Georgia Journal of Science

Volume 69 *No. 2 Scholarly Contributions from the Membership and Others* Article 7

2011

Effects of Hydrilla Control on Wintering Waterfowl at Lake Seminole, Georgia

Gregory D. Balkcom
Georgia Department of Natural Resources, greg.balkcom@dnr.state.ga.us

Donald M. Morgan

EFFECTS OF HYDRILLA CONTROL ON WINTERING WATERFOWL AT LAKE SEMINOLE, GEORGIA

Gregory D. Balkcom
Georgia Department of Natural Resources
Wildlife Resources Division
1014 Martin Luther King Jr. Dr.
Fort Valley, GA 31030

Donald M. Morgan
U. S. Army Corps of Engineers
Lake Seminole Project
P.O. Box 96
Chattahoochee, FL 32324

Address all correspondence to:
Gregory D. Balkcom
Ga. Dept. of Natural Resources
1014 Martin Luther King Blvd.
Fort Valley, GA 31030
Phone 478-825-6354
Fax 478-825-6421
greg.balkcom@dnr.state.ga.us

ABSTRACT

Hydrilla (*Hydrilla verticillata*) is an exotic, submergent plant that clogs waterways in the southeastern United States yet appears to be beneficial to migratory waterfowl. We studied the effects of hydrilla control on wintering waterfowl populations at Lake Seminole, GA. We applied fluridone (Sonar®) in a low-dose injection system starting May 2000 in the Spring Creek arm of the reservoir. We used aerial photography and ground-truthing methods to quantify coverage of vegetation types and open water pre- and post-treatment for the entire reservoir. We flew weekly aerial surveys to document waterfowl numbers and distribution across the reservoir between 1 November and 15 March during 1998-1999 and 2001-2002 for pre- and post-treatment estimates. Application of Sonar® in the Spring Creek arm reduced hydrilla coverage in the reservoir from approximately 35% to 24%. Average number of ducks per flight before treatment ($\bar{x}$= 2864, SE = 304) did not differ from after treatment counts ($\bar{x}$= 2774, SE = 273) for the reservoir. However, the distribution of ducks changed, with use decreasing 12% in Spring Creek arm. Distribution of ducks before and after treatment revealed that ducks selected hydrilla greater than its availability. Our results indicate that biologists in the Southeast can reduce coverage of hydrilla using Sonar® applied in a low-dose injection system; however, waterfowl distribution may change following treatment.

Key Words: chi square, fluridone, herbicide, hydrilla, Lake Seminole, Georgia, waterfowl

INTRODUCTION

Southern reservoirs can provide important habitat for migrating and wintering waterfowl (1), especially when local food supplies are sufficient. Submerged aquatic vegetation is one important type of food for wintering waterfowl in the southern United States (2, 3, 4, 5). Hydrilla (*Hydrilla verticillata*) is an exotic, submergent species that appears to be beneficial to waterfowl (1, 2, 3, 6). Hydrilla was the most important food plant by volume and by frequency of occurrence in a central Florida study (2) and was the most preferred plant cover type selected by waterfowl in Fisheating Bay, Lake Okeechobee, Florida (3). Hydrilla also provides benefits to invertebrates, forage fish, and juvenile largemouth bass (*Micropterus salmoides*) (7).

While hydrilla is utilized by waterfowl, it has many characteristics that make it a problem for aquatic resource managers. Hydrilla spreads rapidly, forms large dense mats that displace desirable native species, and impedes water use activities (8, 9). Hydrilla is considered a pest and deemed the most problematic aquatic species in South Carolina (9, 10). Additionally, hydrilla has been implicated in the spread of an emerging avian disease known as avian vacuolar myelinopathy that affects herbivorous waterbirds and their predators (11, 12, 13).

