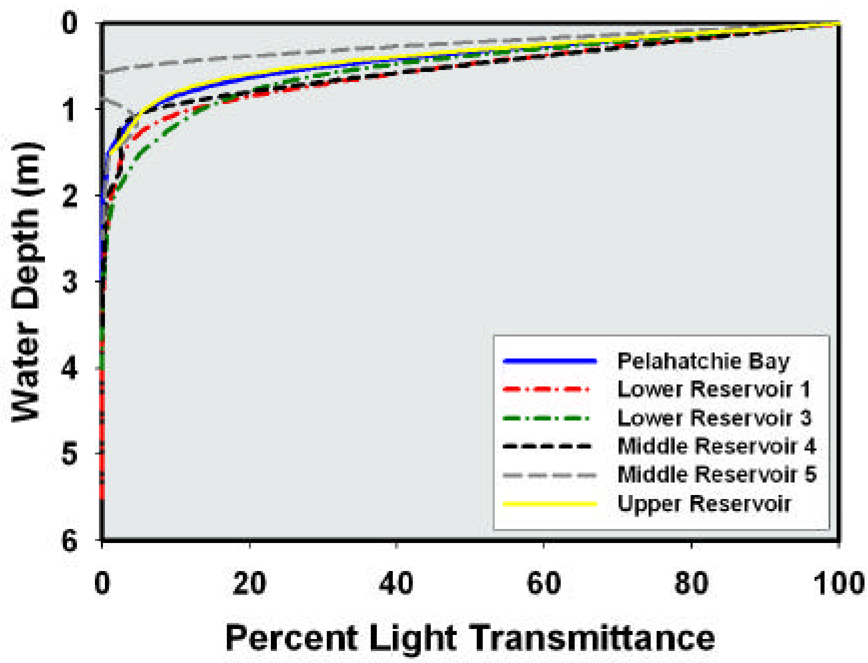

Figure 7. Light profiles for six sites in the Ross Barnett Reservoir.

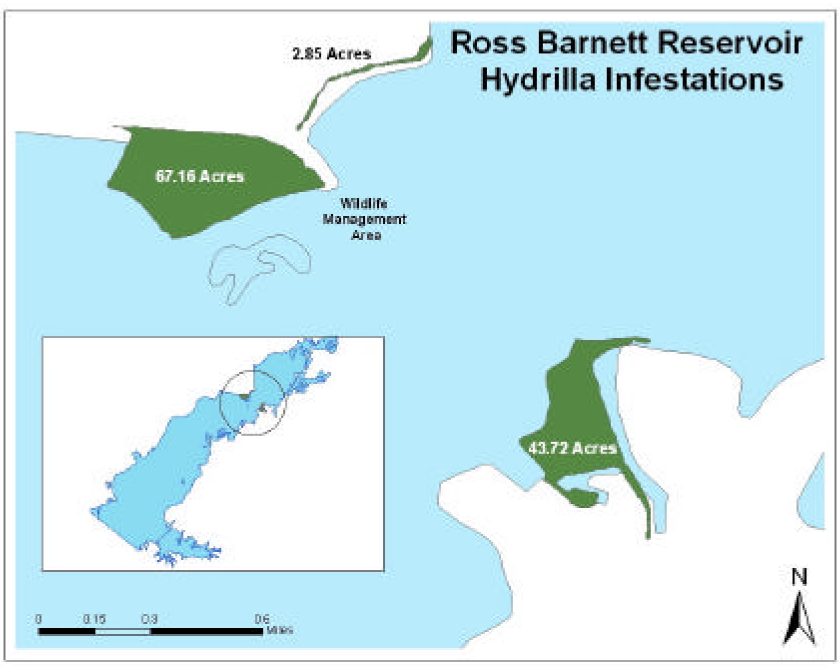

Figure 8. Location of hydrilla found in Ross Barnett Reservoir.