Survey of Invasive and Native Aquatic Plants in the Ross Barnett Reservoir

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Ross Barnett Reservoir is a 33,000-acre impoundment on the Pearl River and serves as the primary source of drinking 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. Invasive aquatic plants have become increasingly troublesome in recent years, specifically impacting navigation, fishing, and reducing the aesthetics of waterfront properties. To assess the distribution and abundance of invasive species in the Reservoir a point intercept survey was conducted on a 300 meter by 300meter grid in June of 2005. A plant rake was deployed at each of the 1,423 points visited. The primary areas of infestations were in the shallow upper reservoir, Pelahatchie Bay, and along the eastern shoreline. Alligatorweed and American lotus were the most common plant species observed (10.0 % and 8.2% respectively), followed by pennywort (3.0%), water hyacinth (2.4%), water primrose (2.3%), and parrotfeather (0.4%). Plant species presence may be influenced by light availability in different locations within the reservoir as noted by light profiles. Light transmittance at all sites was less than 20% in the upper 1 meter of the water column. The exotic invasive species, especially alligatorweed and water hyacinth, due to their growth habits can infest a large area of the reservoir if left unmanaged.

Keywords: Invasive species, Ecology, Wetlands

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 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 (Rockwell 2003). It is estimated that over $100 million is 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 extensive residential growth, 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.

Invasive aquatic plants have become increasingly problematic in the Ross Barnett Reservoir by impeding navigation channels, reducing recreational fishing opportunities, and reducing access for users of the reservoir. A long-term management plan is required to address the current and potential problems posed by the presence of invasive aquatic plants. The objective of this study was to assess the reservoir's plant community by mapping the current distribution of aquatic plants throughout the reservoir. The survey will serve as the starting point in the development of a long-term aquatic plant management plan.

Methods

A point intercept survey (Madsen 1999) was conducted on a 300 m grid in June of 2005 to assess the distribution and abundance of aquatic plants in the Ross Barnett Reservoir. Points were sampled throughout the Reservoir and along the main channel of the Pearl River as far north as Low Head Dam (Figure 1). The original boundary of the reservoir and a portion of the Pearl River were sampled, as well as areas of the reservoir that were not accessible by boat (Figure 1). Due to their inaccessibility these areas were not sampled. A hand-held computer (Hewlett Packard 2110 Ipaq) outfitted with a GPS receiver (Holux GM-270) was used to navigate to each point. Spatial and presence/absence data were directly recorded in the hand-held computer using Farm Works® Farm Site Mate software. Data were recorded in database

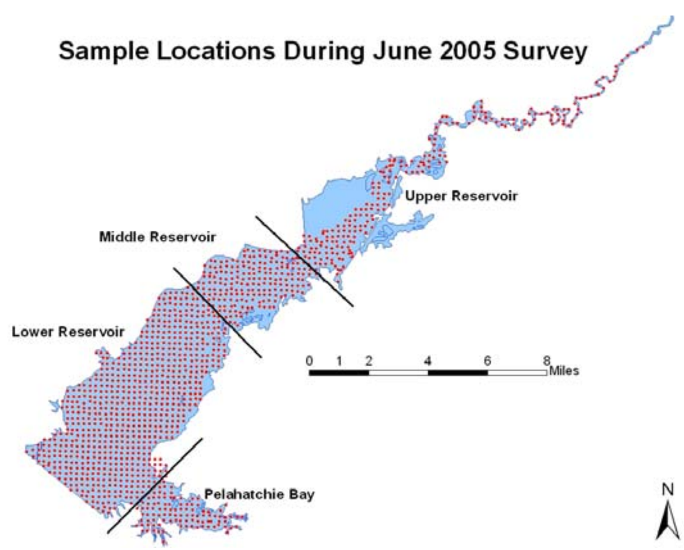

Figure 1. Points sampled on the Ross Barnett Reservoir during the survey conducted in June of 2005.

templates using specific pick lists constructed exclusively for this project. 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 to give an estimate of plant occurrence throughout the entire reservoir not just littoral zone.