Because of the problems associated with hydrilla, the U. S. Army Corps of Engineers (USACE) at Lake Seminole developed a "Hydrilla Action Plan" in 1998 to control the spread of hydrilla in the reservoir. This plan included five techniques for reducing the hydrilla coverage in the reservoir: 1) herbicide spot-spraying, 2) herbicide low-dose injection, 3) confined grass carp stocking, 4) mechanical harvesting, and 5) biological control with insects (14). The goal of the hydrilla control plan was to reduce the coverage of hydrilla to less than 40% in each arm of the reservoir (15). One of the more controversial techniques was the low-dose injection system that was proposed for the Spring Creek arm of the reservoir. Because of known use of hydrilla by waterfowl, hunters were the most vocal opponents of the proposal due to possible reductions in duck use of the reservoir during winter. Hydrilla control on Lake Wales, Florida, led to reduced ring-necked duck (*Aythya collaris*) and canvasback (*Aythya valisineria*) use of the lake (6). After much discussion, the USACE approved the low-dose injection herbicide application. The four objectives of our study were to 1) quantify changes in hydrilla coverage across the reservoir, 2) quantify waterfowl numbers on the reservoir, 3) document waterfowl distribution across the reservoir by vegetation type, and 4) document waterfowl distribution across the reservoir by watershed. All comparisons were made for the entire reservoir before and after implementation of the herbicide low-dose injection system.

MATERIALS AND METHODS

Study Site - Lake Seminole is a 15,176 ha reservoir located in extreme southwestern Georgia and northern Florida that was impounded in 1957. The reservoir is managed by the USACE primarily for navigation and hydropower, but other uses include public recreation, regulation of streamflow, water quality, and fish and wildlife conservation (14). The reservoir is composed of 4 major watersheds: the Chattahoochee River, Fish Pond Drain, Spring Creek, and the Flint River (Fig. 1). Lake Seminole is relatively shallow and clear, and aquatic vegetation is widespread. Since its discovery in Lake Seminole in 1967, hydrilla has spread widely, and has covered as much as 64% of the reservoir (USACE, unpublished data). Because of its large size and the ample food supply, Lake Seminole holds the largest inland concentration of wintering waterfowl in Georgia (G. Balkcom, GA DNR, unpublished data). The reservoir is especially important for wintering ring-necked ducks, canvasbacks, and lesser scaup (*Aythya affinis*). Other waterfowl species commonly observed on the reservoir include American wigeon (*Anas americana*), gadwall (*Anas strepera*), bufflehead (*Bucephala albeola*), Canada goose (*Branta canadensis*), ruddy duck (*Oxyura jamaicensis*), wood duck (*Aix sponsa*), and blue-winged teal (*Anas discors*).

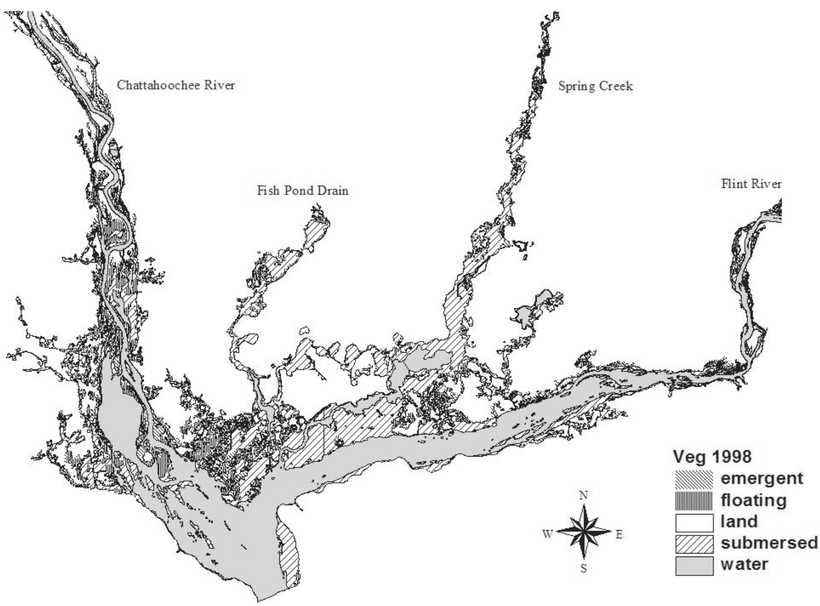

Figure 1. Pre-treatment vegetation coverage and four major watersheds of Lake Seminole, Georgia, 1998.

Hydrilla Control – The herbicide low-dose injection system consisted of a single injection site directly above the Georgia Highway 253 bridge over Spring Creek (Fig. 2) that would release a small amount of fluridone (Sonar®) over a long period of time. The targeted fluridone concentration downstream of the injection site was 15 parts per billion (ppb). The drip system was operated for 189 days in 2000 with an average downstream concentration of 15.7 ppb. In 2001, the system was operated for 221 days, but higher streamflows reduced the average downstream concentration to 6 ppb.

