Aquatic Plant Community and Invasive Plant Management Assessment of the Ross Barnett Reservoir, MS in 2012

A Report to the Pearl River Valley Water Supply District

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EXECUTIVE SUMMARY

Summary

- The coverage of target plants alligatorweed, water hyacinth, 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.
- The introduction of new invasive plants is an ongoing concern.

Recommendations

- Continue monitoring of lake-wide plant populations and assessing plant management activity.
- Continue current management approaches for alligatorweed and waterhyacinth.
- For 2013, continue to approach hydrilla management using the contact herbicide mixture of diquat and chelated copper, treating each site twice as needed and implement fluridone treatments in sites were water exchange is minimal. In addition, we suggest a demonstration project to evaluate using chelated copper alone at some sites to reduce off-target effects on American lotus.
- Aggressively treat any new invasive species, such as the Cuban bulrush, water lettuce, torpedo grass, and giant salvinia, in order to prevent the establishment of new species in the reservoir.
- Install signage at popular boat ramps regarding the spread of aquatic invasive plants to educate users on the importance of checking and cleaning plants from motors, trailers, and hulls both before launching and after retrieving boats.

INTRODUCTION

The Ross Barnett Reservoir, located in central Mississippi, is a 33,000 acre water supply reservoir that was 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, disruption of nutrient cycling, constricting navigation canals, lowering property values, and declined recreational use of rivers and lakes (Madsen 2004, Pimentel et al. 2000). In 2005, the exotic weed hydrilla (*Hydrilla verticillata* (L.f.) Royle) was observed in the Ross Barnett Reservoir (Wersal et al. 2006). 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 (*Alteranthera 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 evoked the Pearl River Valley Water Supply District to create a long term management plan in order to suppress their spread by monitoring and evaluating control techniques. During 2012, glyphosate was used at 3 quarts (qt) per acre in combination with 1 qt non-ionic surfactant for alligatorweed and water hyacinth control. Hydrilla treatments from 2006-2011 have consisted of the systemic herbicide fluridone, as well as, combinations of copper and diquat. Although fluridone has led to adequate control in most areas, diquat and copper combinations were used exclusively in 2012. Other non-native aquatics plants that have been sighted and have caused concerns are water lettuce (*Pistia stratiotes*), giant salvinia (*Salvinia molesta*) and torpedo grass (*Panicum repens*.) An assessment for each is included in this report. 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 $\leq$ 10 feet);
2) Monitor and assess the current hydrilla populations; as well as document the occurrence and establishment of other invasive plant populations; and
3) Gauge the efficiency of hydrilla management techniques within the Ross Barnett Reservoir, as well as the effectiveness of management of other species. 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 2012 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 2012 (Figure 1). 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 lake wide frequency of hydrilla. A 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 March and May of 2012. Four sites were sampled for hydrilla tubers. A PVC coring device was used to collect 20 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 2012 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 common species at 21.4 % (Table 1). White water-lily (*Nymphaea odorata* Aiton) records were stable from 2011 (4.8 %) to 2012 (5.7 %). Coontail (*Ceratophyllum demersum* L.) sightings were more common in 2011 (5.8 %) than 2012 (4.2 %). Water primrose (Ludwigia peploides) occurrence also increased from 2011 (5.6%) to 2012 (8.3%). The increase of both white water lily and water primrose in 2012 is most likely related to the decrease in American lotus.

The occurrence of all non-native plant species was less than 4 %. Alligator weed populations have been reduced from 11.6% in 2010 to 4.6% in 2011 and an even further reduction to 3.6% in 2012 (Figure 7). Hydrilla occurrence has dropped from 2011 (0.9 %) to 2012 (0.5%). Water hyacinth populations have been greatly reduced from 2010 to 2011. But, waterhyacinth occurrence increased from 2011 (0.4%) to 2012 (2.1%). Water hyacinth does not tolerate cold temperatures very well, and the increase in occurrence from 2011 to 2012 is most likely due to the mild winter experienced throughout Mississippi (Owens and Madsen 1995). Other non-native species observed in the survey include brittle naiad (*Najas minor*) (1.1%), Cuban bulrush (*Oxycaryum cubense* (Poepp. & Kunth)Lye) (0.6%) and water lettuce (*Pistia striates*) (0.3 %), which was not observed during the 2010 and 2011 surveys. The non-native plant parrotfeather (*Myriophyllum aquaticum*) was the only species not observed during the 2012 littoral survey that has been previously recorded. Species diversity has remained relatively constant (Figure 2).

Invasive Species Management

Water-hyacinth and Alligatorweed Assessment: Since 2010, alligatorweed occurrence has been on a steady decline throughout the Ross Barnett Reservoir (Table 1, Figure 7). Fluctuations in occurrence are evident when looking at the previous sampling years (2005-2012); these fluctuations are most likely due the different water levels over the years, which can affect alligatorweed growth. Alligatorweed occurrence more than doubled between 2008 (7.3%) and 2009 (14.9%) (Sartain et al. 2012). 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). Water hyacinth populations have been reduced dramatically since 2009. This year was the first time water hyacinth has shown growth in percent occurrence since 2009. The small growth is most likely due to the mild winter experienced in Mississippi during 2011-2012 where temperatures dropped below freezing 27 days between November and February as opposed to 49 days in 2010-2011 (NOAA 2012). Moderate winters typically result in higher overwintering survival and increased water hyacinth populations the following growing season (Owens and Madsen 1995). Both alligatorweed (Figure 3) and water hyacinth (Figure 4) populations are capable of spreading through fragmentation and small floating mats are most likely responsible for establishing new populations.

