**U.S. Army Corps**
**Of Engineers**
Savannah District

# *AVIAN VACUOLAR MYELINOPATHY (AVM) PLAN*

# *FOR*

# *U.S. ARMY CORPS OF ENGINEERS, SAVANNAH DISTRICT*

# *J. STROM THURMOND PROJECT*

**April 2016**

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# AVIAN VACUOLAR MYELINOPATHY (AVM) PLAN FOR J. STROM THURMOND PROJECT

## 1.0 Background and Need for Action

The U.S. Army Corps of Engineers, Savannah District, has prepared this Avian Vacuolar Myelinopathy Plan (AVMP) for the J. Strom Thurmond reservoir (JST) with a goal of reducing or eliminating adverse impacts of AVM on birds. Research has shown AVM mortality to be the result of a bioaccumulation of a toxin from a cyanobacterium (*Aetokthonos hydrillicola*) (Wilde et al, 2014). This cyanobacteria attaches to aquatic vegetation and produces a neurotoxin during late fall and winter (November-February). AVM related mortalities have occurred in waterfowl that feed on submerged aquatic vegetation (SAV) and raptors that feed on infected waterfowl. Species known to be affected include bald eagle, American coot, great horned owl, kill deer, Canada goose, mallard, ring-necked duck, scaup, and bufflehead. The effects of AVM on mammals are unknown. However, ten beavers, four raccoons, and a fox at JST showed no AVM lesions when coots were indicating a 17-94% prevalence of the disease (Fischer et. al. 2006).

Of particular interest at JST, is the disease pathway that occurs from American coots (*Fulica americana*) to bald eagles (*Haliaeetus leucocephalus*). Coots are typically present in late fall and winter and ingest hydrilla (*Hydrilla verticillata*) that grows in the shallow areas of the lake. The hydrilla may have the toxin-producing cyanobacteria attached to its stems and leaves. After ingesting the aquatic vegetation, the coots develop neurological symptoms associated with AVM and become easy prey for eagles, resulting in AVM-related mortalities in eagles. This plan assumes that reducing the biomass of hydrilla would minimize and potentially eliminate AVM mortalities.

Eighty-one dead bald eagles have been recovered at JST from 1998 through 2015. AVM was confirmed in 29 of these eagles. Aspergillosis was the cause of one mortality, while the remaining 51 mortalities could not be determined due to decomposition. AVM occurs not only at JST, but also at over 18 lakes and reservoirs throughout the southeastern US.

Although the toxic cyanobacteria can concentrate on any densely growing SAV, hydrilla is the predominant aquatic plant in JST. Hydrilla was first located in the Little River, Georgia arm of JST in 1995. Aggressive herbicide treatments failed to provide any long term control and by 1999 hydrilla had increased to approximately 2,000 acres. Based on Savannah District’s 2015 survey, hydrilla now occurs on approximately 10,644 acres at a percent area coverage of 22.2% for a total of 2,363 acres of hydrilla. By comparison, hydrilla estimates from 2010 indicated approximately 11,271 acres contained hydrilla at a percent area coverage of 44% resulting in a total of 4,959 acres of hydrilla. Although a small area of dioecious hydrilla is found at JST, the vast majority of hydrilla is the monoecious biotype. The growth forms of the two biotypes are very different. Dioecious hydrilla grows vertically and then begins to spread laterally at the surface, whereas moneocious hydrilla grows laterally along the bottom and then begins vertical growth later in the growing season. As a result, monoecious hydrilla reaches the surface later than the dioecious biotype.

Maps of the known distribution and density of hydrilla based on the September – October 2015 survey are found in Appendix A. The prevalence of other aquatic and shoreline plants found at JST is in Appendix B. The locations of recovered bald eagles are located in Appendix C.

Aquatic plants provide important habitat for insects, fish, and waterfowl. However, when fast growing plant species become well established, they can reach nuisance levels and can impact authorized uses of an impoundment, i.e., hydropower production, recreation, or navigation. With the exception of AVM, the JST project has only experienced minor impacts to recreation and those events have only occurred during the late-summer and fall. The current Savannah District Aquatic Plant Management Plan (APMP) has adequately addressed nuisance aquatic plant management That Management Plan can be found at the following website: http://www.sas.usace.army.mil/About/DivisionsandOffices/OperationsDivision/JStromThurmondDamandLake/NaturalResources.aspx. The APMP also describes permitted activities that adjoining property owners can undertake to minimize nuisance aquatic vegetation around private docks.