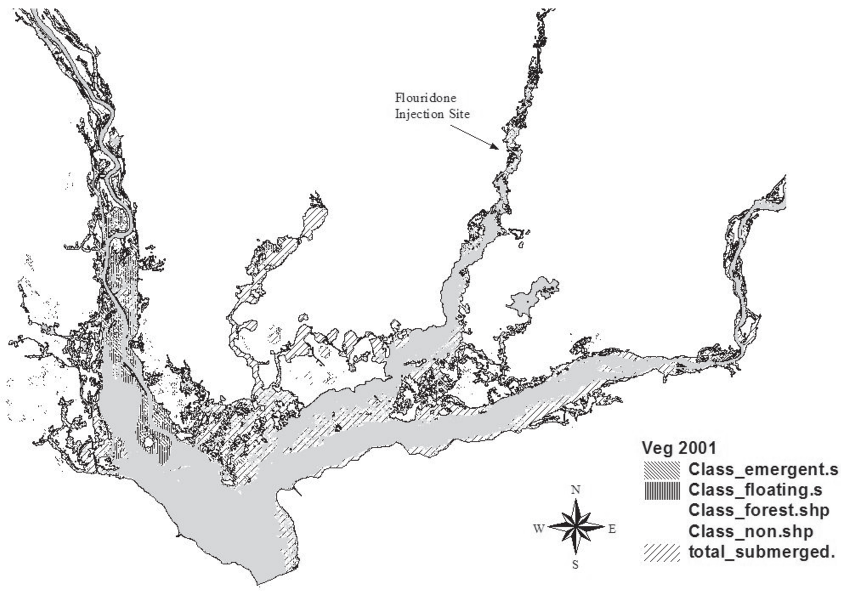

Figure 2. Post-treatment vegetation coverage and location of the low-dose herbicide injection system at Lake Seminole, Georgia, 2001.

Data Collection - Pre-treatment waterfowl data were collected between November 1998 and March 1999. Because of unexpected funding limitations, the herbicide drip system was not installed in Spring Creek until May 2000. We considered growing seasons 2000 and 2001 to be the treatment period, and post-treatment waterfowl data were collected between November 2001 and March 2002.

We estimated acreage of vegetation types on the reservoir using aerial photographs taken during October 1998 and again in October 2001 for pre- and post-treatment comparison. Aerial photographs were digitized into ArcView® (ESRI, Redlands, CA, USA) software for analysis. Vegetation types were defined as open water, floating or floating-leaf plants, emergent, and submergent. Ground-truthing methods for determining species composition and biomass are detailed in Stewart *et al*. (15). Though the post-treatment vegetation ground-truthing in Spring Creek did not occur until 2002, we believe the vegetation composition was comparable to what we observed during the waterfowl data collection flights over the fall and winter of 2001-2002.

Predominant species in each category were as follows: water hyacinth (*Eichhornia crassipes*), salvinia (*Salvinia rotundifolia*), duckweed (*Lemna* spp.) water fern (*Azolla* spp.), American lotus (*Nelumbo lutea*), white water lily (*Nympheae odorata*), yellow water lily (*Nuphar luteum*), banana lily (*Nymphoides* spp.), and watershield (*Brasenia schreberi*) for floating plants; giant cutgrass (*Zizaniopsis milacea*) torpedograss (*Panicum repens*), cattail (*Typha* spp.), pickeralweed (*Pontedaria cordata*), bacopa (*Bacopa caroliniana*), and water primrose (*Ludwigia* spp.) for emergent plants; and hydrilla, pondweeds (*Potamogeton* spp.), coontail (*Ceratophyllum demersum*), naiad (*Najas* spp.), Eurasian watermilfoil (*Myriophyllum spicatum*), fanwort (*Cabomba caroliniana*), limnophila (*Limnophila sessiflora*), muskgrass (*Chara* spp.) and nitella (*Nitella* spp.) for submergent plants. Though there were several species found in the submergent category, the dominant species was hydrilla. In pre-treatment point intercept sampling in Spring Creek, 86.3% of all points contained submergent vegetation, and 80.1% contained hydrilla (15). In pre-treatment plant biomass sampling, hydrilla composed 82.7% of the plant biomass in Spring Creek (15). We also estimated coverage of open water.

