Littoral Zone Plant Communities in the Ross Barnett Reservoir, MS

Ryan M. Wersal, John D. Madsen and Mary Love Tagert
GeoResources Institute
Mississippi State University
Box 9652
Mississippi State, MS 39762-9652
662-325-4595
E-mail rwersal@gri.msstate.edu

ABSTRACT

The Ross Barnett Reservoir is a 33,000 acre surface water impoundment created on the Pearl River near Jackson, Mississippi. The Reservoir is the primary source of potable water for the city of Jackson. It also provides recreational opportunities in the form of fishing, boating, water sports, and onshore camping and hiking; activities that bring revenue to the state. In recent years, non-native aquatic macrophytes have increased in distribution, impeding navigation, fishing, and reduced the aesthetics of waterfront properties. The Pearl River Valley Water Supply District requested assistance in developing and implementing a long term management plan for the Reservoir. Prior to developing and implementing lake-wide management programs, reservoir-wide surveys were needed to assess the current distribution of plant communities in the Reservoir. For this reason, we conducted a whole-lake survey in June 2005 to assess the distribution and abundance of plant communities in the Reservoir. In October 2006 a survey of the littoral zone (water depths of ≤ 10 feet) was conducted based on the points sampled in 2005. A plant rake was deployed at each of the 508 points visited. Species distribution was mapped using handheld computers outfitted with GPS receivers, and data stored in database templates using Farm Site Mate software. Areas of increased plant occurrence were in the upper Reservoir, Pelahatchie Bay, and along the eastern shoreline. A total of 21 aquatic or riparian plant species were observed growing in or along the shoreline of the littoral zone. American lotus and water primrose were the most common plant species observed in the littoral zone (17.7 % and 7.4% respectively). Non-native plants included alligatorweed (3.9%), waterhyacinth (2.9%), and hydrilla (0.6%). Bladderwort, a native submersed aquatic plant was also observed (0.4%) for the first time. Overall, species distribution was lower during October 2006 than in 2005.

Keywords: Invasive species, Ecology, Water Use, Wetlands

Introduction

The Ross Barnett Reservoir is a 13,400 hectare (33,000 acre) freshwater impoundment that is located just north of Jackson, Mississippi. The reservoir is the largest surface water impoundment in Mississippi and serves as the primary drinking water supply for the City of Jackson. The reservoir is surrounded by over 4,600 homes and provides recreation in the form of fishing, boating, camping, and trail systems along the shoreline. In recent years, invasive plant species have become an increasing problem by clogging navigation channels, reducing recreational fishing opportunities, and reducing access for users of the reservoir (Madsen 2004).

In 2005, hydrilla (*Hydrilla verticillata* L.f. Royle) was discovered at four locations within the Reservoir (Wersal et al. 2006). Hydrilla is an invasive submersed aquatic plant that was introduced into the United States in the 1960's by the aquaria market (Blackburn et al. 1969). Hydrilla is spread by asexual reproduction via tubers (produced below the sediment), turions (produced in leaf axils), and fragmentation of stems. These reproductive structures can remain viable for

several days out of water, remain in the sediment up to four years, survive the ingestion and regurgitation of waterfowl, and survive herbicide applications (Langeland 1996). Hydrilla has been called "the perfect aquatic weed" as a result of its reproductive mechanisms and its resiliency to survive under adverse environmental conditions (Langeland 1996).

The objectives of this study were to 1) monitor the aquatic plant community in the Ross Barnett Reservoir, specifically plants growing in the littoral zone; 2) identify new hydrilla populations and monitor populations that already exist; and 3) assess herbicide applications of established hydrilla populations.