Cuban bulrush, water lettuce, and torpedo grass assessment: Cuban bulrush and water lettuce populations were first observed in 2009 in Pelahatchie Bay. Water lettuce had not been seen

since 2009 until this year. Until this year both species had been controlled using combinations of 2, 4-D and diquat, but during 2012 glyphosate was utilized. Cuban bulrush has spread to various parts of the Ross Barnett since its introduction in 2009 (Figure 5). Water lettuce populations have been restricted to Pelahatchie Bay and have not been recorded in any other portion of the Reservoir (Figure 10). Torpedo grass has been recently seen in various portions of the Ross Barnett (Figure 11). Although none was reported during the 2012 Littoral Survey, several plants were seen during other trips in 2012. Populations of torpedo grass have been reported in Pelahatchie Bay and above highway 43. All torpedo grass populations were treated with glyphosate during 2012.

Giant Salvinia : Giant salvinia is native to South America and considered extremely invasive. It has currently been established in over 20 countries and is considered one of the world's worst weeds (Nelson 2009). It has the ability to form large dense mats that can lead to a multitude of problems. On October 20, 2012, it was reported that giant salvinia had been discovered near the marina at Tommy's Trading post. Upon further investigation it was confirmed by Mississippi State University botanist, Dr. Victor Maddox that the plants seen were in fact giant salvinia (*Salvinia molesta* Mitchell). On October 25, 2012 Aqua Services employees and Dennis Reicke from the MSDWFP removed the giant salvinia from the boat ramp area and extensively surveyed the surrounding areas. Aqua Services employees also treated the shoreline with a diquat application.

Hydrilla Assessment*:* Hydrilla was only found in existing hydrilla sites 6 and 11 during the 2012 littoral survey (Figure 6). During 2011, there were 24 existing hydrilla sites, and an additional 4 were created during 2012 (Table 2, Figure 8, 9). The new sites were found both above and below the highway 43 bridge, as well as, Pelahatchie Bay. During a survey within hydrilla sites in September, hydrilla was found in sites: 4, 6, 7, 10, 11, 15, 17, 20, 22, 25, 26*, 27*, and 28* (* newly discovered site). Three hydrilla treatments were performed during 2012, the first round treatments began in June, the second in September, and a third round was performed in October. Fortunately, the newly discovered sites were able to be surveyed and treated during the October treatment. The hydrilla sites treated are shown in Table 2. The discovery of several new hydrilla populations above/below highway 43 and in Pelahatchie Bay shows how efficiently hydrilla is being spread through the Ross Barnett. Until 2012 hydrilla had only been discovered about as south as mile marker 7, but has since made its way to Pelahatchie Bay. The discovery of the newly formed hydrilla site in Pelahatchie Bay is most likely the result of hydrilla fragments being transported by water craft. Public education and outreach programs should be implemented to help Reservoir users correctly identify invasive species and know the potential impacts that the spread of these species can cause.

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 (Sartain et al. 2012). 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 (Sartain et al. 2012). During 2012, hydrilla sites 4, 5, 11, and 12 were sampled for hydrilla tubers during March and May. During March, site 4 was the only site where tubers were found, but during May, sites 11 and 5 showed the presence of hydrilla tubers. Based off the core sampling, sites 4 and 5 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 (Sartain et al. 2012). In addition both sites have been treated with fluoridone in the past and herbicide treatments of fluridone have been shown to reduce biomass as well as inhibit tuber production (MacDonald et al. 1993). In site 11, 13 tubers were found; this could explain the repeated annual growth of hydrilla in site 11. Although, site 11 has been treated with fluridone in the past, Rhodamine WT dye studies conducted in 2011 indicate that water exchange characteristics within the site may have impacted the effectiveness of the treatments. Due to the small number of tubers collected over the years of sampling, transport and fragmentation are the most likely candidates for the spread of hydrilla.

Hydrilla Treatments: The contractor (AquaServices) treated hydrilla at the sites indicated in table 2 on three separate time periods: early summer (June 6-7), late summer (August 15-16), and mid-autumn (October 16-19). All treatments in 2012 were done using contact herbicides; namely, a tank-mix of diquat (Reward) and chelated copper (Komeen). For the first treatment, 142 acres were treated. The second treatment involved 187 acres. The final treatment, in October, targeted 378 acres of new infestations and regrowth.

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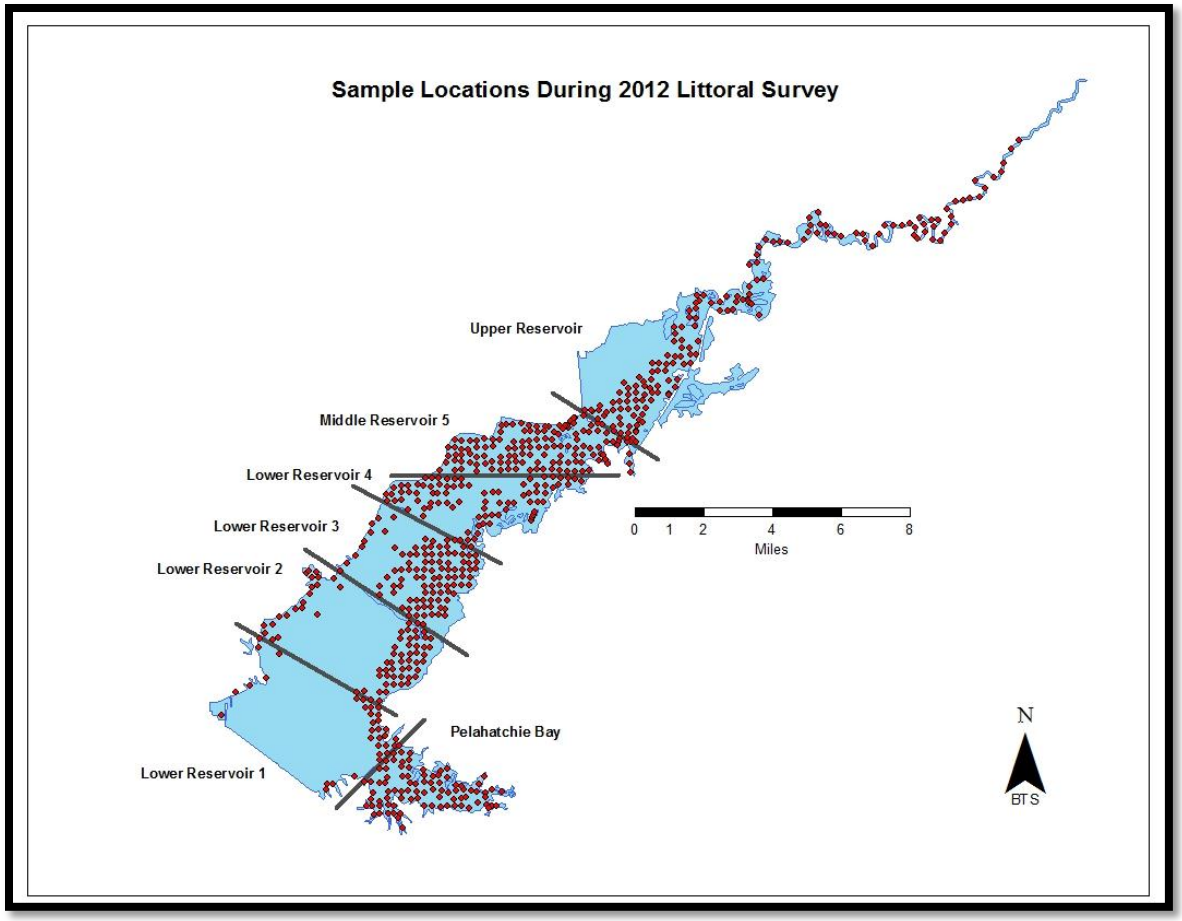