USACE hosted meetings to discuss ongoing AVM research at the project in 2004, 2005, 2007, 2009, 2011, 2012, and 2014. Those meetings have included participation from staff of the Georgia Department of Natural Resources (GADNR), South Carolina Department of Natural Resources (SCDNR), the U.S. Fish and Wildlife Service (USFWS) and a number of researchers. Researchers from the University of Georgia (UGA) continue to evaluate AVM, hydrilla, and the possible environmental factors affecting toxin production. As a result of extensive coordination with these agencies and researchers, the Corps has developed this AVMP to guide efforts to reduce or eliminate AVM at JST.

In 2013, a public survey titled “Investigating Stakeholder Perceptions of Aquatic Plant Management on J. Strom Thurmond Lake (Clarks Hill) Lake” was developed by UGA in cooperation with the Corps of Engineers. UGA conducted the survey, which was designed to evaluate public perceptions of AVM and hydrilla, hydrilla control methods, and grass carp. The survey evaluated five stakeholder groups: fishermen, hunters, campers, boaters, and shoreline permit holders Although there were differences among individual user groups, collectively the results indicate that 84.5% of respondents prefer less hydrilla or native plants only, while 74.3% were indifferent or support stocking grass carp. Details of the survey can be found at:

http://www.sas.usace.army.mil/Portals/61/docs/lakes/thurmond/UGA%20Perception%20Survey_Final%20Report.pdf .

## 2.0 Management Objectives

There are four management objectives for this management plan: (1) reduce or eliminate AVM at JST; (2) surveillance and monitoring of both AVM and aquatic vegetation to determine treatment effectiveness, without eliminating all aquatic vegetation; (3) collaborate with stakeholders and subject matter experts to ensure decisions are science based; and (4) use public education and outreach in AVM and vegetation management.

## 3.0 Affected Environment

An Environmental Assessment (EA) for Avian Vacuolar Myelinopathy reduction at J. Strom Thurmond Lake has been prepared and provides a full description of the affected environment, treatment alternatives, and potential impacts of implementing this AVMP. This EA is being provided with this AVMP.

## 4.0 Treatment Alternatives

### 4.1 No Action

Based on past and ongoing research results, failure to treat dense non-native aquatic vegetation at JST lake will likely result in continued AVM-related mortalities. The USFWS has recommended that Savannah District obtain a "take permit" for the expected future bald eagle mortalities. Without a permit, these mortalities may be considered a violation of the Bald and Golden Eagle Protection Act of 1940 and the Migratory Bird Treaty Act of 1918. Also, based on the public perception survey completed in 2013 by UGA, most of the respondents would prefer less hydrilla or native plants only. As a result, the No Action Alternative is not considered a viable option.

### 4.2 Mechanical Control

Mechanical control consists of physically removing hydrilla with special machinery. On other large reservoirs, this approach has not proven to be an economical option for aquatic plant management due to the high cost per acre to remove and dispose of vegetation and the short-term results. This approach is not completely effective, as hydrilla fragments that remain unrecovered during the removal process often contain turions that can drift to other areas and establish new hydrilla populations. The abundance of submerged obstacles in the lake and the undulating lake bottom substrate makes operating the harvesting equipment difficult. The cutting depth for most mechanical harvesting equipment is limited to 5 or 6 feet deep, so hydrilla that grows in deeper waters cannot be effectively removed. Additionally, mechanical control is non-selective resulting in impacts to native vegetation. As a result of these factors, mechanical removal is not considered an effective alternative.

### 4.3 Herbicide Applications

As discussed in our APMP, the safe and effective use of aquatic herbicides to reduce nuisance levels of aquatic plants has been demonstrated nationwide. While herbicides applied in large reservoirs generally do not eradicate nuisance plants, the applications can reduce water user conflicts without negative impacts to the natural resources. However, due to the large acreage requiring treatment in JST, the high cost ($175+ per acre per year), and the short-term results, herbicide use alone is not considered an effective alternative for hydrilla control.

### 4.4 Lake Drawdown

Drawdowns can be effective in killing the vegetative portions of aquatic plants such as hydrilla and elodea. If a draw-down is timed to coincide with winter freezing, root structures may also be killed. However, studies at the Corps Engineer Research and Development Center (ERDC) have found that hydrilla tubers can survive for 5-10 years in hydrated soils and establish new growth when inundated (Netherland and Green, 2014). Therefore, lake drawdowns are not expected to be an effective option to manage hydrilla in JST lake. Repeated drawdowns would be required to maintain aquatic vegetation below nuisance levels.