To document the number and distribution of waterfowl on the reservoir, weekly aerial surveys were conducted by helicopter between 1 November and 15 March in both the pre-treatment period and the post-treatment period, weather permitting. A cruise survey method, rather than a fixed transect method, was used to survey the reservoir. A consistent pattern was flown each time, and surveys were between 2.5 and 3 h in duration and normally occurred between 1030 and 1330 hours on weekdays. Helicopters were flown at low altitude (ca. 75 – 100 m) and low airspeed (ca. 80-100 kph) to reduce bias associated with differential visibility of waterfowl in various vegetation types. The observer (GDB) carried paper maps of the reservoir and recorded the location, species, and number of waterfowl in each flock observed during each flight.

Data Analysis - Following flights, waterfowl data were entered into ArcView® software as a point coverage, with the center of each flock being one point, and the species and number of ducks were entered in the attribute table. For flocks that flushed ahead of the helicopter, the center of the flock when it had been on the water was recorded. We overlaid the point coverages of the weekly flights onto the polygon coverages of vegetation type and watershed to determine waterfowl habitat use and distribution across the reservoir. The total number of ducks and flocks in each vegetation type and watershed of Lake Seminole were summed across species for each flight, and then a per flight average was calculated during the pre-treatment and post-treatment periods. We used a *t*-test to compare the average number of ducks observed per flight between pre- and post-treatment periods (16).

There are three design categories for resource use and availability studies (17). Our study design was classified Design I, which allows investigation of resource selectivity at the population level because individual animals are not identified. Given this study design, we used a chi-square test to compare the observed and expected number of ducks and flocks in each vegetation type and each watershed according to availability for pre- and post-treatment periods (18, 19) to determine if cover types were used by waterfowl in greater proportion to their availability, hence inferring preference (20).

While it may have been more correct to use only each flock detected as the experimental unit, because flock size was so variable ($\bar{x}$ = 31.1, SD = 68.5, and range = 1 to 1200), the analysis was done for both flocks and ducks to provide the reader with additional information. All analyses were conducting using Program R software (R Project, Vienna, Austria) at $\alpha = 0.05$.

RESULTS

Coverage of submergent vegetation, composed primarily of hydrilla, decreased from 35% to 24% in Lake Seminole (Figs. 1 and 2) after two years of implementing the low-dose injection system with fluridone (Sonar®) in Spring Creek (Table I). Correspondingly, coverage of open water increased by 6% lake wide. In the Spring Creek arm of the reservoir, submergent vegetation coverage was reduced from 66.9% to 23.3%.

Table I. Percent of reservoir in each cover type before (1998) and after (2001) implementing the low-dose injection of fluridone (Sonar®) in Spring Creek arm, Lake Seminole, Georgia.

Cover Type	% Pre-treatment	% Post-treatment
Emergent	13.25	14.74
Floating	4.48	7.64
Submersed[1]	35.00	24.22
Open water	46.97	53.40

[1]Submersed vegetation was over 80% hydrilla in pre-treatment sampling.

During the pre-and post-treatment periods, 14 and 11 flights were conducted, respectively. The total number of ducks observed on the reservoir did not differ following implementation of the low-dose herbicide injection system ($P = 0.833$, $t_{23} = 0.213$). During the pre-treatment period, an average of 2864 (SE = 304) ducks were observed per survey. Following implementation of the low-dose herbicide injection system in Spring Creek, an average of 2774 (SE = 273) ducks were observed per survey (Table II).

Table II. Number of waterfowl observed per flight before (November 1998 – March 1999) and after (November 2001 – March 2002) implementing the low-dose injection of fluridone (Sonar®) in Spring Creek arm, Lake Seminole, Georgia.