Figure 1. Points surveyed during the 2012 Ross Barnett Littoral Survey (n = 665).

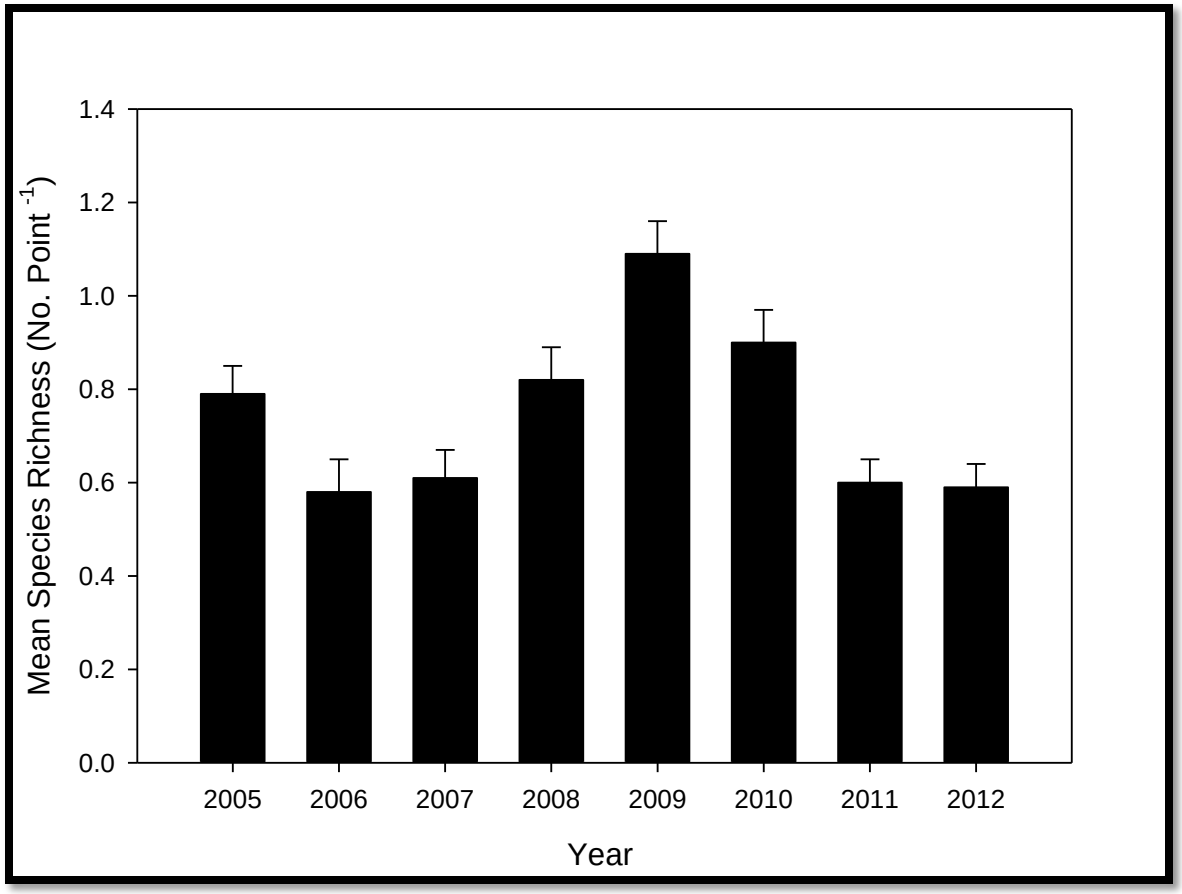

Figure 2. Mean species richness of plant occurrence from 2005-2012 during the Ross Barnett littoral survey.