Drawdowns during the summer months have been used in some reservoir systems to dry plants that grow to the surface and create thick mats along the reservoir margins. Summer drawdowns are usually applied in reservoirs with short water retention times, which make it possible to refill them quickly. These drawdowns are usually short in duration (2 to 3 weeks) and do not include large changes in pool elevation (only 2 to 3 feet). However, drawdowns of sufficient magnitude (greater than 15 feet) and duration to provide long term control of hydrilla cannot be accommodated without major impacts to other authorized project purposes such as hydropower and recreation. Recurring droughts and corresponding low lake levels since 1995 did not have a long term impact on hydrilla growth. Lake drawdown is not considered a viable alternative.

### 4.5 Biological Control With Insects or Pathogens

Some vegetation can be controlled through biological control, which generally consists of introducing an organism that eats or kills the target vegetation. The use of insects such as the Pakistani fly (*Hydrellia pakistanae)* or other pathogens as a biological method to control hydrilla has not been effectively demonstrated at the operational level, particularly with monoecious hydrilla which is the primary biotype at JST. This alternative can have significant costs due to the construction of insect rearing facilities and man hours required to disperse and monitor insect populations. Should this method prove to be effective in the future, this alternative can be revisited. Due to concerns about the potential for an introduced organism to also impact non-target plants, an extensive assessment of this alternative would be required prior to implementation.

### 4.6 Biological Control with Grass Carp

This alternative consists of stocking USFWS certified sterile triploid grass carp (*Ctenopharyngodon idella*). Grass carp have been shown to reduce or eliminate hydrilla depending on stocking levels. Research has shown that with early detection of hydrilla during colonization and maintaining a sufficient density of grass carp, hydrilla at a reservoir can be reduced and maintained at a coverage of 1% or less. The recommended density of grass carp to produce that effect is 20 per vegetated acre for approximately 10 years followed by maintaining 1 grass carp per 8 surface acres (Kirk and Manuel, 2012). Hydrilla has existed in JST for 20 years; therefore, an even higher level of stocking per vegetated acre may be initially required. It is likely that attempts to eliminate hydrilla with this level of stocking may also eliminate most SAV. Another consideration is that as the size of the aquatic system increases, the effects of grass carp stocking rates become less predictable (Maceina et al., 1999). As a result, stocking grass carp in large systems like JST's 71,000 surface acres increases the likelihood of either total elimination of vegetation or inadequate vegetative control. Control of hydrilla by a single, large scale stocking of grass carp, followed by annual maintenance stockings based on estimated mortality rates is not considered a viable alternative.

## 5.0 Preferred Alternative – Integrated Management – Incremental Triploid Grass Carp Stocking with Herbicide

### 5.1 Background

Incremental stocking of grass carp still uses a desired number of fish per vegetated acre, but the target fish densities can be adjusted over time based on the observed hydrilla coverage. The fish density can also be adjusted over time to meet the original purpose of this plan, which is to minimize AVM-related mortality of eagles. Typically, after a target fish density is determined, the grass carp mortality rate is considered to determine the level of maintenance stocking needed. Average annual grass carp mortality estimates have ranged from 20-25% at Lake Gaston to 22-39% at Santee Cooper reservoirs (Kirk and Socha, 2003). Managers of the John H. Kerr reservoir use a 30% annual mortality rate based on recommendations from state agencies. The North Carolina Wildlife Resources Commission (NCWRC) has developed a model for Piedmont reservoirs that is based on a 30% mortality rate in Year 1 post-stocking followed by a 20% annual mortality rate beginning in Year 2 (Mark Fowlkes, NCWRC, pers. comm.).

Recommended grass carp stocking rates are highly variable and as previously mentioned, larger reservoir systems have an increased chance of error. In comparing reservoirs where grass carp have been stocked, one factor that makes comparisons difficult is that stocking rates alone do not provide sufficient information because some calculate vegetation acres based on density estimates or percent area coverage.

However, most managers estimate standing hydrilla acres as those acres containing hydrilla without accounting for density. In addition, grass carp mortality rates may be unknown for a particular system so the best available information is used to estimate future maintenance stocking levels. At Lake Murray, South Carolina a 15 fish per vegetated acre stocking eliminated almost all aquatic vegetation. However, effects of a drawdown may have contributed to that level of control. In contrast, a 15 fish per vegetated acre stocking at Lake Gaston reduced hydrilla coverage by 50%. The managers at Lake Gaston also used herbicide in combination with grass carp, so vegetated acres for carp stocking purposes did not include areas where herbicides were used. Managers at John H. Kerr stocked 15 fish per vegetated acre with no observable results two years after stocking. Surveys three years after stocking are still ongoing (Michael Hosey, USACE, pers. comm.).

