Aquatic Plant Community Assessment within the Littoral Zone of the Ross Barnett Reservoir, MS in 2011: A Seven Year Evaluation

An Annual Report to the Pearl River Valley Water Supply District

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INTRODUCTION

The Ross Barnett Reservoir, located in central Mississippi, is a 33,000 acre water supply reservoir constructed in the early 1960's. The Ross Barnett Reservoir is the largest surface water impoundment within the state, and is a popular recreation area for boaters, water skiers, anglers, campers, and other users. In addition to recreation, it also provides shoreline commercial and residential land developments, as well as, a vast expanse of wildlife habitat (Cox et al. 2010). The introduction of non-native aquatic plants has threatened biodiversity and natural processes within the Ross Barnett. Nuisance aquatic plant species can cause many negative effects, such as altering ecological relationships among aquatic species, disrupting nutrient cycling, constricting navigation canals, lowering property values, and reducing recreational use of rivers and lakes (Madsen 2004, Pimentel et al. 1999). In 2005, the exotic weed hydrilla (*Hydrilla verticillata* (L.f.) Royle) was observed in the Ross Barnett Reservoir (Wersal et al. 2006a). Hydrilla is a submersed plant species that is listed on the State and Federal Noxious Weed Lists, and due to its growth and reproduction habits hydrilla has been referred to as "the perfect aquatic weed" (Langeland 1996). Waterhyacinth (*Eichhornia crassipes* (Mart.) Solms) and alligatorweed (*Alternanthera philoxeroides* (Mart) Griseb.) are also exotic plant species that are causing problems within the Reservoir. The ability of these plants to spread quickly and negatively impact services and recreational opportunities provided by the Reservoir resulted in the Pearl River Valley Water Supply District creating a long term management plan in order to suppress their spread.

Alligatorweed and waterhyacinth populations have been primarily controlled with systemic herbicides over the past decade (Wersal et al. 2009), but diquat, a contact herbicide, was included in waterhyacinth treatment during 2010. Hydrilla treatments over the last five years have consisted of the systemic herbicide fluridone, as well as, combinations of copper and diquat. Fluridone has led to adequate control in most areas, but fragmentation and water flow has caused populations to spread and new areas are continuing to be found both above and below Mississippi Highway 43. In addition, the advent of fluridone-resistant populations of hydrilla in Florida has reminded natural resource managers to rotate herbicide modes of action and otherwise practice herbicide stewardship. To ensure the success of any long-term management plan, regular assessments and intensive surveying are required to ensure current management strategies are sufficient (Madsen 2007).

OBJECTIVES

Objectives were to 1) monitor the aquatic plant communities within the Ross Barnett Reservoir by mapping the location and 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 occurrence and establishment of new populations; and 3) gauge the efficiency of hydrilla management techniques within the Ross Barnett Reservoir. The results of this assessment are included in this report.

MATERIALS AND METHODS

Vegetation Survey

A point-intercept survey was conducted on a 300 meter grid (Madsen 1999), in June of 2011 in order to assess the distribution of aquatic plant communities within the Ross Barnett Reservoir. Points located in the littoral zone at locations previously sampled from the past six years were surveyed. The sampling of points located within the littoral zone (water depths ≤ 10 feet) allows for a more effective survey to be conducted in areas more prone to aquatic plant growth (Figure 1). Some sampling points were inaccessible by boat due to low water and/or high vegetation density. These points were either not sampled or a new point in close relation to the inaccessible point was created. Annual point-intercept surveys are beneficial by showing differences in aquatic plant communities that can be statistically quantified over time.

A Trimble Yuma™ (Sunnyvale, California) tablet computer, with an internal global positing system (GPS), was used to navigate to each point. A total of 665 points were sampled in 2011. Presence and absence of plant species was collected by deploying and pulling in a weighted plant sampling rake attached to a rope and by visual observations at each survey point. Depth was also recorded at each point by a Lowrance LCX-28C depth finder (Tulsa, Oklahoma). Spatial data were directly recorded into the tablet computer using FarmWorks Site Mate® software version 11.4 (Hamilton, Indiana). The software enables navigation to specific points and displays attribute and geographic data for this survey. Data was recorded in database templates with pick lists created specifically for this project (Cox et al. 2011).

Presence and absence of plant species was averaged over all points sampled and multiplied by 100 in order to obtain percent frequency. Percent frequency was calculated in order to assess control techniques. Mean species richness was also calculated and compared to previous years using a general linear model.

Invasive Species Management

Waterhyacinth and Alligatorweed Assessment: Data collected from the point intercept surveys conducted on the Ross Barnett Reservoir were used to assess the effectiveness of management techniques on these two species. An analysis of changes in the frequency of occurrence for each species between years allows for a quantitative comparison to be made.

Hydrilla Assessment: Data collected from the point intercept surveys was used to assess changes in lakewide frequency of hydrilla. A quantitative comparison was made between the years based off changes in hydrilla occurrence throughout the Reservoir.

In order to assess the current density of hydrilla tubers in the Ross Barnett, a tuber survey was conducted in June of 2011. Four sites were sampled for hydrilla tubers. A PVC coring device was used to collect 15 sediment cores within these four sites (Madsen et al. 2007). The sediment collected was sieved through a pail with a wire mesh bottom to separate sediment from any hydrilla tubers and/or plant matter. Any tubers found were collected and transported to Mississippi State University where they were sorted, dried, and weighed in order to obtain tuber biomass and density.