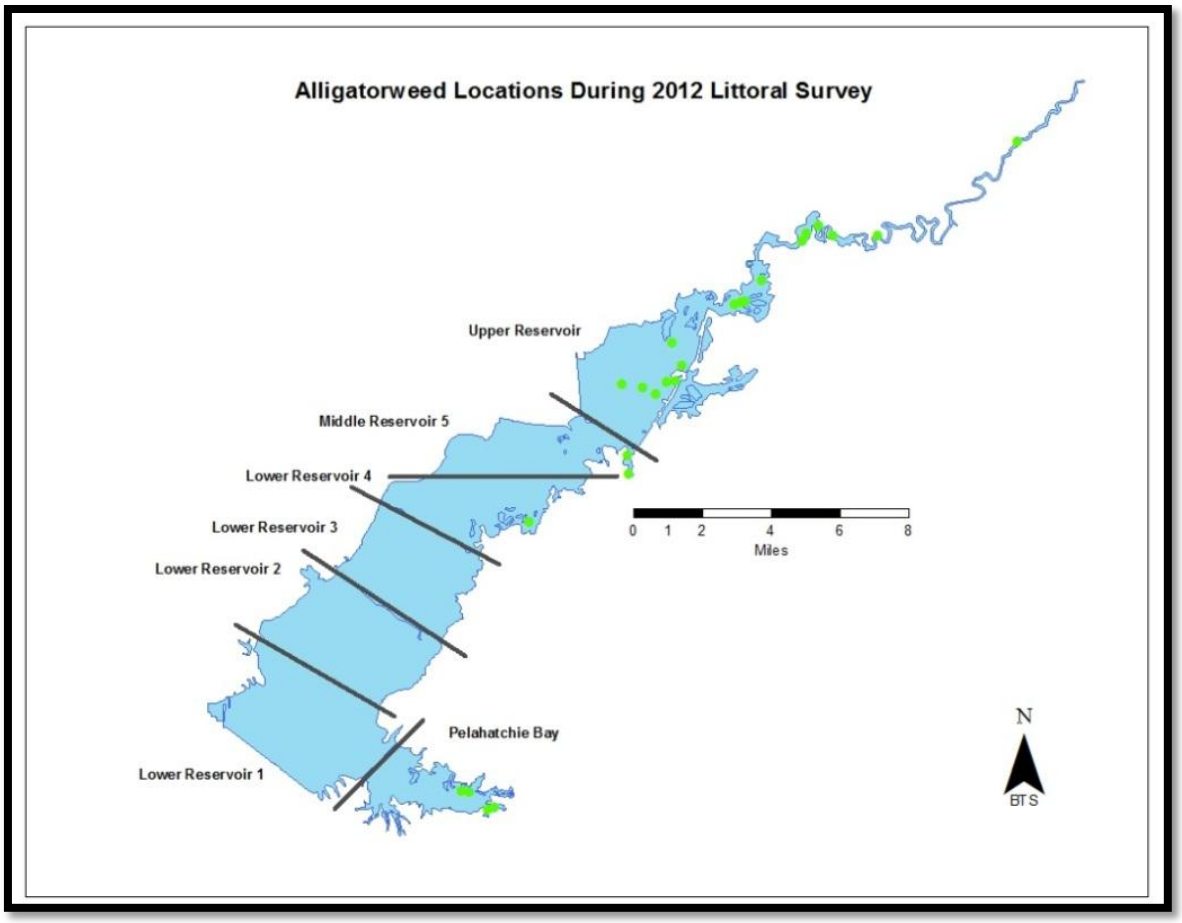

Figure 3. Alligatorweed locations during the 2012 Ross Barnett littoral survey.

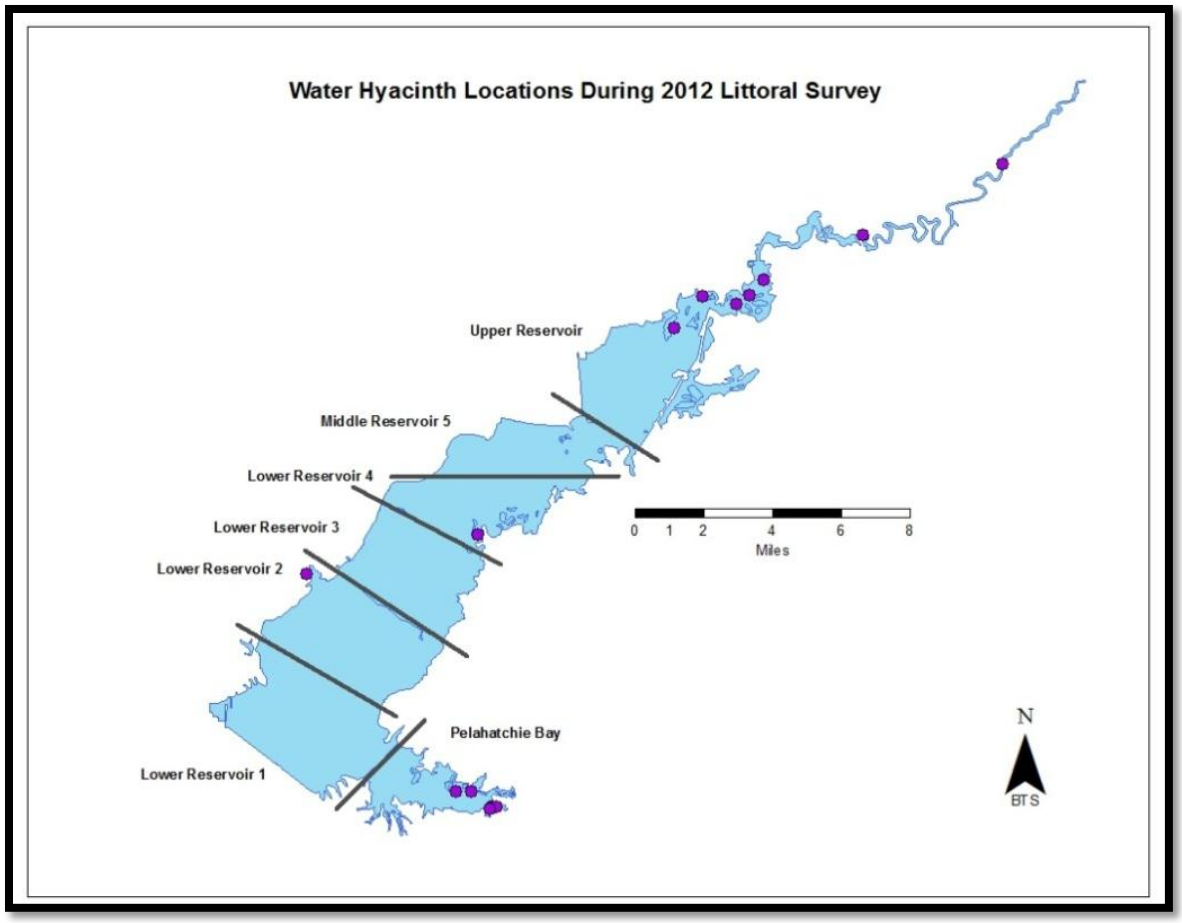

Figure 4. Water hyacinth locations during the 2012 Ross Barnett littoral survey.

