Littoral zone aquatic plant community assessment of the Ross Barnett Reservoir, Mississippi for 2007

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As the threat of non-native plant species increases, the development and refining of methods to rapidly detect, monitor and ultimately control these species to mitigate negative impacts is critical. Three non-native aquatic plant species that have caused major problems throughout the United States are waterhyacinth (*Eichhornia crassipes*) alligatorweed (*Alternanthera philoxeroides*), and hydrilla (*Hydrilla verticillata*), and all three species. In Mississippi, these species can be found in the Ross Barnett Reservoir. Waterhyacinth and alligatorweed have been under intensive management for almost a decade, primarily through the use of contact herbicides. Hydrilla was first observed in the Reservoir in 2005 and has since undergone aggressive management through the use of the systemic herbicide fluridone. To ensure that these management techniques are successful and to assess impacts to the native plant community, we conducted a survey of the littoral zone to monitor and record changes in the occurrence of plant species. The survey of the Ross Barnett Reservoir yielded 19 species of aquatic and riparian plants. The dominant species was the native plant American lotus with a percent frequency of occurrence of 21.1%. The occurrence of each non-native species was below 5% with alligatorweed observed most often (4%). Hydrilla had a frequency of occurrence of 1.4%. The frequency of occurrence for both waterhyacinth and alligatorweed decreased significantly ($p \leq 0.01$) from 2005 to 2007. The frequency of occurrence for waterhyacinth in 2005 was 4.9% and declined to 2.9% and 1.2% in 2006 and 2007, respectively. The occurrence of alligatorweed was reduced from 21.1% in 2005 to 4.0% in 2007, approximately an 80% reduction. Furthermore, the removal of waterhyacinth and alligatorweed from some areas of the Reservoir has not impacted the overall species richness (mean number species per point) over the past three years. The occurrence of species (American lotus, white waterlily, American pondweed, and coontail) growing in association with both alligatorweed and waterhyacinth did not significantly change between years, indicating that waterhyacinth and alligatorweed are being selectively removed with little impact on native plant species or species richness. Additionally, hydrilla has been effectively removed from 5 areas of the reservoir totaling more than 161 acres.

Key words: Invasive Species, Ecology, Water Use, Wetlands

Introduction

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 fraction of non-native plants that are harmful does not have to be large to inflict significant damage to an ecosystem (Pimentel et al. 2000). As the threat of non-native plant species increases, the development and refining of methods to rapidly detect, monitor and ultimately control these species to mitigate negative impacts is critical. Three non-native aquatic plant species that have caused major problems throughout the United States are waterhyacinth (Eichhornia crassipes) alligatorweed (Alternanthera philoxeroides), and hydrilla (Hydrilla verticillata). In Mississippi, all three of these species can be found in the Ross Barnett Reservoir. This is of concern because this reservoir is not only the largest reservoir in the state (33,000 acres), but it also supplies the City of Jackson with potable water. Waterhyacinth and alligatorweed have been under active management for almost a decade, primarily through the use of systemic herbicides. Hydrilla was first observed in the Reservoir in 2005 and has since undergone aggressive management through the use of the systemic herbicide fluridone and the contact herbicide endothall. To ensure that these management techniques are successful, we conducted a survey of the littoral zone plant community to monitor and record changes in the occurrence of plant species as well as to assess management techniques. Regular

assessment of management effectiveness is a significant component of successful long-term maintenance management programs (Madsen 2007).

Objectives

Our objective was to 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), with special attention to invasive aquatic plant species.

Materials and Methods

Aquatic plant distribution was evaluated using a point intercept survey method using a 300 meter grid in July 2007 (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. There were still 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 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 (Wersal et al. 2006a, Wersal et al. 2007, Wersal et al. 2008). 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 the specific points of this survey. A total of 423 points were sampled during the survey by deploying a rake to determine the presence or absence of aquatic plant species at these points. Water depth was also recorded at each point during the survey.

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. The change in occurrence of plant species was determined using McNemar's Test to account for repeated measures (sampling the same points in multiple years) in the sampling design (Stokes et al. 2000, Wersal et al. 2006b). A pairwise comparison of species occurrences was made between years using the Cochran-Mantel-Haenszel statistic (Stokes et al. 2000, Wersal et al. 2006b). References and comparisons to the 2005 survey were done using only the littoral zone sample points that correspond to the surveys conducted in 2006 and 2007.

Results and Discussion

The survey of the Ross Barnett Reservoir yielded 19 aquatic and riparian plant species (Table 1). The dominant species was the native plant American lotus with a percent frequency of occurrence of 21%, followed by white waterlily at 5%. Other native plant species included coontail (4%) and American pondweed (2%). The occurrence of all non-native species was below 5%, with alligatorweed observed most often (4%). Hydrilla had a frequency of occurrence of 1%, followed by waterhyacinth. Hydrilla was observed at 5 locations during the littoral zone survey in July 2007, resulting in the 1% frequency of occurrence. Brittle naiad (Najas minor), a non-native plant from Europe, had a frequency of occurrence of 2% and was observed for the first time during the survey in July of 2007. It is unclear; however, how problematic it will become due to the presence of other submersed species such as hydrilla, the shading caused by American lotus, and stresses associated with fluctuating water levels. Brittle naiad does not typically cause the widespread nuisance problems of the other nonnative species, but it should be monitored in the future. The low water levels of the past two years may contribute to increased abundance of brittle naiad which, as an annual, is favored by this type of disturbance.