RESULTS AND DISCUSSION

Littoral Survey

The 2011 Ross Barnett Reservoir littoral survey showed a total of 24 aquatic or riparian plant species (Table 1). Since the surveys began in 2005, a total of 28 species have been documented. American lotus (*Nelumbo lutea* (Willd.)), a native emergent plant species, was the most dominant species at 23.1 % (Table 1). White water-lily (*Nymphaea odorata* Aiton) records were stable from 2010 (5.3 %) to 2011 (4.8 %). Coontail (*Ceratophyllum demersum* L.) sightings were more common in 2011 (5.8 %) than 2010 (3.9 %). The occurrence of all non-native plant species was less than 5 %. Alligatorweed occurrence was 4.6 % in 2011. Hydrilla occurrence (0.9 % in 2011) has remained relatively stable over the past few years. Waterhyacinth populations have been greatly reduced from 2010 to 2011 (Table 1) Waterhyacinth occurrence was 5.2 % in 2010 and dropped to less than 1 % in 2011 (Table 1). Other non-native species observed in the survey include brittle naiad (*Najas minor*) and Cuban bulrush (*Oxycaryum cubense* (Poepp. & Kunth) Lye), which was not observed during the 2010 survey. Non-native plants that have been observed in the past that were not present in the 2011 survey include parrotfeather (*Myriophyllum aquaticum*) and waterlettuce (*Pistia stratiotes*). Species diversity has remained relatively constant (Figure 2).

Invasive Species Management

Waterhyacinth and Alligatorweed Assessment: In 2011, alligatorweed frequency of occurrence was 4.6%, which is quite a bit lower than the 11.9% recorded in 2010 (Table 1, Figure 3). Fluctuations between alligatorweed populations are evident when looking at the data from 2005 to 2011. These fluctuations are most likely due to different water levels between years which can allow increases and/or decreases in hospitable areas for alligatorweed growth. Alligatorweed occurrence more than doubled between 2008 (7.3%) and 2009 (14.9%). These results are likely a cause of the high water levels in 2009 and the addition of 25 new alligatorweed locations that were not surveyed in 2008 (Cox et al. 2011). Waterhyacinth populations have also been greatly reduced from 2010 (5.2%) to 2011 (0.4%) [Table 1, Figure 4]. Waterhyacinth populations show similar trends to alligatorweed which is most likely due to water level fluctuations, herbicide treatments, and differences among points sampled throughout the years. Like alligatorweed, waterhyacinth was recorded more from 2008 to 2009 which is most likely due to high water levels. Both alligatorweed and waterhyacinth populations are capable of spreading through fragmentation. Small populations of either plant species along the Pearl River are likely responsible for establishing new populations through fragmentation. Small populations of waterhyacinth are often hidden among stands of other plants species which tends to make treatment and surveying more difficult.

Cuban bulrush Assessment: Cuban bulrush populations were first observed in 2009 in Pelahatchie Bay. Combinations of 2, 4-D and diquat have been made to control Cuban bulrush populations since 2009. Cuban bulrush is capable of overgrowing waterhyacinth mats; so continued monitoring and aggressive management of this species is suggested.

Hydrilla Assessment: Hydrilla was found in the existing sites 1 and 4, as well as, newly discovered areas in close proximity to existing sites during the littoral survey (Figure 3). During 2010, there were 16 existing hydrilla sites; an additional 6 sites were added during 2011. The

majority of the new sites are showing up below the highway 43 bridge, but several sites have also been found upriver. During a survey within existing hydrilla sites conducted in June of 2011 hydrilla was found in sites 4, 5b, 7, 11, 13, 14, and 15 (Table 2). Sites 1 and 4 have continued to show hydrilla annually, despite consecutive fluridone treatments 2007, 2008, and 2009. In June of 2011, sites 12, 13, and 14 were treated with fluridone (Table 3). Sites 1, 6, 5, 16, 11, and 14 were treated with combinations of copper and diquat. Second round treatments of copper and diquat were applied in August of 2011 to sites 1, 4, 5, 6, 11, 12, 13, 14, 17*, 18*, and 19* (* indicates newly formed site during 2011). During September a third herbicide application of copper and diquat was applied to sites 6, 7, 4, 10*, 12, 13, 17*, 18*, 19*, 20*, 21*. The discovery of several new hydrilla populations both above and below highway 43 shows how efficiently hydrilla is being spread through fragmentation in the Ross Barnett. Hydrilla treatment and careful monitoring is essential to help suppress the spread of hydrilla to other un-infested areas. Public education and outreach programs should be implemented to help Reservoir users correctly identify hydrilla and other invasive species; and the problems associated with these plants.

Following the September treatment, Aquaservices, Inc. had discovered four new hydrilla sites up the Pearl River and in close proximity to sites 11, 14, and 16. We propose that these new sites be included in the current management strategies on the Reservoir. Diquat and copper herbicide combination applications should begin as soon as possible, as well as, monitoring to assess treatment efficacy and prevent further spread of hydrilla in these sites and throughout the reservoir (Table 2).

Tuber Survey: Tuber surveys have been conducted since 2005 and have accounted for very few hydrilla tubers being found. During 2006, site 4 showed the presence of hydrilla tubers, but that is the only record of tubers being found since 2005. The recovery of hydrilla tubers in 2006 explains the repeated occurrence of hydrilla each year within site 4. Although site 4 was also sampled for tubers in 2011, none were found. Hydrilla plants could be showing very little tuber production, and re-growth may be due to the overwintering of plants and re-growing from healthy root crowns. Herbicide treatments of fluridone have been shown to reduce biomass as well as inhibit tuber production (MacDonald et al. 1993). Due to the fact that fluridone has been used annually since 2006 and that very few tubers have been found within the Reservoir, hydrilla transport and fragmentation may be the most critical component regarding the spread of hydrilla populations.