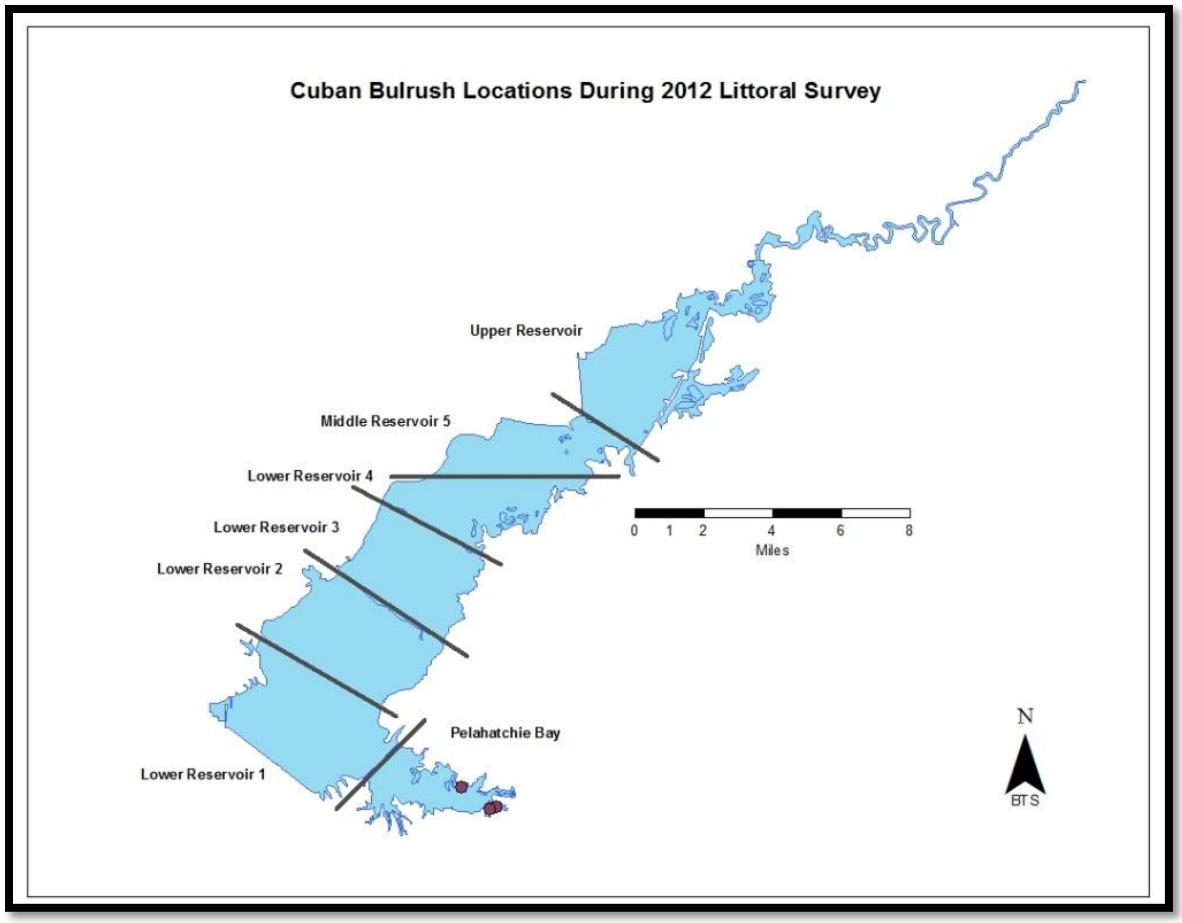

Figure 5. Cuban bulrush locations during the 2012 Ross Barnett littoral survey.