Materials and Methods

Vegetation Survey

Aquatic plant distribution was evaluated using a point intercept survey method using a 300 meter grid in October 2006 (Madsen 1999). The grid of points for the current survey was modified from the 2005 survey to include only those points occurring in water depths of ≤ 3 meters (Wersal et al. 2006). 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). There were still areas within the littoral zone that were inaccessible by boat due to low water levels experienced at the time of the survey. Points that were located in those areas

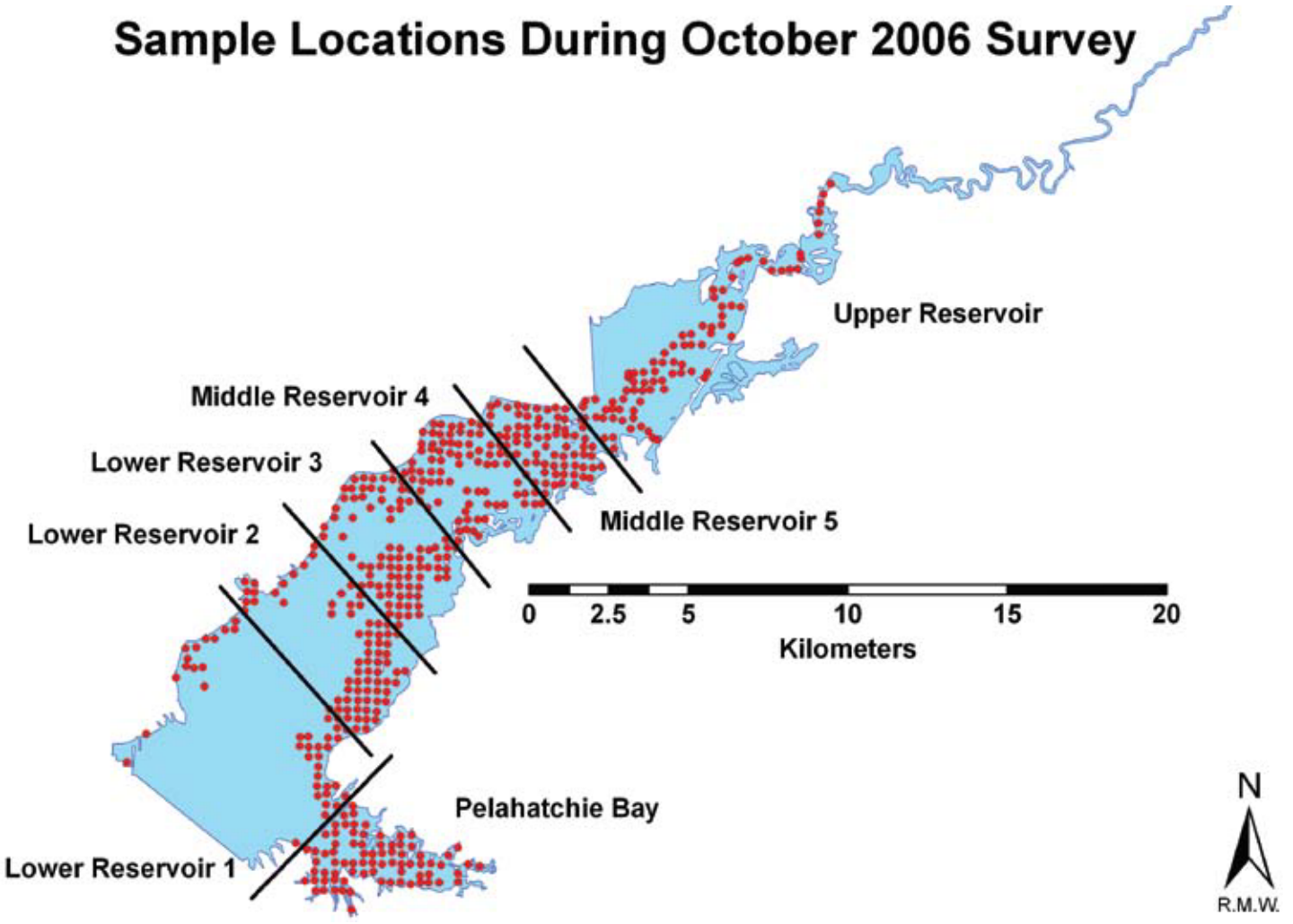

Figure 1. Points sampled within the littoral zone of the Ross Barnett Reservoir during the survey conducted in October 2006.