Summary

- The coverage of target plants alligatorweed, waterhyacinth, and hydrilla has remained low in the reservoir, indicating that the ongoing maintenance management has been effective in containing the spread of these three species.
- While hydrilla has been found at new sites, management of hydrilla has been successful in completely controlling hydrilla in a number of sites in which it was previously found.
- Native species diversity remains similar to previous years; native plant coverage still far exceeds that of the target invasive plants

Recommendations

- Continue monitoring of lakewide plant populations and assessing plant management activity.
- Continue current management approaches for alligatorweed and waterhyacinth.
- For 2012, continue to approach hydrilla management using the contact herbicide mixture of diquat and chelated copper, treating each site twice as needed, pending the outcome of water exchange research in 2012.
- Aggressively treat any new invasive species, such as the Cuban bulrush and waterlettuce found in 2010, to prevent the establishment of new species in the reservoir.

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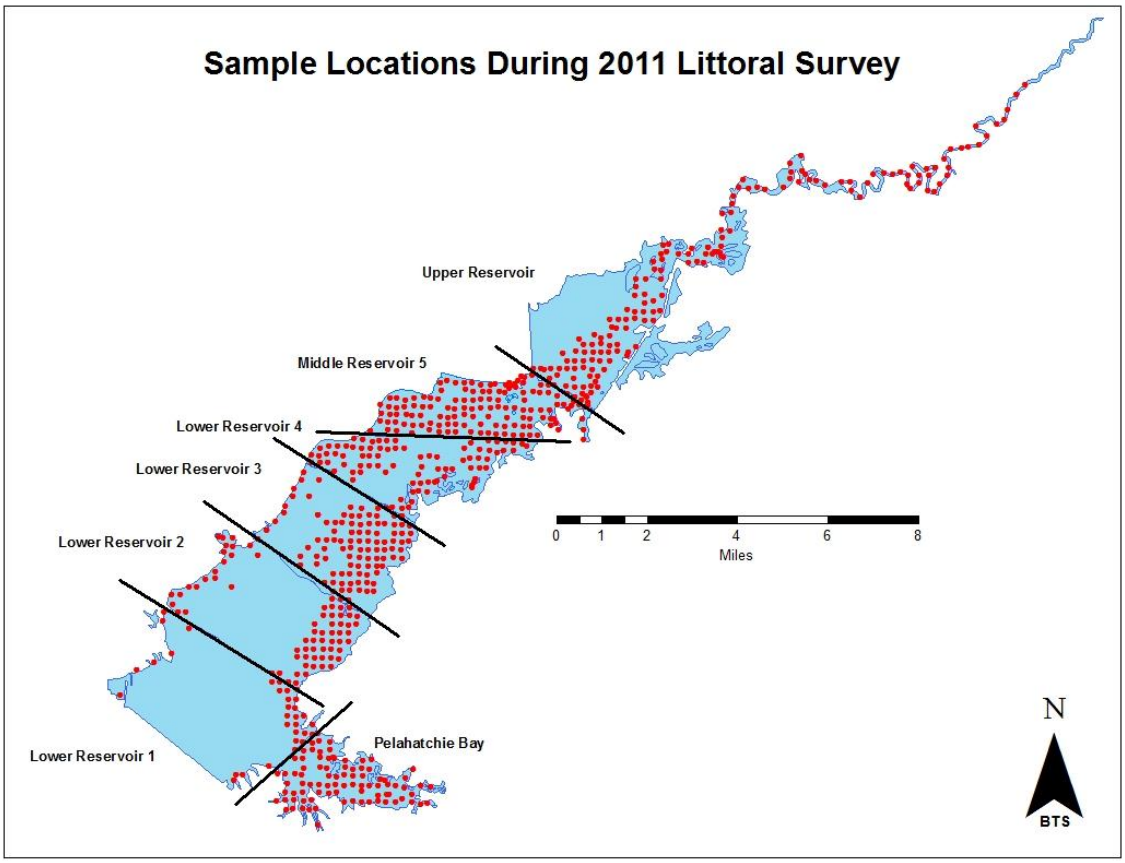

Figure 1. Sampling locations for the 2011littoral zone survey of the Ross Barnett Reservoir