Recent research at Lake Gaston, North Carolina indicates that biomass of grass carp over several years is the best predictor of vegetative control, rather than solely targeting a number per acre with annual maintenance stockings to account for mortality. As a result, typical stocking rates of 15 carp per vegetated acre may have a time lag of up to 4-years before any significant vegetation control (Stich et al. 2013). Similarly, the AMUR/STOCK model developed by the Corps Engineer Research and Development Center (Stewart and Boyd 1999) suggests that a time lag occurs that is inversely related to stocking rates and that the increased biomass of carp provide increasing levels of control out to years 5 and 6 after stocking and continue to provide some control at 10 years after stocking. However, this model is based on dioecious hydrilla rather than monoecious and is no longer widely used to determine stocking levels (Mike Netherland, ERDC, pers. comm.). Based on results with monoecious hydrilla in Piedmont lakes of North Carolina, the North Carolina Wildlife Resources Commission (NCWRC) has developed a model that allows for variable stocking rates. Using some standard mortality estimates can provide the stocking level of carp needed on an annual basis (Fowlkes 2015).

Available research has not identified what percent reduction in hydrilla biomass is needed to eliminate AVM. However, the District will establish an initial objective of a minimum 50% reduction in hydrilla coverage lake-wide, with an increased emphasis where the majority of eagle mortalities occur. The District may revise this objective depending on future occurrences of AVM.

### 5.2 Management Plan

Because the peak effectiveness of stocked carp is often delayed until Year 4 after stocking (Stich et al., 2013), an initial stocking of grass carp will occur in Year 1 and 2, followed by a Year 3 maintenance stocking to account for initial mortality. A comprehensive evaluation of hydrilla coverage according to the District's standardized sampling will occur in Year 6. Based on results from the hydrilla survey, activities in Year 6 will consist of either incremental stocking or further maintenance stocking depending on if the program objectives are being met.

An estimate of hydrilla percent area coverage was used to calculate vegetated acres. Hydrilla coverage in 2010 was based on a survey of 80 randomly located transects. Data was collected using a BioSonics DT-X Echosounder. In 2015, we determined hydrilla coverage with a survey of 70 randomly located transects using Lowrance Elite series depth finders and analyzed data using the BioBase Aquatic Mapping Program. Due to the high variability in vegetated acres between transects and between years as indicated by our hydroacoustic surveys (hydrilla coverage was 4,959 acres in 2010 and 2,363 acres in 2015), we will use the average between those two years. Therefore, for treatment purposes, we will use 3,661 acres as our estimate of vegetated acres of hydrilla.

Grass carp stocking will target 7.5 fish per vegetated acre in Year 1 and 9.75 fish per vegetated acre in Year 2 resulting in a total of 15 fish per vegetated acre. The Year 2 stocking rate of 7.5 fish per acre was increased by 2.25 fish per acre to offset an estimated 30% mortality rate in the fish stocked in Year 1.

Grass carp stocking will occur in fall or spring at various locations around JST. To reduce mortality, grass carp should be a minimum of 12" in length when stocked. Using a 30% mortality rate for Year 2 fish (1-year post stocking) and a 20% mortality rate for Year 1 fish (2-years post stocking), 3.75 fish per vegetated acre will be stocked in Year 3 to compensate for mortality. Carp stocking locations will be determined based on hydrilla occurrence with stocking numbers at each location proportional to District estimates of vegetated acres in that area.

At this level of stocking, the District expects a minimum 4-year time lag from the initial stocking until significant effects are observed. Therefore, no activity other than possible herbicide treatments will occur during years 4 and 5. At Year 6, standard vegetation sampling will occur at 0.5-mile intervals along the shoreline, along with hydrilla density estimates using hydroacoustics to evaluate the effectiveness of the treatments (See Monitoring Section 6.0). After the survey results are analyzed, a determination will be made regarding additional incremental or maintenance grass carp stocking.

In addition to the grass carp stocking component of this integrated approach, Savannah District would apply spot treatments of herbicide in areas where hydrilla is at or near the surface with priority given to those locations known to have high concentrations of American coots and past eagle mortalities. During years when hydrilla is present at the surface, herbicide treatments will target a minimum of 200 acres and will be applied with the objective of affecting to top 3-5 feet of the hydrilla plant. Favorable conditions for hydrilla to be at the surface occur when hydrilla is abundant and water levels are declining from late-summer through fall.