were not sampled. For the purposes of recording 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 hand-held personal digital assistant (PDA) outfitted with a global positioning systems (GPS) receiver was used to navigate to each point. Spatial data were directly recorded in the hand-held computer using Farm Works® Farm Site Mate software. Data were recorded in database templates using specific pick lists constructed for this project. The software provides an environment for displaying geographic and attribute data and enables navigation to specific points during the survey. A total of 508 points were sampled by deploying a rake to determine the presence or absence of aquatic plant species. Percent frequency of occurrence was calculated for each species by dividing the number of detections for that species by the total number of points sampled. Estimated total acreage for commonly occurring aquatic plant species was also calculated by using the total number of points that a given species was observed at and multiplying that number by 39.5 (the acreage represented by one survey point).

Hydrilla Population Assessment

Thirty and 60 days after fluridone treatments to the four hydrilla populations (Site 1, Site 2, Site 3, and Site 4) in April 2006, approximately 25 plant rake tosses were performed in each of the hydrilla sites to assess herbicide efficacy on hydrilla. Also, a tuber survey of the four hydrilla sites was conducted in February and December of 2006 to assess the density of the tuber bank. Thirty core samples were collected within each hydrilla site using a PVC (0.018 m2) coring device (Madsen et al. 2007). Core samples were washed in a pail with a 0.25 m2 wire mesh bottom to separate plant material (tubers) from the sediment. Plant material was placed into 3.78 Liter Ziploc® bags for transport back to Mississippi State University. Samples were sorted, dried to a constant mass, and weighed to assess tuber biomass and density.

Results

Vegetation Survey

A total of 19 species of aquatic or riparian plants were observed during the survey. Of the 19 species, 15 are strictly aquatic species (Table 1). Alligatorweed was the exotic invasive aquatic plant species observed most often, followed by waterhyacinth and hydrilla. The distributions of these species were located primarily in the Upper Reservoir and Pelahatchie Bay. Native species found during the survey include American lotus, coontail, fragrant waterlily, American pondweed, duckweed, frogbit, cattail, soft-stem bulrush, two species of arrowhead, and bladderwort (Table 1). American lotus was the most common native plant species observed, followed by waterprimrose. American lotus was observed throughout the Reservoir, with increased occurrence in the Upper Reservoir and Pelahatchie Bay. The occurrence of aquatic plants was greatest in the Upper Reservoir and Pelahatchie Bay. Species occurrence was low in parts of the Middle Reservoir and the Lower Reservoir where water depths are too great to support aquatic plant growth.

The estimated acreages for the commonly occurring native and non-native aquatic plant species are shown in Table 2. Native species occupied the greatest area, with American lotus occupying the largest area (1998 acres), followed by waterprimrose (844 acres), and coontail (555 acres). The non-native alligatorweed occupied approximately 444 acres followed by waterhyacinth (333 acres), and hydrilla (67 acres). Based on these acreage estimates, native plant species occupy the greatest area and non-native aquatic plant species currently occupy less than 2.5% of the total Reservoir area. These estimates are derived from the point survey, in which each point of occurrence represents 22.2 acres. There were approximately 125 acres of hydrilla treated in 2006 resulting in a 54% reduction based on the estimates from the survey. For accurate mapping of waterhyacinth and alligatorweed, the use of remote sensing may be needed, since access is limited in some areas where these species are found.

Table 1. Percent frequency of occurrence for plant species observed in the littoral zone during the survey, October 2006 (n=508). The percent frequency of occurrence reported for 2005 data (n=677) are from points that where sampled in 3 m of water or less during that survey.