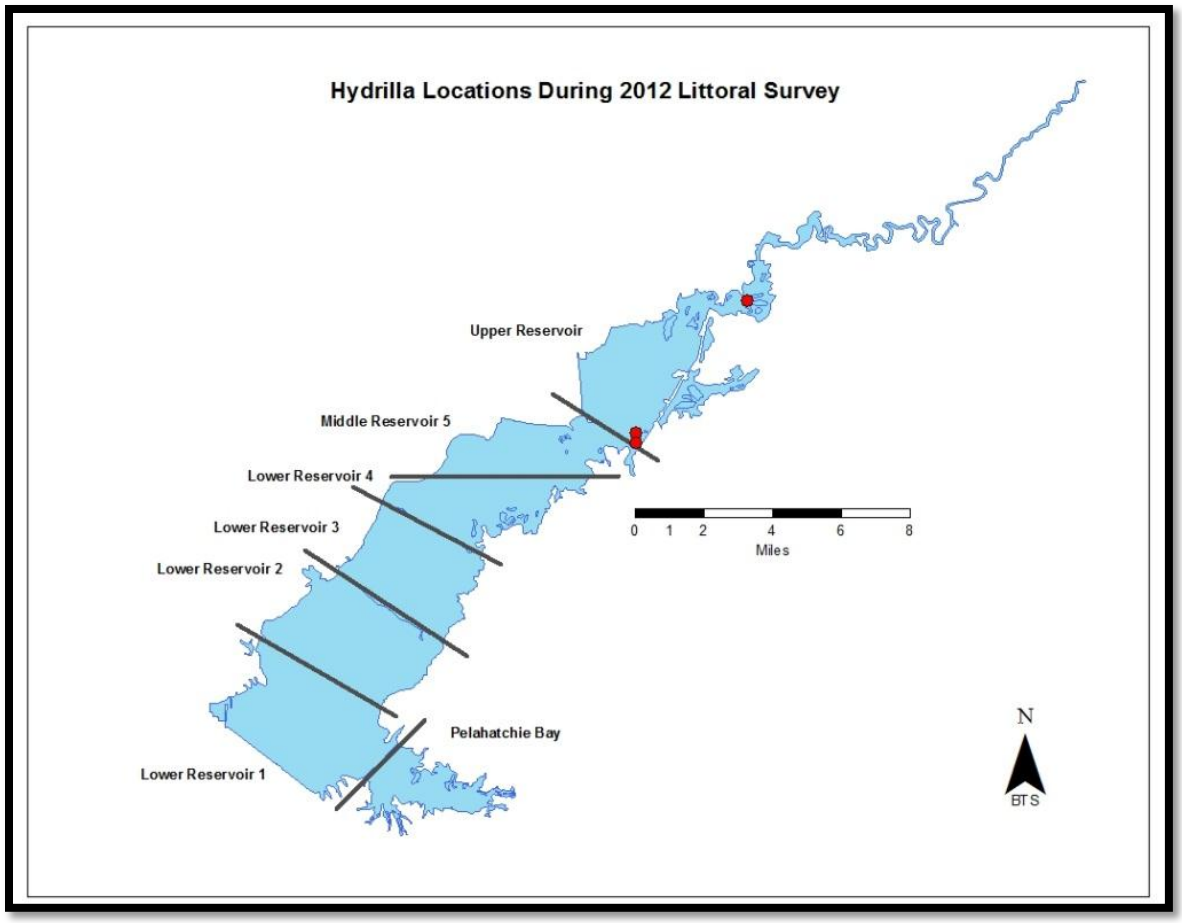

Figure 6. Hydrilla locations during the 2012 Ross Barnett littoral survey.

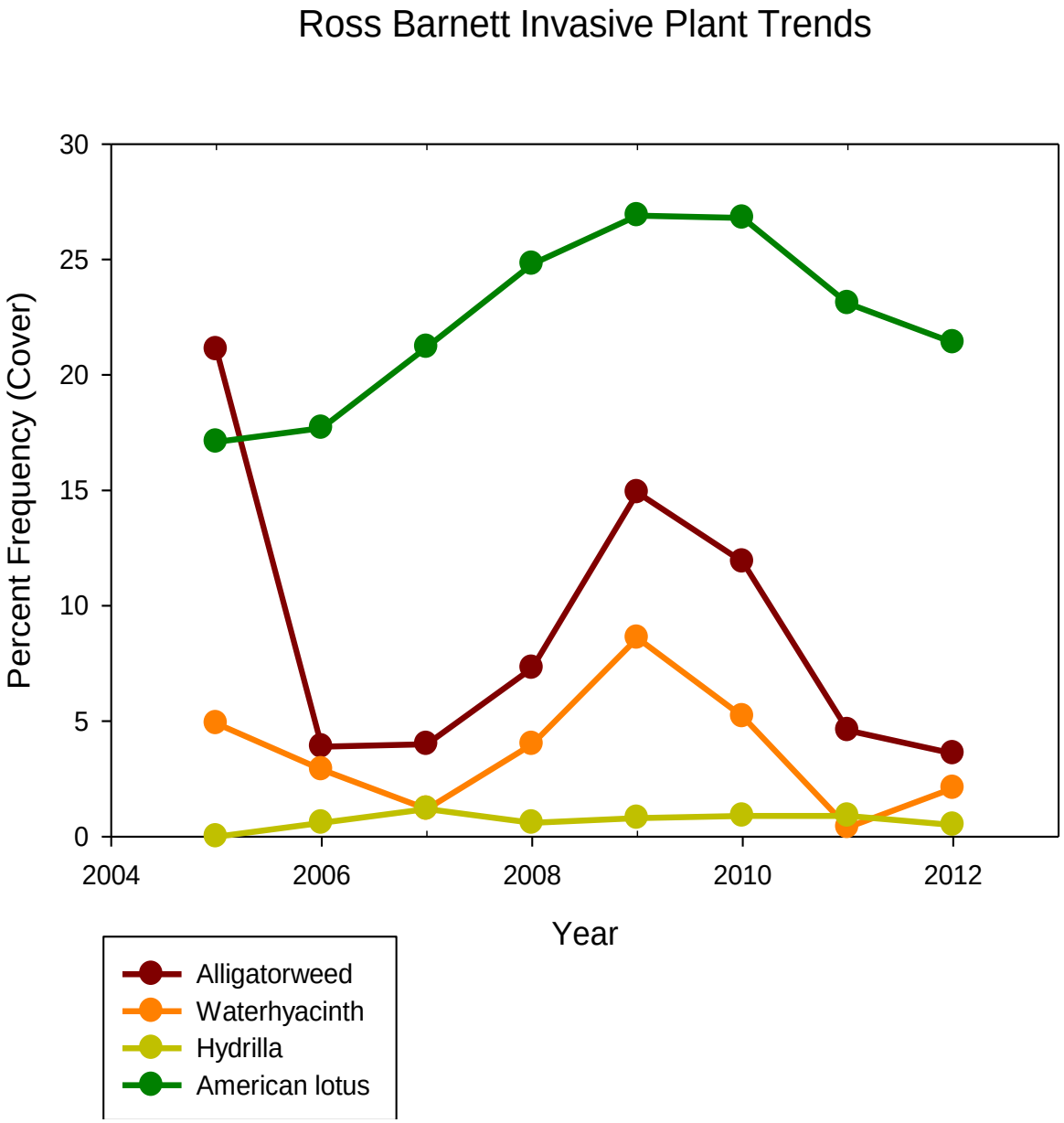

Figure 7. Percent frequency of American lotus and three invasive plant species from annual point intercept surveys, 2005 through 2012.