Only those herbicides labeled for "aquatic use" and registered by the Environmental Protection Agency (EPA) will be used. Product labels with instructions and warnings can be found at http://www.cdms.net/manuf/default.asp. The following herbicides may be used to treat hydrilla: Copper-based compounds, Diquat, Endothall, and Fluridone.

The product labels include water use restrictions. The Corps will identify specific herbicides to be used in a given area based on the water use restrictions, cost, and desired level of control.

Herbicides will be applied by a contractor licensed in the Aquatic Plant category by the appropriate state. Contractors will be required to use application equipment that is capable of metering the herbicide as it is applied to assure they use the proper application rate.

Stocking grass carp and herbicide use are dependent on available funding. The District is developing a budget package to compete in the government funding process, however the competition for funding is severe in these times of constrained budgets with many highly deserving projects. Therefore, implementation of this plan is contingent upon funding appropriations.

## 6.0 Monitoring Vegetation

Savannah District has developed a standardized methodology to survey for aquatic vegetation in JST. The procedure divides the reservoir into 9 survey routes and transects have been established approximately every ½ mile along the entire lake shoreline, including selected islands and shoals. Each transect is surveyed for the presence or absence of hydrilla as well as other aquatic and shoreline vegetation.

The survey teams use a two-sided metal garden rake with a rope to drag the lake bottom perpendicular to the shoreline to a depth of approximately 20 feet. If hydrilla is detected visually at the survey point, the use of the rake is still required to determine the presence of other aquatic vegetation. After completing the survey, hydroacoustics will be used to determine hydrilla coverage along a subsample of the transects.

## 7.0 Monitoring the Effects of AVM

As in previous years, the Corps will cooperate with the Southeastern Cooperative Wildlife Disease Study (SCWDS) for collection of coots for scientific study. Coot collections involve random collections of live coots for sampling. All eagle mortalities or birds exhibiting clinical signs of disease will be reported to the USFWS, Migratory Bird Division, Atlanta, Georgia and taken to SCWDS for examination. The District will continue to conduct our annual mid-winter eagle and waterfowl surveys as well as eagle nest surveys. The Project will host AVM meetings periodically to share information and discuss research results with UGA, State agencies, and the USFWS.

## 8.0 Research

In April 2015, UGA researchers attached transmitters to three bald eagle nestlings to determine if birds remain onsite and develop AVM or fly offsite to another location. In October 2015, one nestling was killed in Pennsylvania by a teenager; the individual stated that he thought the bird was a vulture. Through funding from the

USFWS, UGA conducted an experimental stocking of grass carp in JST in October 2015 as part of a telemetry study to evaluate movements of stocked grass carp. This study will also evaluate herbicide treatments alone and herbicide treatments with grass carp. This study will aid in determining site-specific mortality for the first year after stocking and how much site fidelity grass carp demonstrate, provided there is adequate aquatic vegetation present to serve as food. Carp movements could impact stocking site locations and number of stocking sites.

## 9.0 Public Education

The District will continue to implement the following public educational activities as part of its AVM Management Plan:

a. Nuisance aquatic plant warning signs have been installed at all public boat ramps. In addition, the Corps will provide and place signs to discourage harvest of grass carp by bowfishermen. Each managing agency will be responsible for installing and maintaining these signs.

b. The District will provide a flyer explaining the aquatic plant management program and outlining measures lake visitors can take to reduce the spread of nuisance aquatic plants. The Corps will make those flyers available to the public at the Project Visitor Centers, Corps recreation area gate houses, state park offices, and marinas.

c. As appropriate, the Corps' news releases, interpretive programs, and public workshops will contain information concerning measures visitors can take to reduce the spread of nuisance aquatic plants. The Corps website will also be used to provide updated information:
http://www.sas.usace.army.mil/About/DivisionsandOffices/OperationsDivision/JStromThurmondDamandLake/NaturalResources.aspx.

## 10.0 Coordination

Savannah District will make this plan available for public review as part of the NEPA process. The District coordinated this plan with Federal and State Natural Resource Agencies and will issue news releases to solicit comments from the public. The District will continue to host AVM meetings and provide vegetation data and results to interested Federal and State Natural Resource agencies.