Species Name	Common Name	Native (N) or Exotic (E), Invasive (I)	2005[1] % Frequency	2006 % Frequency
Alternanthera philoxeriodes	alligatorweed	E I	21.10	3.94
Azolla caroliniana	mosquito fern	N	0.00	0.20
Cabomba caroliniana	fanwort	N	2.20	0.00
Ceratophyllum demersum	coontail	N	4.40	4.92
Colocasia esculenta	wild taro	E I	0.00	0.98
Eichhornia crassipes	waterhyacinth	E I	4.90	2.95
Hydrilla verticillata	hydrilla	E I	0.00	0.79
Hydrocotyle ranunculoides	pennywort	N	6.40	0.59
Lemna minor	common duckweed	N	3.10	2.56
Limnobium spongia	American frogbit	N	1.50	0.79
Ludwigia peploides	waterprimrose	N	4.90	7.48
Myriophyllum aquaticum	parrotfeather	E I	0.70	0.00
Nelumbo lutea	American lotus	N	17.10	17.72
Nitella sp.	stonewort	N	0.10	0.00
Nuphar odorata	fragrant waterlily	N	4.40	3.35
Potamogeton nodosus	American pondweed	N	2.70	2.76
Sagittaria latifolia	arrowhead	N	1.00	1.18
Sagittaria platyphylla	arrowhead	n	0.00	1.77
Scirpus validus	softstem bulrush	N	1.20	0.20
Typha sp.	cattail	N	1.30	2.36
Utricularia vulgaris	bladderwort	N	0.00	0.39
Zizaniopsis miliacea	giant cutgrass	N I	1.50	3.54

[1]A direct comparison between years is not valid due to the different times of the year that the two surveys were conducted. The difference in time likely introduced seasonal effects on the growth of aquatic plant species.

Hydrilla Population Assessment

Hydrilla was observed growing at the four locations treated with fluridone during the water sample collection at 30 and 60 days after treatment. Although plants were found, they exhibited symptoms typical of exposure to fluridone. During the October survey, hydrilla was observed growing in a previously unreported area near a boat landing along Pipeline Road on the eastern side of the Upper Reservoir (Figure 2). The hydrilla observed at these sites was green, healthy, and exhibited no herbicide symptoms. There was no hydrilla observed at Site 3 on the western side of the Reservoir. Hydrilla Site 4 was not sampled due to low water

Table 2. Estimated acreage of the commonly occurring aquatic plants in the littoral zone during the Ross Barnett Reservoir Survey, October 2006.

Species Name	Common Name	Native (N) or Exotic (E), Invasive (I)	Estimated Acreage[1]
Alternanthera philoxeriodes	alligatorweed	E I	444
Eichhornia crassipes	waterhyacinth	E I	333
Hydrilla verticillata	hydrilla	E I	67
Ceratophyllum demersum	coontail	N	555
Lemna minor	common duckweed	N	289
Ludwigia peploides	waterprimrose	N	844
Nelumbo lutea	American lotus	N	1998
Nuphar odorata	fragrant waterlily	N	377
Potamogeton nodosus	American pondweed	N	310

[1]Each point of the survey represents approximately 22.2 acres.