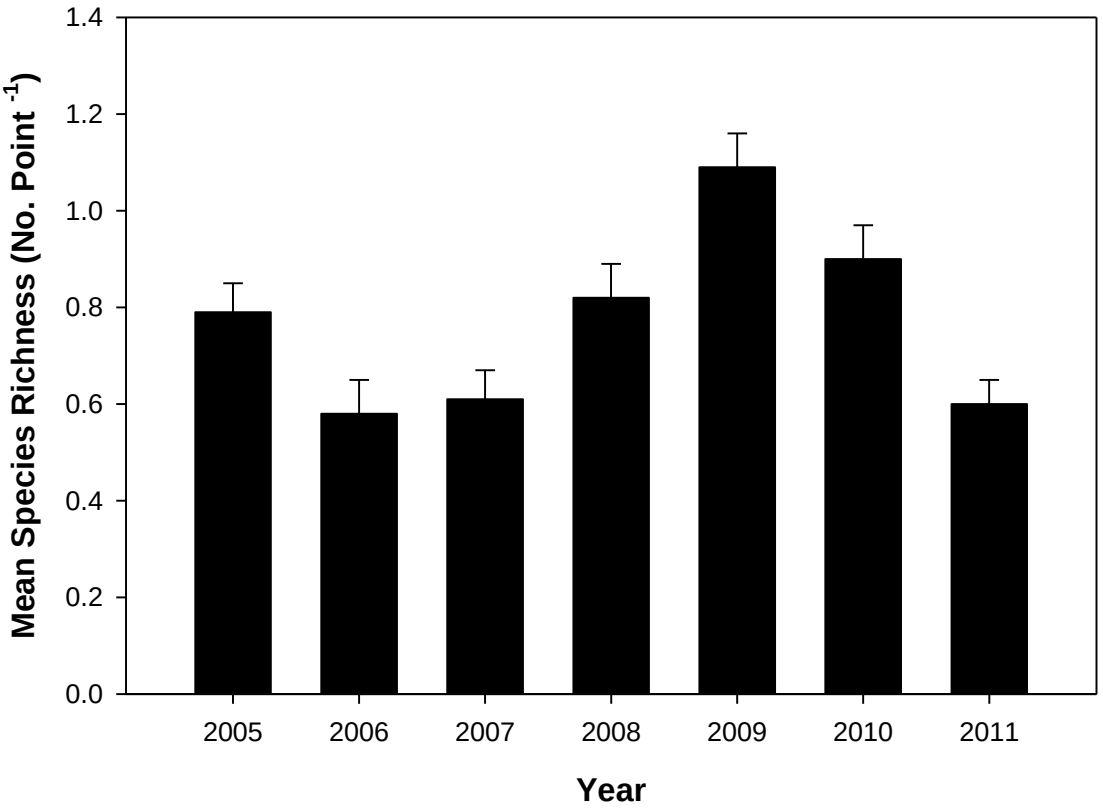

Figure 2. Mean (±1 SE) species richness during surveys conducted between 2005 and 2011.

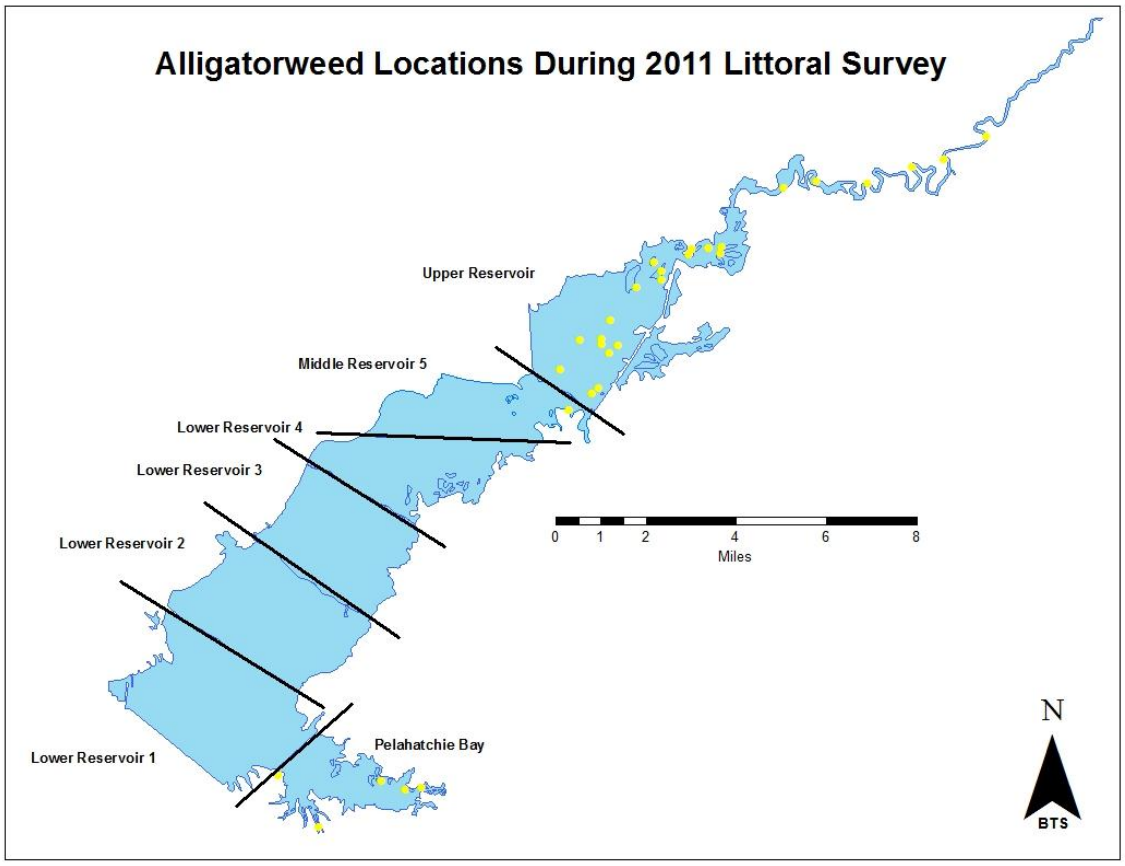

Figure 3. Alligatorweed locations during 2011 littoral zone survey of the Ross Barnett Reservoir