Flight Date	Before	After
Nov. 5		1513
Nov. 6	1019	
Nov. 10	1292	
Nov. 14		1904
Nov. 17	2113	
Nov. 18	2948	
Nov. 20		2766
Nov. 30		3426
Dec. 1	2694	
Dec. 3		3190
Dec. 8	2694	
Dec. 9	3177	
Dec. 23	4380	
Dec. 27		4356
Dec. 31	3694	
Jan. 7	4003	
Jan. 9		3259
Jan. 12	3626	
Jan. 28		2942
Feb. 5		3397
Feb. 15	4432	
Feb. 26		2373
Mar. 2	2861	
Mar. 10	1153	
Mar. 14		1386
$\bar{x} \pm$ SE	2863 ± 304.3	2774 ± 272.8

During the pre-treatment period, ducks preferred the areas of hydrilla ($P < 0.001$, $\chi^2_3 = 24.92$ for flocks and $P < 0.001$, $\chi^2_3 = 72.77$ for ducks), avoided open water and emergent vegetation, and used floating pad plants approximately equal to their availability (Table III). During the post-treatment period, ducks still preferred areas of hydrilla, selected open water in proportion to its availability, and avoided all other cover types ($P = 0.039$, $\chi^2_3 = 8.32$ for flocks and $P < 0.001$, $\chi^2_3 = 42.53$ for ducks; Table IV).

Table III. Pre-treatment distribution[1] of ducks by cover type in Lake Seminole, Georgia, 1998.

Cover Type	% of Reservoir	# of Flocks (%)[2]	# of Ducks (%)[2]
Emergent	13.25	3.21 (3.11)	68.43 (2.39)
Floating	4.48	6.79 (6.59)	116.00 (4.05)
Submersed	35.00	69.00 (66.94)	1934.21 (67.56)
Open water	46.97	24.07 (23.35)	744.64 (25.99)

[1]Waterfowl use differed ($P < 0.001$ for both flocks and ducks) with respect to the availability of cover types according to a chi-square test.

[2]Number of flocks and ducks are averages from all pre-treatment flights.

Table IV. Post-treatment distribution[1] of ducks by cover type in Lake Seminole, Georgia 2001.

Cover Type	% of Reservoir	# of Flocks (%)[2]	# of Ducks (%)[2]
Emergent	14.74	6.82 (9.05)	94.45 (3.41)
Floating	7.64	5.36 (7.11)	111.36 (4.01)
Submersed	24.22	33.55 (44.51)	1139.27 (41.07)
Open water	53.40	29.64 (39.33)	1428.73 (51.51)

[1]Waterfowl use differed ($P = 0.040$ for flocks and $P < 0.001$ for ducks) with respect to the availability of cover types according to a chi-square test.

[2]Number of flocks and ducks are averages from all post-treatment flights.

The distribution of ducks on the reservoir changed following the implementation of the low-dose herbicide injection system. Before treatment, all areas of the reservoir were used approximately equal to their availability ($P = 0.397$, $\chi^2_3 = 2.97$ for flocks and $P = 0.130$, $\chi^2_3 = 5.64$ for ducks; Table V). Following treatment, analysis based on the number of flocks observed indicated that there was no change from the pre-treatment use ($P < 0.447$, $\chi^2_3 = 2.66$); however, based on the number of ducks observed, use in the Chattahoochee and Flint drainages increased and use in Fish Pond Drain and Spring Creek decreased ($P < 0.001$, $\chi^2_3 = 18.74$; Table VI).

Table V. Pre-treatment distribution[1] of ducks by drainage area in Lake Seminole, Georgia 1998.

Drainage	% of Reservoir	# of Flocks (%)[2]	# of Ducks (%)[2]
Chattahoochee River	35.82	26.29 (25.50)	738.57 (25.79)
Fish Pond Drain	11.36	13.79 (13.37)	414.43 (14.47)
Spring Creek	17.34	24.36 (23.65)	648.36 (22.64)
Flint River	35.48	38.64 (37.47)	1061.93 (37.09)

[1]Waterfowl use did not differ ($P = 0.397$ for flocks and $P = 0.130$ for ducks) with respect to the availability of drainage areas according to a chi-square test.

[2]Number of flocks and ducks are averages from all pre-treatment flights.

Table VI. Post-treatment distribution[1] of ducks by drainage area in Lake Seminole, Georgia 2001.