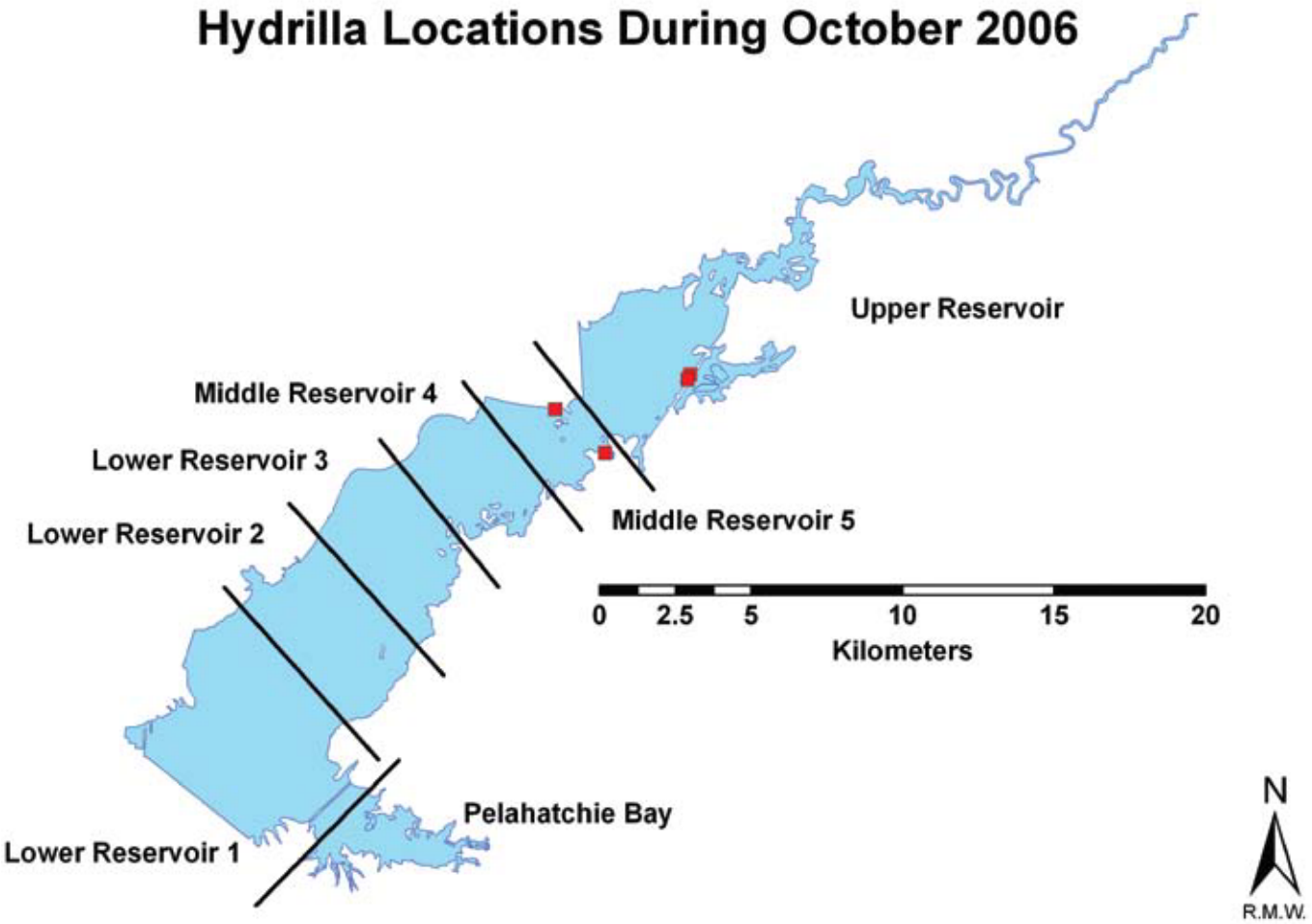

Figure 2. Locations of hydrilla in the Ross Barnett Reservoir, October 2006.

depths and the inaccessibility by boat to these points. Based on the October survey and the finding of a new hydrilla population, the Ross Barnett Reservoir now has at least five separate locations where hydrilla is growing.

Hydrilla is typically a prolific producer of tubers, however, no tubers were found at any of the hydrilla sites surveyed in February 2006. During a similar survey of the same four sites in December 2006, only two tubers were found. These tubers were found in Site 4 and appeared unviable. A single small shoot of hydrilla was also found in Site 1 and appeared to be healthy and viable.