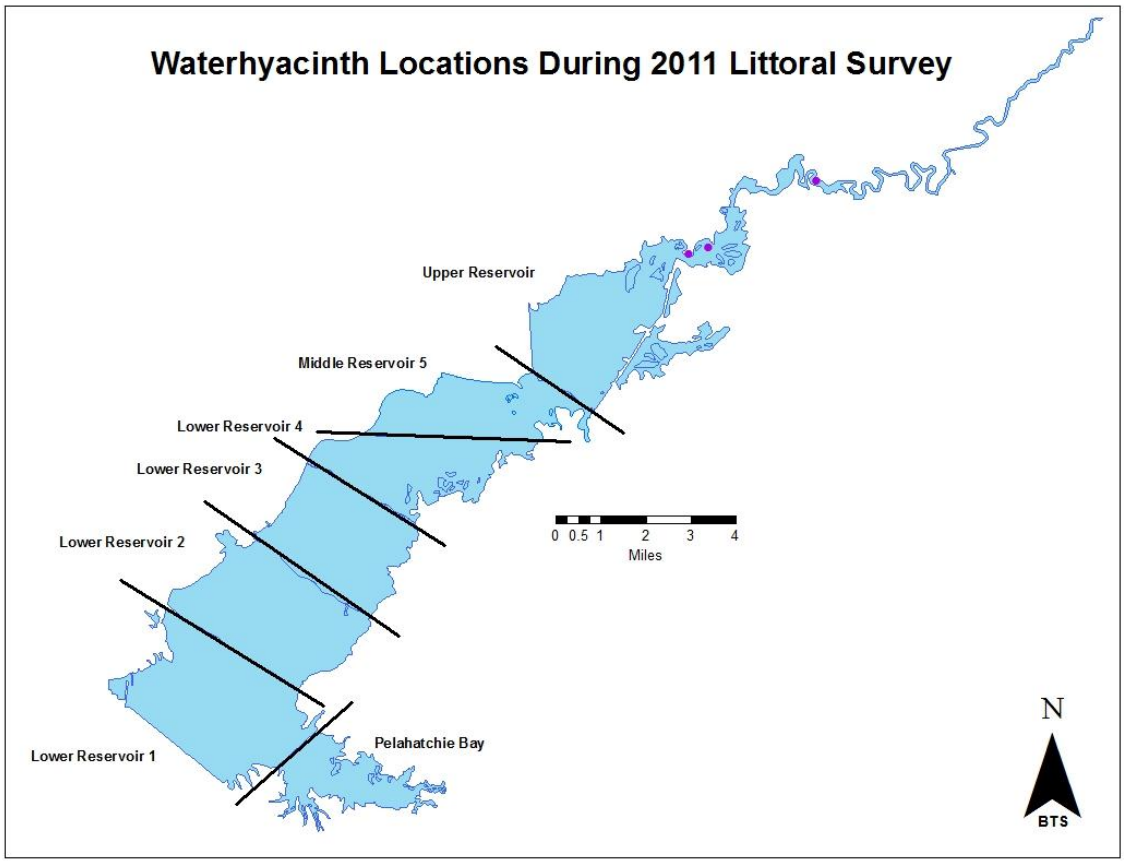

Figure 4. Waterhyacinth locations during the 2011 littoral zone survey of the Ross Barnett Reservoir

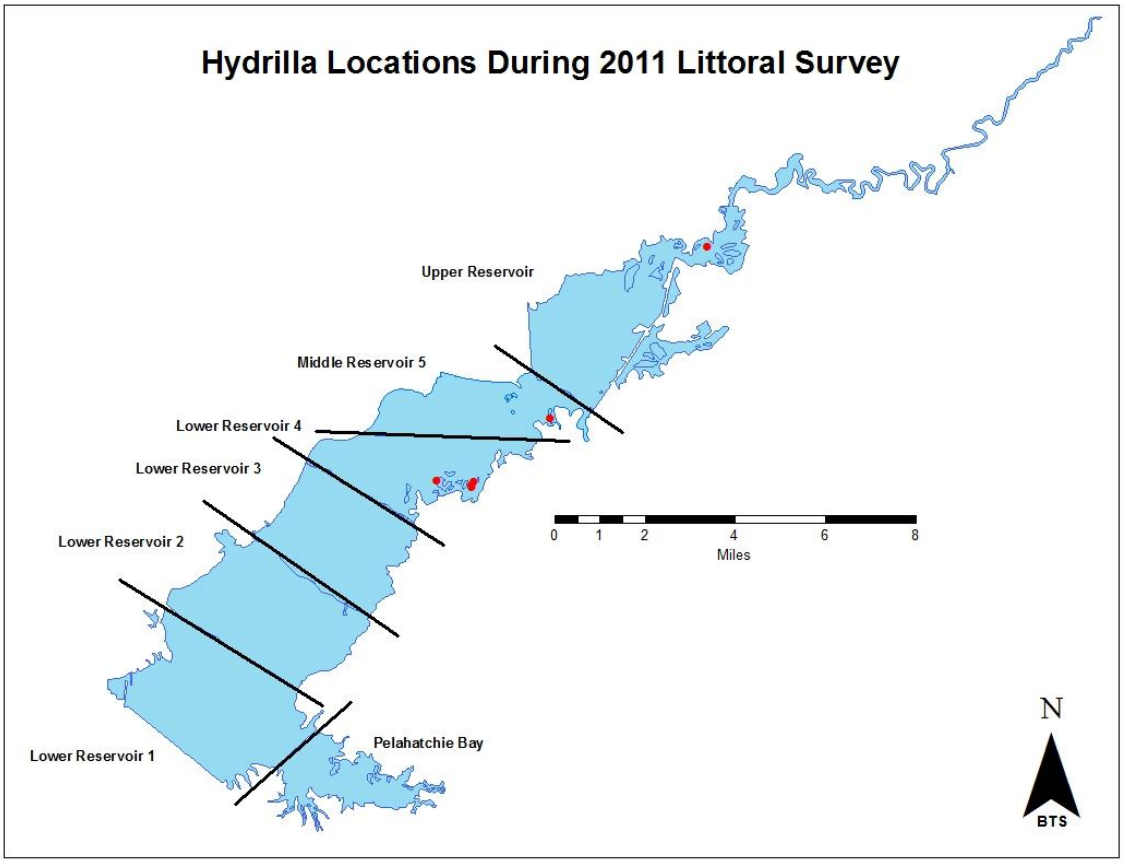

Figure 5. Hydrilla locations during the 2011 littoral zone survey of the Ross Barnett Reservoir