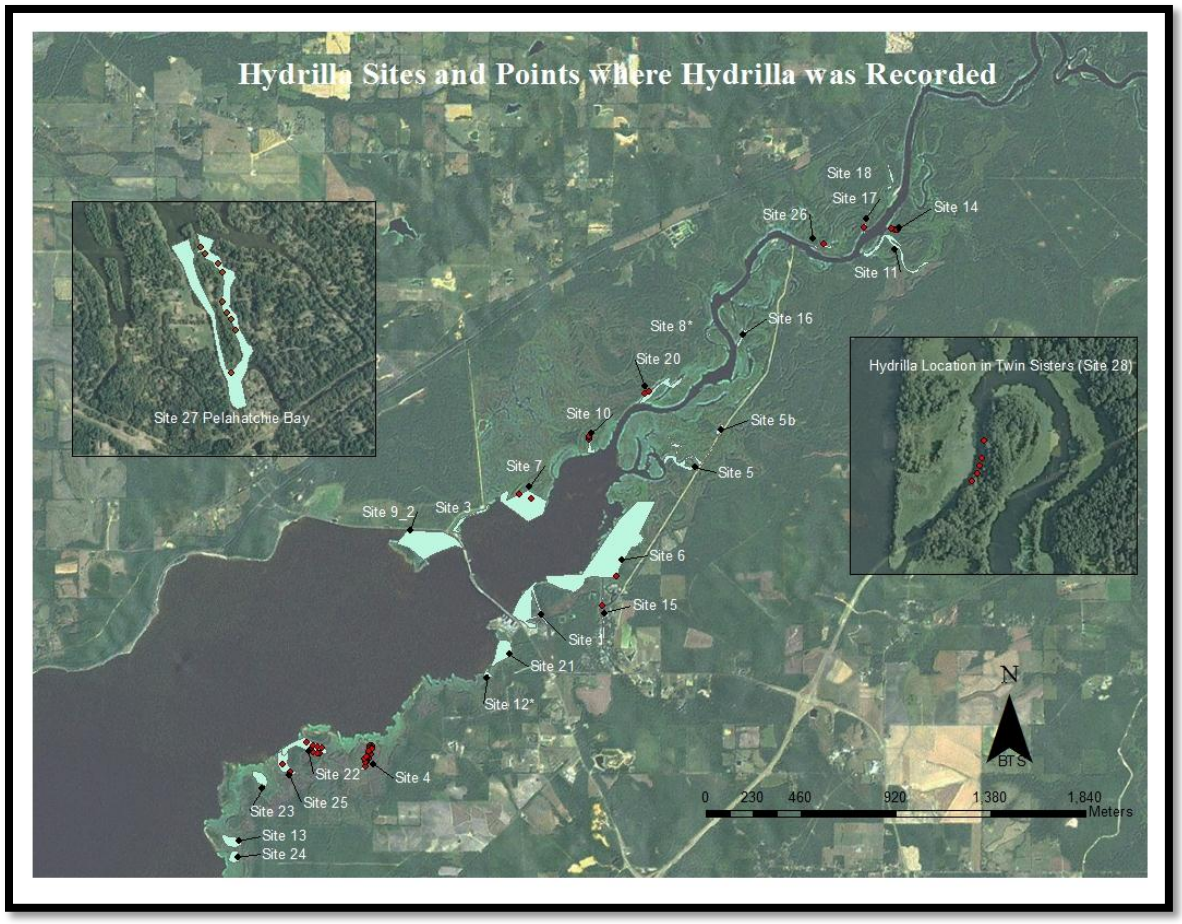

Figure 8. All documented locations where hydrilla has been found since 2005, red dots indicate the observation of hydrilla during a September 2012 survey within each site.

Figure 9. Hydrilla growing in site 14 during September 2012.

Figure 10. Water lettuce recorded during the 2012 littoral survey in Pelahatchie Bay.

Figure 11. Torpedo grass growing along pipeline road in hydrilla site 5 during September 2012.

Table 1. Percent frequency of occurrence for aquatic plant species observed in the littoral zone during the Ross Barnett Reservoir Surveys 2006-2011. 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 & 2012

Species Name	Common Name	Native (N) or Exotic (E), or Invasive (I)	2006 % Frequency (n=508)	2007 % Frequency (n=423)	2008 % Frequency (n=627)	2009 % Frequency (n=695)	2010 % Frequency (n=620)	2011 % Frequency (n=665)	2012 % Frequency (n=665)
Alternanthera philoxeroides	alligatorweed	EI	3.9	4.0	7.3	14.9a	11.9	4.6	3.6
Azolla caroliniana	mosquito fern	N	0.2	0.4	0.0	0.5	0.0	0.2	0.0
Brasenia schreberi	water shield	N	-	-	-	-	-	-	0.1
Cabomba caroliniana	fanwort	N	0.0	0.5	1.3a	0.6	0.0	0.5	1.7
Ceratophyllum demersum	coontail	N	4.9	3.5	7.6a	3.6a	3.9	5.8	4.2
Colocasia esculenta	wild taro	EI	0.9	0.7	2.4a	2.4	2.1	0.7	0.5
Eichhornia crassipes	water hyacinth	EI	2.9	1.2	4.0a	8.6a	5.2a	0.4	2.1
Hydrilla verticillata	hydrilla	EI	0.6a	1.2a	0.6a	0.8	0.9	0.9	0.5
Hydrocotyle ranunculoides	pennywort	N	0.5	1.4	2.8a	1.3a	0.3	0.1	0.9
Juncus effusus	common rush	N	0.0	0.0	0.2	1.7	1.6	0.1	0.0
Lemna minor	common duckweed	N	2.5	1.9	1.4a	1.3	1.5	3.1	0.8
Limnobium spongia	American frogbit	N	0.8	0.7	1.3	0.3	0.3	0.4	0.3
Ludwigia peploides	waterprimrose	N	7.4	4.3	10.2a	14.8a	11.9	5.5	8.3
Myriophyllum aquaticum	parrotfeather	EI	0.0	0.2	1.0a	0.4	0.2	0	0.0
Najas minor	brittle naiad	EI	0.0	1.9a	1.0a	0.3	0.2	0.9	1.1
Nelumbo lutea	American Lotus	N	17.7	21.2	24.8a	26.9	26.8	23.1	21.4
Nitella sp.	stonewort	N	0.0	0.0	0.0	0.0	0.0	0.3	0.8
Nymphaea odorata	white waterlily	N	3.4	4.9	5.4	5.9	5.3	4.8	5.7