Water depth was taken at each of the sample points. 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 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 maximum depth of plant 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 plants were observed during the survey. Of the 19 species, 14 are most often found in aquatic systems and 3 are exotic invasive species (Table 1). Alligatorweed, an exotic invasive, was observed most often (10%), followed by American lotus (8.2)%, a native species. The two other exotic invasive species observed during the survey were water-hyacinth and parrotfeather. 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. Other species found during the survey include coontail, fragrant waterlily, American pondweed, duckweed, frog's-bit, cattail, soft-stem bulrush, and arrowhead (Table 1). Waterprimrose was the most common native species observed (2.3%).

In general, the occurrence of aquatic plants increased in the Upper Reservoir and Pelahatchie Bay in shallow water. Species occurrence was low in parts of the Middle and Lower Reservoir where water was deeper. Maximum depth of plant 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 plants (Table 2). Light intensities

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), or 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	water hyacinth	E I	2.4
Ludwigia peploides	water primrose	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	Frog's-bit	N	0.7
Typha sp.	cattail	N	0.6
Scirpus validus	softstem bulrush	N	0.6
Sagittaria latifolia	arrowhead	N	0.5

at these locations were generally reduced to less than 20 percent of surface light intensity within the upper 100 cm of the water column (Figure 2).

Discussion

Rooted submersed plants 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 likely limiting the growth of rooted plants. Water depths were shallower in the Upper Reservoir and in Pelahatchie Bay, areas where plant presence was greatest as they were better able to overcome light deficiencies in the shallower water. Data from this study indicate that light transmittance is less than 20% in

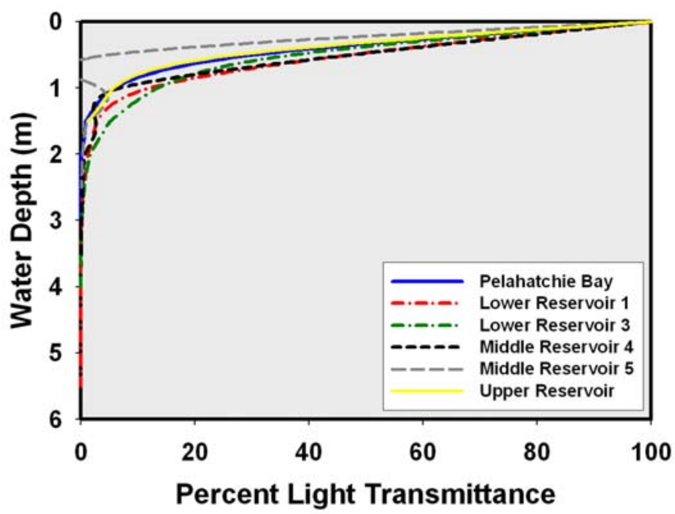

Figure 2. Light profiles for six sites in the Ross Barnett Reservoir.

the upper 100 cm of the water column. In general, submersed plants are located at depths where at least 21% of light reaches the bottom (Chambers and Kalff 1985). The corresponding mean maximum depth of plant colonization (Zc) is approximately 1.6 ± 0.1 meters based on light intensity measurements, meaning that rooted plants, preferably native species, would be able to colonize 22% or 7,200 acres of the Ross Barnett Reservoir. However, this relationship is exacerbated by the presence of floating invasive species, such as waterhyacinth, and canopy-forming species such as alligatorweed, pennywort, and waterprimrose, as they shade native species and can out-compete native species for available nutrients.

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. Two of the three infestations including the largest infestation (~ 67 acres) are in the Middle Reservoir site. The third and smallest (~ 3 acres) infestation of hydrilla is on the boarder of the Middle Reservoir and Upper Reservoir sites. Hydrilla is a submersed aquatic macrophyte introduced into the US in the 1960's. Hydrilla is considered a serious threat to water bodies in the United States as it can rapidly out-compete native plants establishing dense monotypic stands. If left alone these dense beds of hydrilla can be difficult and expensive to control and or manage. Florida spends approximately $14.5M each year on hydrilla control (Pimentel et al. 2000). If control efforts are not implemented in the Ross Barnett Reservoir the hydrilla infestation could encompass over 7, 200 acres. Future research needs to continue monitoring aquatic plant 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; and implement and assess herbicide applications to control the hydrilla infestations.

Table 2. Light extinction coefficients (Kd), estimated maximum depth of macrophyte colonization (Zc), 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

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