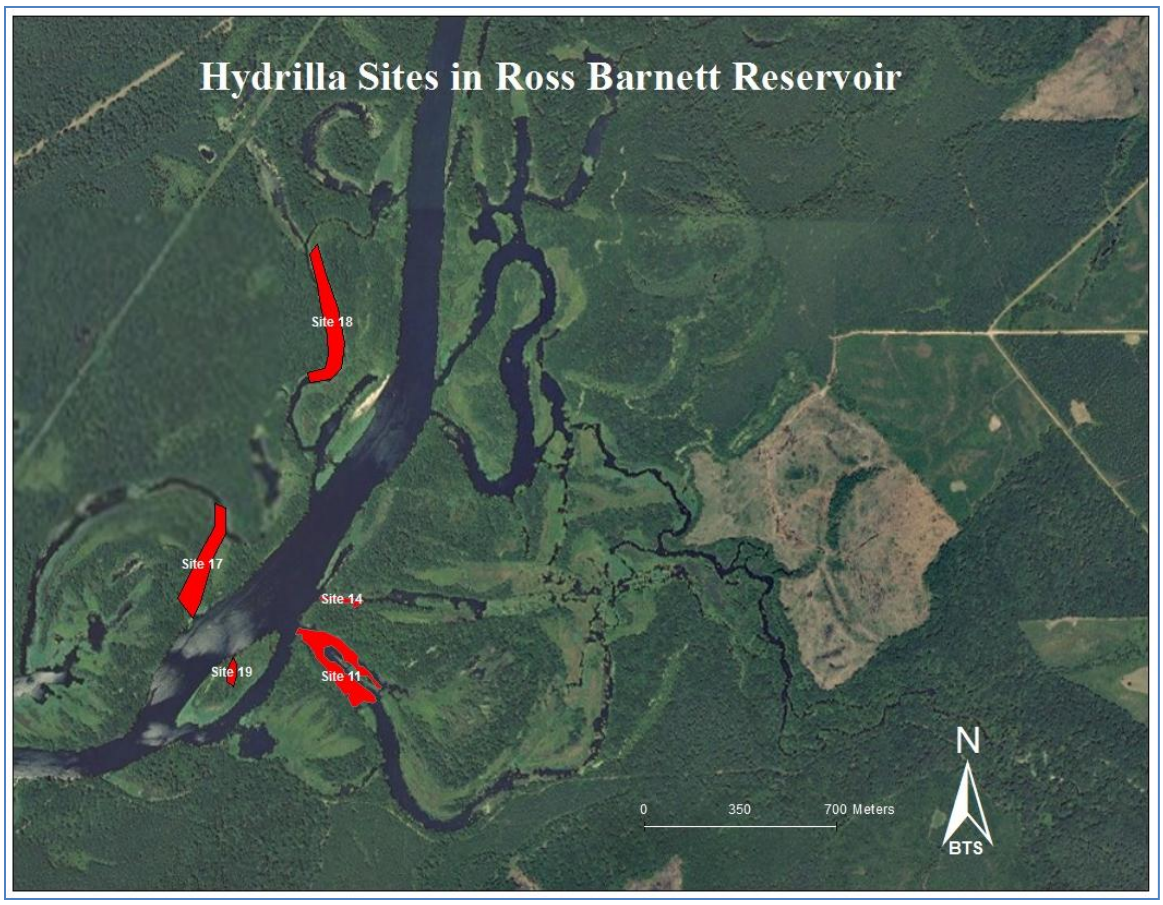

Figure 6. Hydrilla sites above Mississippi Highway 43 in 2011

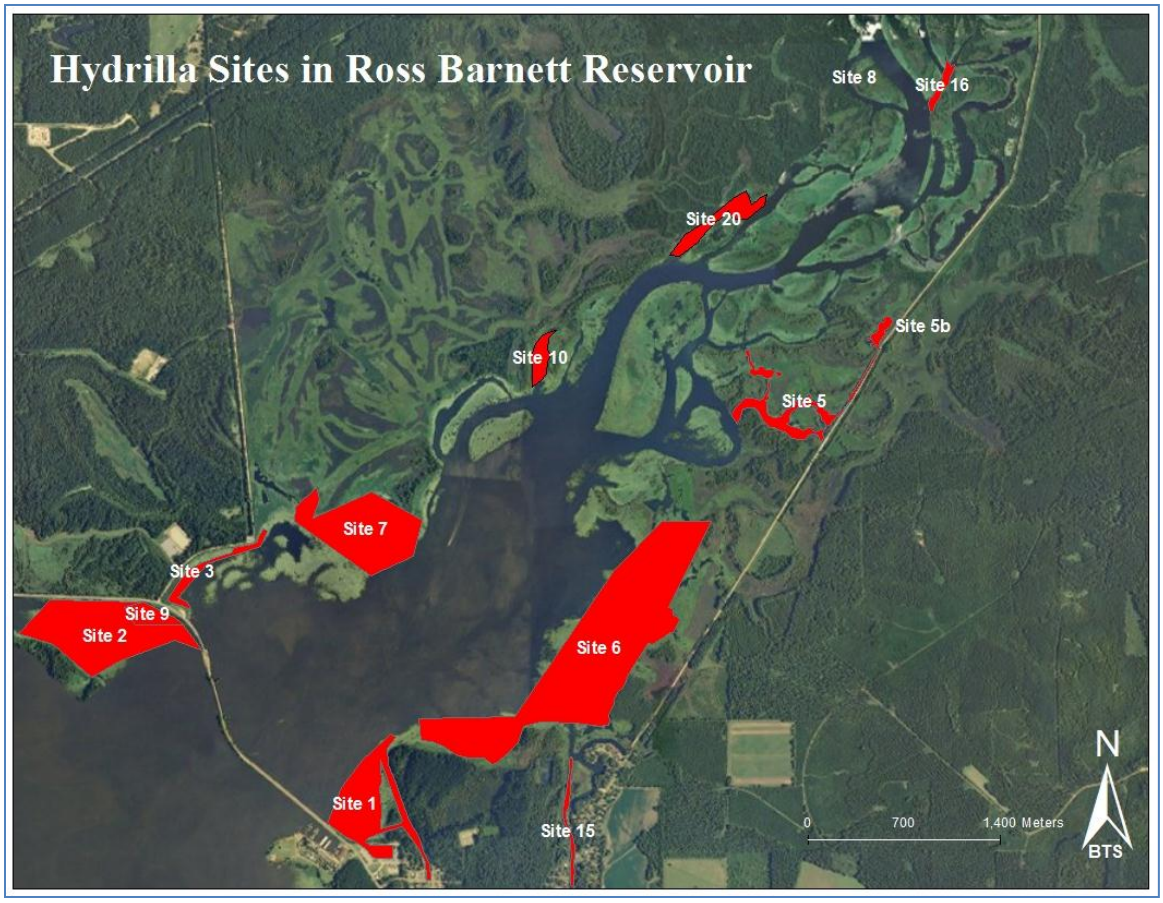

Figure 7. Hydrilla sites above and below