Discussion

Aquatic plant growth in the Ross Barnett Reservoir appears to be limited to the Upper Reservoir, Pelahatchie Bay, and the eastern shoreline of the Reservoir. Species that are able to overcome deficiencies in light availability were observed most often. These species included American lotus, alligatorweed, waterprimrose, and waterhyacinth, species with an emergent or floating growth habit. Light profiles from seven sites within the Reservoir indicate that light transmittance is less than 20% in the upper 3 ft of the water column (Wersal et al. 2006). The limitation of light in deeper water areas excludes submersed plant species from inhabiting these areas and forces colonization to shallower water depths where greater than 21% of surface light reaches the bottom sediments (Chambers and Kalff 1985). However, species such as coontail and hydrilla are well adapted to survive in low light environments and have mechanisms to overcome the stresses associated with light limitations, which may explain their dominance as submersed species in the Reservoir. Under low light availability, hydrilla can increase its shoot length to reach the water surface rapidly where it forms a dense canopy to overcome deficiencies in light availability (Barko and Smart 1981). The elongation of shoots under low light conditions may allow hydrilla to expand its depth distribution more so than other species (Barko and Smart 1981). Furthermore, the ability of hydrilla to increase shoot elongation confers a competitive advantage over other species in waterbodies of limited transparency (Barko and Smart 1981).

Intensive management efforts have been deployed to control the hydrilla populations in the Reservoir. These include herbicide applications of endothall in the fall of 2005 to control actively growing hydrilla prior to tuber formation, followed by spring to early summer herbicide applications of fluridone in 2006 to offer greater control of new hydrilla growth. Intensive monitoring was conducted in and around the hydrilla populations following the fluridone applications. To date, only two tubers have been collected, indicating that the tuber bank may be small and year-to-year recruitment is from over-wintering of individual plants or from fragmentation of live stems. The potential small size of the tuber bank may be a good indicator of how long hydrilla has been growing in the reservoir and also an indicator of the potential for eradication. The longevity of hydrilla tubers is unknown, but field evidence suggests that there has been a decrease in tuber numbers over time following fluridone treatments (Netherland 1997). However, it has also been noted that hydrilla tubers can remain viable for up to three years following an application (Netherland 1997). The tubers found during the December survey were soft, white, and appeared non-viable, likely a result of the fluridone treatments. Long-term monitoring and repeated herbicide applications to hydrilla populations need to continue to allow for effective control of hydrilla from the Reservoir.

Acknowledgements

Approved for publication by the Mississippi Agricultural and Forestry Experiment Station. The Pearl River Valley Water Supply District funded this research. We thank Billy Lester, Wilfredo Robles, Josh Cheshier, and Jimmy Peeples for assisting during the survey. Joe Massey, Victor Maddox, and Todd Tietjen provided reviews of this manuscript.

Literature Cited

Barko, J. W. and R. M. Smart. 1981. Comparative influences of light and temperature on the growth and metabolism of selected submersed freshwater macrophytes. Ecological Monographs 51:219-235.

Blackburn, R. D., L. W. Weldon, R. R. Yeo, and T. M. Taylor. 1969. Identification and distribution of certain similar-appearing submersed aquatic weeds in Florida. Hyacinth Control Journal 8:17-23.

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.

Langeland, K. A. 1996. Hydrilla verticillata (L. F.) Royle (Hydrocharitaceae), "The perfect aquatic weed". Castanea 61: 293-304.

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., R. M. Wersal, and T. E. Woolf. 2007. A new core sampler for estimating biomass of submersed aquatic macrophytes. Journal of Aquatic Plant Management 45:31-34.

Netherland, M. D. 1997. Turion ecology of hydrilla. Journal of Aquatic Plant Management 35:1-10.

Wersal, R. M., J. D. Madsen, and M. L. Tagert. 2006. Aquatic plant survey of Ross Barnett Reservoir for 2005. GeoResources Institute Report 5003 11pp.