	Pre-Treatment		Post-Treatment	
Drainage	% of Flocks	% of Ducks	# of Flocks (%)[2]	# of Ducks (%)[2]
Chattahoochee River	25.50	25.79	22.36 (29.93)	906.09 (32.67)
Fish Pond Drain	13.37	14.47	8.18 (10.95)	294.09 (10.60)
Spring Creek	23.63	22.64	11.09 (14.84)	282.36 (10.18)
Flint River	37.49	37.09	33.09 (44.29)	1291.27 (46.55)

[1]Waterfowl use did not differ ($P = 0.447$ for flocks) but did differ by ducks ($P < 0.001$) when compared to pre-treatment distribution by drainage areas according to a chi-square test.

[2]Number of flocks and ducks are averages from all post-treatment flights.

DISCUSSION

Implementation of the low-dose herbicide injection system in the Spring Creek arm of Lake Seminole did not affect the number of wintering waterfowl on the reservoir, but it did impact their distribution. Fewer ducks used the Spring Creek arm of the reservoir after implementation of the low-dose herbicide injection system. Waterfowl abundance increased in the Chattahoochee and Flint River drainages following implementation of the low-dose herbicide injection system, perhaps due to sustained coverage of hydrilla there. We hypothesize that the shift away from Spring Creek will be temporary because pondweeds, muskgrass, and wildcelery have been spreading in Spring Creek (15), and these species are well documented as important waterfowl food plants in many parts of the country (21, 22, 23, 24). Although this study indicated that hydrilla was the preferred vegetation type, very little coverage of other submerged aquatic vegetation was available. In other locations around the southeastern United States, one study indicated that hydrilla is preferred over natives such as wildcelery or Illinois pondweed (3); while other studies have shown that waterfowl prefer native species to hydrilla or other exotics (4, 5).

Implementation of the low-dose herbicide injection system was effective at reducing the coverage of hydrilla in Lake Seminole by 12% over two years. The Spring Creek arm of the reservoir showed the most dramatic change with coverage of hydrilla decreasing from 66.9% to 23.3%.

Following the guidance of Johnson and Montalbano (7), we recommend that managers carefully consider their management objectives and control methods when deciding on hydrilla control policies. Given the preference for hydrilla by waterfowl at Lake Seminole, managers may select a minimum acceptable coverage of hydrilla (such as 20-40%), rather than complete elimination, especially if waterfowl habitat is a management objective. If hydrilla control is deemed necessary, then control methods that minimize impacts to native submersed vegetation should be considered. In this study, Sonar® was used at a low concentration with a prolonged contact time in an effort to reduce hydrilla but not affect native species, since some studies (4, 5) indicate that waterfowl may prefer natives over hydrilla when both are available, and conservation of native species helps maintain the integrity of native ecosystems (25).

ACKNOWLEDGEMENTS

The authors would like to thank C. Hayes (formerly WRD) for early contributions to the project, J. Staigl (USACE) for habitat delineation and ground-truthing, WRD pilots B. Clines, S. Turner, and D. Ware for flying the aircraft during the waterfowl surveys, and B. Bond, J. Bowers (WRD), and 3 anonymous referees for reviewing earlier drafts of this manuscript. The authors' respective agencies were supportive of this research and provided staff time and funding to complete the project.

REFERENCES

1. Johnson FA and Montalbano, III F: Southern reservoirs and lakes. In Habitat management for migrating and wintering waterfowl in North America (Smith LM, Pederson RL, and Kaminski RM, Eds) Lubbock TX: Texas Tech University Press, p560, 1989.
2. Montalbano, III F, Hardin S, and Hetrick WM: Utilization of hydrilla by ducks and coots in central Florida. Proc Southeast Assoc Fish Wildlife Agencies 33:36-42, 1979.