Water depths during the time of this survey were significantly lower than in 2005 ($p \leq 0.01$) (Wersal et al. 2008). The lower depths may have favored species that could tolerate the stresses associated with low water. Also, some shallow water areas were not accessible and therefore were not sampled, possibly resulting in some species being missed, which may be a plausible explanation for an overall reduction in species richness in 2006 and 2007 (Wersal et al. 2008). Submersed plant species growing in what were shallow areas in 2005 were likely killed as the water receded in 2006 and 2007 and bottom sediments were exposed to air. Typically, draw-downs favor the establishment of mud-flat annuals and emergent species in areas that were previously dominated by aquatic species (van der Valk 1981). Species such

as American lotus reproduce vegetatively via rhizomes and also through the production of large seeds. The production of seeds represents a mechanism for survival of adverse conditions or a mechanism for spread during times of low water (Sculthorpe 1967). The frequency of occurrence of American lotus increased from 2005 to 2007, although the increase was not significant ($p = 0.08$). The frequency of occurrence for the native species white waterlily, American pondweed, and coontail did not change from 2005 to 2007 ($p = 0.44$, $p = 0.92$, and $p = 0.58$, respectively). White waterlily and American pondweed are floating leaved species and may be tolerant of water level fluctuations. Indeed, there was not significant relation found between floating plant species and drawdown (Van Geest et al. 2005). However, coontail is a submersed species and much more sensitive to water depth than the floating species. The fact that the occurrence of coontail did not change between 2005 and 2007 may suggest that it occurs in the deeper portions of the littoral zone, sheltering it from water fluctuations.

While we are confident of the estimates of floating and submersed plant distributions, we are concerned that alligatorweed and other emergent plants may be under-sampled. Alligatorweed may grow in very shallow water or even in moist soil. We propose using remote sensing (either aerial photography or satellite imagery) to validate our estimates of alligatorweed distribution from point sampling and determine areas of existence beyond the shoreline of the Reservoir.

While the frequency of native species has remained essentially unchanged over the past three years, the frequency of invasive species have changed significantly. Alligatorweed and waterhyacinth have significantly decreased significantly, due to both active management and a drop in water level. Hydrilla, on the other hand, has increased significantly, although active management has undoubtedly reduced the potential spread in the reservoir.

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Table 1. Percent frequency of occurrence for aquatic or riparian plant species observed in the littoral zone during the Ross Barnett Reservoir Survey, July 2007 (n=423). 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.

Species Name	Common Name	Native (N), Exotic (E) or Invasive (I)	2005 % Frequency	2006 % Frequency	2007 % Frequency	Significance[1] Value p = 0.05
Althernanthera philoxeroides	alligatorweed	E I	21.1	3.9	4.0	<0.01
Azollo caroliniana	mosquito fern	N	0.0	0.2	0.4	
Cabomba caroliniana	fanwort	N	2.2	0.0	0.5	
Ceratophyllum demersum	coontail	N	4.4	4.9	3.5	0.58
Colocasia esculenta	wild taro	E I	0.0	0.9	0.7	
Eichhornia crassipes	waterhyacinth	E I	4.9	2.9	1.2	<0.01
Hydrilla verticillata	hydrilla	E I	0.0	0.7	1.4	<0.01
Hydrocotyle ranunculoides	pennywort	N	6.4	0.5	1.4	
Lemna minor	common duckweed	N	3.1	2.5	1.9	
Limnobium spongia	American frogbit	N	1.5	0.7	0.7	
Ludwigia peploides	waterprimrose	N	4.9	7.4	4.3	
Myriophyllum aquaticum	parrotfeather	E I	0.7	0.0	0.2	
Najas minor	brittle naiad	E I	0.0	0.0	1.9	
Nelumbo lutea	American lotus	N	17.1	17.7	21.2	0.20
Nitella sp.	stonewort	N	0.1	0.0	0.0	
Nymphaea odorata	white waterlily	N	4.4	3.4	4.9	0.44
Potamogeton nodosus	American pondweed	N	2.7	2.7	2.4	0.92
Sagittaria latifolia	arrowhead	N	1.0	1.2	0.0	
Sagittaria platyphylla	arrowhead	N	0.0	1.8	0.8	
Scirpus validus	softstem bulrush	N	1.2	0.2	0.0	
Typha sp.	cattail	N	1.3	2.4	0.7	
Utricularia vulgaris	bladderwort	N	0.0	0.4	0.0	
Zizaniopsis miliacea	giant cutgrass	N I	1.5	3.5	1.9	

[1]Analyses were only conducted on the commonly occuring species, or the species most often growing in association with waterhyacinth, alligatorweed and hydrilla that may be impacted by control techniques.