Table 1 (cont.). Percent frequency of occurrence for aquatic plant species observed in the littoral zone during the Ross Barnett Reservoir Surveys 2006-2011. 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 & 2012

Species Name	Common Name	Native (N) or Exotic (E), or Invasive (I)	2006 % Frequency (n=508)	2007 % Frequency (n=423)	2008 % Frequency (n=627)	2009 % Frequency (n=695)	2010 % Frequency (n=620)	2011 % Frequency (n=665)	2012 % Frequency (n=665)
Oxycaryum cubense	Cuban bulrush	EI	-	-	-	-	0.0	0.3	0.6
Pistia stratiotes	water lettuce	EI	-	-	-	-	0.0	0.0	0.2
Potamogeton foliosus	leafy pondweed	N	0.0	0.0	0.6	0.0	0.3	0.0	0.0
Potamogeton nodosus	American pondweed	N	2.7	2.4	3.0	2.9	1.1	1.2	2.0
Sagittaria latifolia	broadleaf arrowhead	N	1.2	0.0a	0.5	1.3	1.0	1.2	0.5
Sagittaria platyphylla	deltaleaf arrowhead	N	1.8	0.8	0.3a	2.3a	1.1	0.1	0.9
Scirpus validus	softstem bulrush	N	0.2	0.0	0.0	0.0	0.0	0	0.3
Spirodella polyrhiza	giant duckweed	N	0.0	0.0	0.16	0.7	0.5	0.6	0.0
Typha sp.	cattail	N	2.4a	0.7	1.1	7.1a	5.5	2.4	1.5
Utricularia vulgaris	bladderwort	N	0.4	0.0	0.5	0.1	0.0	1.2	0.6
Zizaniopsis miliacea	giant cutgrass	NI	3.5	1.9a	4.1	10.4a	8.5	0.9	2.0

Note: An "a" indicates a statistically significant change in frequency of occurrence from the previous year for the indicated plant species, excluding 2011 and 2012

Table 2. Hydrilla sites with hydrilla present (1) each year since 2005, treatment record by month and product (F, fluridone; C, contact), and treatment recommendations per site (if hydrilla is found in spring 2013) for each site.

Hydrilla Site	Year Discovered	2005	2006	2007	2008	2009	2010	2011	2012	2013 Treatment Recommendation
		1	1-F (April)	1-F	1	1-FC	C (Jun, Aug, & Oct)	1-C (Jun, August)	1-C (Jun, Aug)	Contact
1	2005									
2	2005	1	1-F (April)	F						Systemic
3	2006		1-F (April)	F						Systemic
			1-F (April)	1-F	1	F		1-C (Aug, Sept)	1-C (Jun, Aug, Oct)	Systemic
4	2006									
			1-F (April)	F	?	1-FC	1-C (Jun, Aug, & Oct)	1-FC (Jun, Aug)	1-C (Jun, Aug, Oct)	Systemic
5	2006									
				1-F	?	1	1-C (Jun, Aug, &Oct)	C (Jun, Aug, Sept)	1-C(Oct)	Contact
6	2007									
				1	?	F		C (Sept)	1-C (June, Aug, Oct)	Systemic
7	2007									
8	2007			1	?					Systemic
9	2007			1	?					Systemic
10	2007			1	?			1-C (Sept)	1-C (Oct)	Systemic
				1-F	1-F	1-F	C (Jun, Aug, & Oct)	1-C (Jun, Aug)	1-C (Jun, Aug, Oct)	Contact
11	2007									
						1	F (June)	FC (Jun, Aug, Sept)	1-C (Jun, Aug)	Systemic
12	2009									
13	2009					1	F (June)	1-FC (Jun,	1-C (Jun,	Systemic

ROSS BARNETT RESERVOIR AQUATIC PLANT SURVEY 2012

Hydrilla Site	Year Discovered	2005	2006	2007	2008	2009	2010	2011	2012	2013 Treatment Recommendation
								Aug, Sept)	Aug)	
							1-C (Aug	1-C (Jun,	1-C (Jun,	Contact
14	2010						& Oct)	Aug)	Aug, Oct)	
							1-C	1-F (Jun)	1-C (Jun,	Contact
15	2010						(August)		Aug, Oct)	
16	2010						1	C (Jun)		Contact
								1-C (Aug,	1-C (Aug,	Contact
17	2011							Sept)	Oct)	
								1-C (Aug,	1-C (Jun,	Contact
18	2011							Sept)	Aug)	
								1-C (Aug,	1-C (Jun,	Contact
19	2011							Sept)	Aug)	
								1-C (Sept)	1-C (Jun,	Contact
20	2011								Aug, Oct)	
21	2011							1-C (Sept)		Contact
									1-C (Jun,	Systemic
22	2011								Aug, Oct)	
									1-C (Jun,	Systemic
23	2011								Aug)	
									1-C (Jun,	Systemic
24	2011								Aug)	
									1-C (Jun,	Systemic
25*	2012								Aug, Oct)	
26*	2012								1-C (Oct)	Systemic
27*	2012								1-C (Oct)	Contact
28*	2012								1-C (Oct)	Contact

Table 3. Dates of hydrilla treatment, total acreage treated, and total amount of formulated product used for hydrilla treatments in the Ross Barnett Reservoir in 2012.

Treatment/Date	Total Acres Treated	Product Used
Treatment #1 June 6 and 7	142	Reward-285 gallons Komeen-427 gallons
Treatment #2 August 15th and 16th	187	Reward-386gallons Komeen-580 gallons
Treatment #3 October 16th 17th 18th and 19th	378	Reward-756 gallons Komeen-1134 gallons