Mississippi Highway 43 in 2011

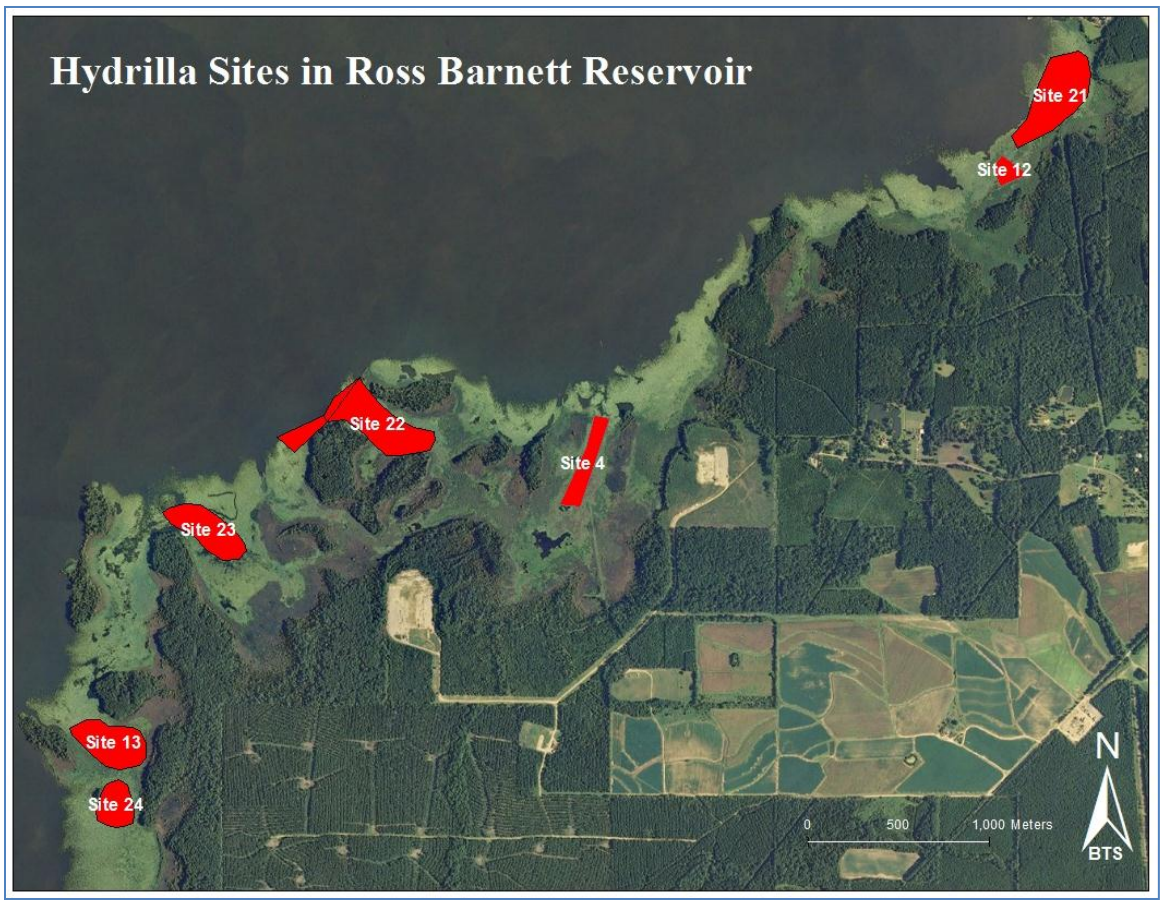

Figure 8. Hydrilla sites below Mississippi Highway in 2011

Figure 9. Hydrilla growing in site 4, July 2011.