3. Johnson FA and Montalbano, III F: Selection of plant communities by wintering waterfowl on Lake Okeechobee, Florida. J Wildl Manage 48:174-178, 1984.
4. Benedict, Jr RJ and Hepp GR: Wintering waterbird use of two aquatic plant habitats in a southern reservoir. J Wildl Manage 64:269-278, 2000.
5. Dick GO, Smith JK and Smart RM: "Migratory waterfowl habitat selection in relation to aquatic vegetation." Vicksburg MS: APCRP Technical Notes Collection (ERDC/TN APCRP-EA-09) U. S. Army Engineer Research and Development Center, 2004.
6. Gasaway RD, Hardin S, and Howard J: Factors influencing wintering waterfowl abundance in Lake Wales, Florida. Proc Southeast Assoc Fish Wildl Agencies. 31:77-83, 1977.
7. Johnson FA and Montalbano, III F: Considering waterfowl habitat in hydrilla control policies. Wildl Soc Bull 15:466-469, 1987.
8. Burkhalter AP, Curtis LM, Lazor RL, Beach ML, and Hudson JC: "Aquatic Weed Identification and Control Manual." Tallahassee FL: Bureau of Aquatic Plant Research and Control. Florida Department of Natural Resources, p100, 1973.
9. Aulbach-Smith CA and de Kozlowski SJ: "Aquatic and wetland plants of South Carolina." South Carolina Aquatic Plant Management Council in cooperation with South Carolina Water Resources Commission, p123, 1990.
10. Godfrey RK and Wooten JW: "Aquatic and wetland plants of the southeastern United States: Monocotyledons." Athens GA: The University of Georgia Press, p712, 1979.
11. Birrenkott AH, Wilde SB, Hains JJ, Fischer JR, Murphy TM, Hope CP, Parnell PG, and Bowerman WM: Establishing a food-chain link between aquatic plant material and avian vacuolar myelinopathy in mallards (*Anas platyrhynchos*). J Wildl Dis 40:485-492, 2004.
12. Lewis-Weis LA, Gerhold RW, and Fischer JR: Attempts to reproduce vacuolar myelinopathy in domestic swine and chickens. J Wildl Dis 40:476-484, 2004.
13. Wilde SB, Murphy TM, Hope CP, Habrun SK, Kempton J, Birrenkott A, Wiley F, Bowermman WW, and Lewitus AJ: Avian vacuolar myelinopathy linked to exotic aquatic plants and a novel cyanobacterial species. Env Toxicology 20:348-353, 2005.
14. U.S. Army Engineer District, Mobile, Inland Environment Section: Volume I, Main Report, Lake Seminole, Florida-Georgia-Alabama Hydrilla Action Plan, p208, 1998.

15. Stewart RM, Way AS, Owens CS, and Morgan DM: "Aquatic Plant Assessments for Spring Creek low-dose fluridone injection treatment: Year-of-treatment and 2-year post-treatment findings." Vicksburg MS: Aquatic Plant Control Research Program (ERDC/EL TR-05-1) U. S. Army Engineer Research and Development Center, p61, 2005. URL <http://el.erdc.usace.army.mil/elpubs/pdf/trel05-1.pdf> Accessed 7 April 2010.
16. Sokal RR and Rohlf FJ: "Biometry: the principles and practice of statistics in biological research." 2nd edition, New York NY: W. H. Freeman and Co, p859, 1981.
17. Thomas DL, and Taylor EJ: Study designs and tests for comparing resource use and availability. J Wildl Manage 54:322-330, 1990.
18. Neu CW, Byers CR, and Peek JM: A technique for analysis of utilization-availability data. J Wildl Manage 38:541-545, 1974.
19. Byers CR, Steinhorst RK, and Krausman PR: Clarification of a technique for analysis of utilization-availability data. J Wildl Manage 48:1050-1053, 1984.
20. Alldredge JR and Griswold J: Design and analysis of resource selection studies for categorical resource variables. J Wildl Manage 70:337-346, 2006.
21. Martin AC, Zim HS, and Nelson AL: "American wildlife and plants: a guide to wildlife food habits." New York NY: McGraw-Hill Inc, p500, 1951.
22. Bartonek JC and Hickey JJ: Food habits of canvasbacks, redheads, and lesser scaup in Manitoba. In Waterfowl ecology and management: selected readings (Ratti JT, Flake LD, and Wentz WA, Eds) Bethesda MD: The Wildlife Society, Inc, p1328, 1982.
23. Korschgen CE, George LS, and Green WL: Feeding ecology of canvasbacks staging on Pool 7 of the upper Mississippi River. In Waterfowl in Winter (Weller MW Ed) Minneapolis MN: University of Minnesota Press, p624, 1988.
24. Payne NF: "Techniques for wildlife habitat management of wetlands." New York NY: McGraw-Hill Inc., p549, 1992.
25. Richards RR, Chambers JC, and Ross C: Use of native plants on federal lands: policy and practice. J Range Manage 51:625-632, 1998.