Table 1. Percent frequency of occurrence for aquatic plant species observed in the littoral zone during the Ross Barnett Reservoir Surveys 2005-2011. The letter "n" refers to the total number of points sampled in a given year. An "a" indicates a statistically significant change in frequency of occurrence from the previous year for the indicated plant species, excluding 2011

Species Name	Common Name	Native (N) or Exotic (E), or Invasive (I)	2005 % Frequency (n=677)	2006 % Frequency (n=508)	2007 % Frequency (n=423)	2008 % Frequency (n=627)	2009 % Frequency (n=695)	2010 % Frequency (n=620)	2011 % Frequency (n=665)
Alternanthera philoxeroides	alligatorweed	EI	21.1	3.9	4.0	7.3	14.9a	11.9	4.6
Azolla caroliniana	mosquito fern	N	0.0	0.2	0.4	0.0	0.5	0.0	0.2
Cabomba caroliniana	fanwort	N	2.2	0.0	0.5	1.3a	0.6	0.0	0.5
Ceratophyllum demersum	coontail	N	4.4	4.9	3.5	7.6a	3.6a	3.9	5.8
Colocasia esculenta	wild taro	EI	0.0	0.9	0.7	2.4a	2.4	2.1	0.7
Eichhornia crassipes	water hyacinth	EI	4.9	2.9	1.2	4.0a	8.6a	5.2a	0.4
Hydrilla verticillata	hydrilla	EI	0.0	0.6a	1.2a	0.6a	0.8	0.9	0.9
Hydrocotyle ranunculoides	pennywort	N	6.4	0.5	1.4	2.8a	1.3a	0.3	0.1
Juncus effusus	common rush	N	0.0	0.0	0.0	0.2	1.7	1.6	0.1
Lemna minor	common duckweed	N	3.1	2.5	1.9	1.4a	1.3	1.5	3.1
Limnobium spongia	American frogbit	N	1.5	0.8	0.7	1.3	0.3	0.3	0.4
Ludwigia peploides	waterprimrose	N	4.9	7.4	4.3	10.2a	14.8a	11.9	5.5
Myriophyllum aquaticum	parrotfeather	EI	0.7	0.0	0.2	1.0a	0.4	0.2	0
Najas minor	brittle naiad	EI	0.0	0.0	1.9a	1.0a	0.3	0.2	0.9
Nelumbo lutea	American Lotus	N	17.1	17.7	21.2	24.8a	26.9	26.8	23.1
Nitella sp.	stonewort	N	0.1	0.0	0.0	0.0	0.0	0.0	0.3
Nymphaea odorata	white waterlily	N	4.4	3.4	4.9	5.4	5.9	5.3	4.8
Oxycaryum cubense	Cuban bulrush	EI	-	-	-	-	-	0.0	0.3
Pistia stratiotes	water lettuce	EI	-	-	-	-	-	0.0	0.0
Potamageton foliosus	leafy pondweed	N	0.0	0.0	0.0	0.6	0.0	0.3	0.0
Potamageton nodosus	American pondweed	N	2.7	2.7	2.4	3.0	2.9	1.1	1.2
Sagittaria latifolia	broadleaf arrowhead	N	1.0	1.2	0.0a	0.5	1.3	1.0	1.2
Sagittaria platyphylla	deltaleaf arrowhead	N	0.0	1.8	0.8	0.3a	2.3a	1.1	0.1
Scirpus validus	softstem bulrush	N	1.2	0.2	0.0	0.0	0.0	0.0	0
Spirodella polyrhiza	giant duckweed	N	0.0	0.0	0.0	0.16	0.7	0.5	0.6
Typha sp.	cattail	N	1.3	2.4a	0.7	1.1	7.1a	5.5	2.4

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Utricularia vulgaris	bladderwort	**N**	**0.0**	**0.4**	**0.0**	**0.5**	**0.1**	**0.0**	**1.2**
Zizaniopsis miliacea	giant cutgrass	**NI**	**1.5**	**3.5**	**1.9a**	**4.1**	**10.4a**	**8.5**	**0.9**
Note: An "a" indicates a statistically significant change in frequency of occurrence from the previous year for the indicated plant species, excluding 2011									

Table 2: Hydrilla treatments in Ross Barnett Reservoir from 2005 to 2011.

		Treatment Records						
Hydrilla Site	**Year Discovered**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
1	2005	1	1-F (April)	1-F	1	1-FC	C (Jun, Aug, & Oct)	1-C (Jun, August)
2	2005	1	1-F (April)	F				
3	2006		1-F (April)	F				
4	2006		1-F (April)	1-F	1	F		1-C (Aug, Sept)
5	2006		1-F (April)	F	?	1-FC	1-C (Jun, Aug, & Oct)	1-FC (Jun, Aug)
5b[1]	2009					1		
6	2007			1-F	?	1	1-C (Jun, Aug, &Oct)	C (Jun, Aug, Sept)
7	2007			1	?	F		C (Sept)
8	2007			1	?			
9	2007			1	?			
10	2007			1	?			1-C (Sept)
11	2007			1-F	1-F	1-F	C (Jun, Aug, & Oct)	1-C (Jun, Aug)
12	2009					1	F (June)	FC (Jun, Aug, Sept)
13	2009					1	F (June)	1-FC (Jun, Aug, Sept)
14	2010						1-C (Aug & Oct)	1-C (Jun, Aug)
15	2010						1-C (August)	1-F (Jun)
16	2010						1	C (Jun)
17	2011							1-C (Aug, Sept)
18	2011							1-C (Aug, Sept)
19	2011							1-C (Aug, Sept)
20	2011							1-C (Sept)
21	2011							1-C (Sept)

"1" indicates observation of hydrilla

"F" indicates fluridone treatment

"C" indicates copper & diquat treatment

"?" indicates that treatment status is unknown

[1] Site 5b was discovered in 2009 and recently merged with Site 5

Table 3. Dates of hydrilla treatment, total acreage treated, and amount of product used.

Treatment/Date	Total Acres Treated	Product Used
Treatment #1 June 7th and 8th	119	Reward-210.2 gallons Komeen-315.3 gallons Sonar Q-240 lbs Sonar PR-330 lbs
Treatment #2 August 10th	90	Reward-180 gallons Komeen-270 gallons
Treatment #3 September 28th and 29th	159.6	Reward-319.7 gallons Komeen-478.8 gallons