## 11.0 Review and Revisions

The Corps will review this AVMP annually to assure aquatic plant management activities are consistent with the stated objectives and methods. It will coordinate significant changes to this plan with interested parties. As with implementation of this plan, any revisions that will require additional funding are dependent on funding appropriations.

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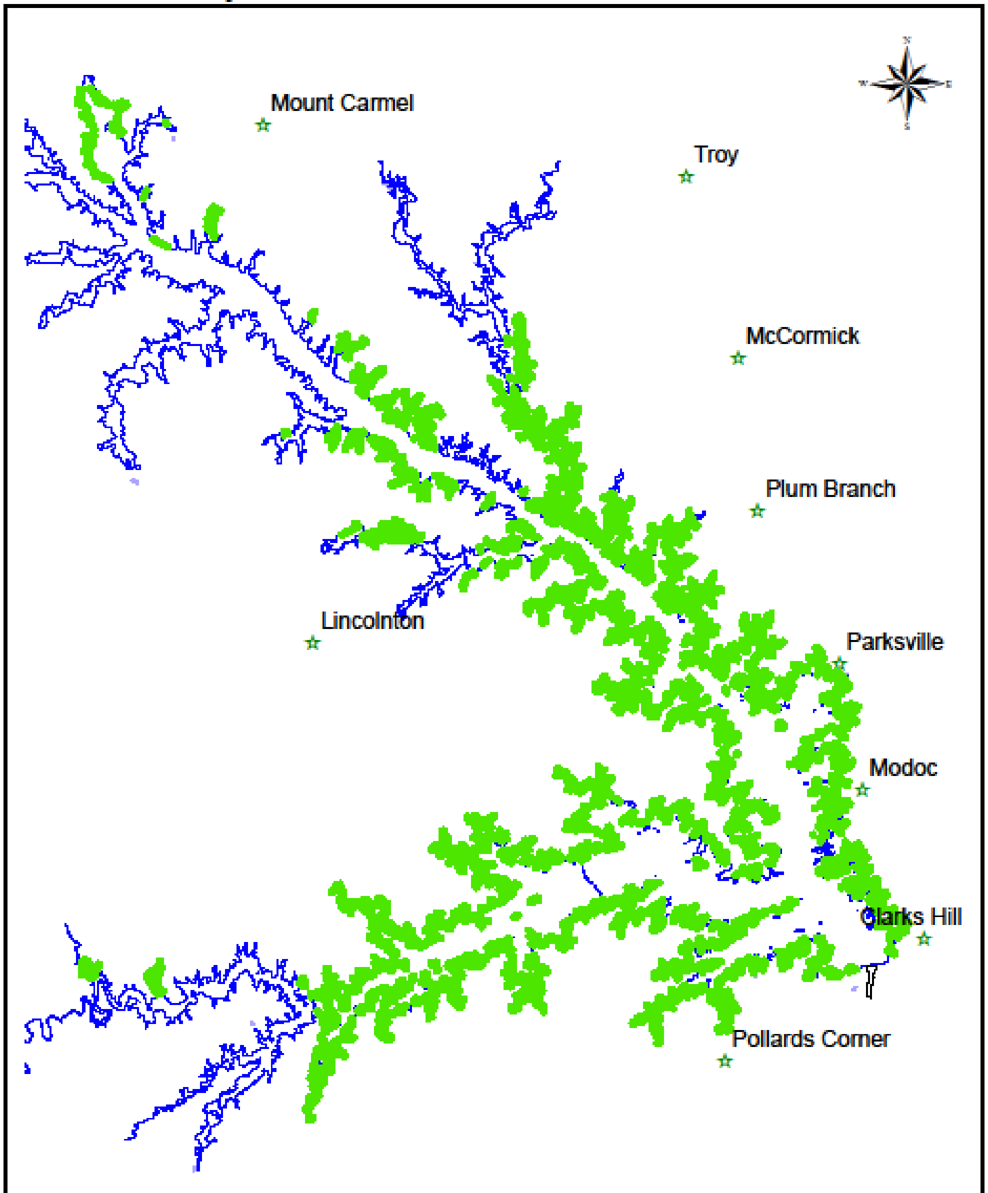
# APPENDIX A

# HYDRILLA DISTRIBUTION MAP

Hydrilla Distribution - October 2015




**Hydrilla Distribution**

1 in = 4 miles

**J. Strom Thurmond Lake**
**U.S. Army Corps of Engineers**
**Savannah District**

# APPENDIX B

# FREQUENCY OF OCCURRENCE OF AQUATIC PLANTS

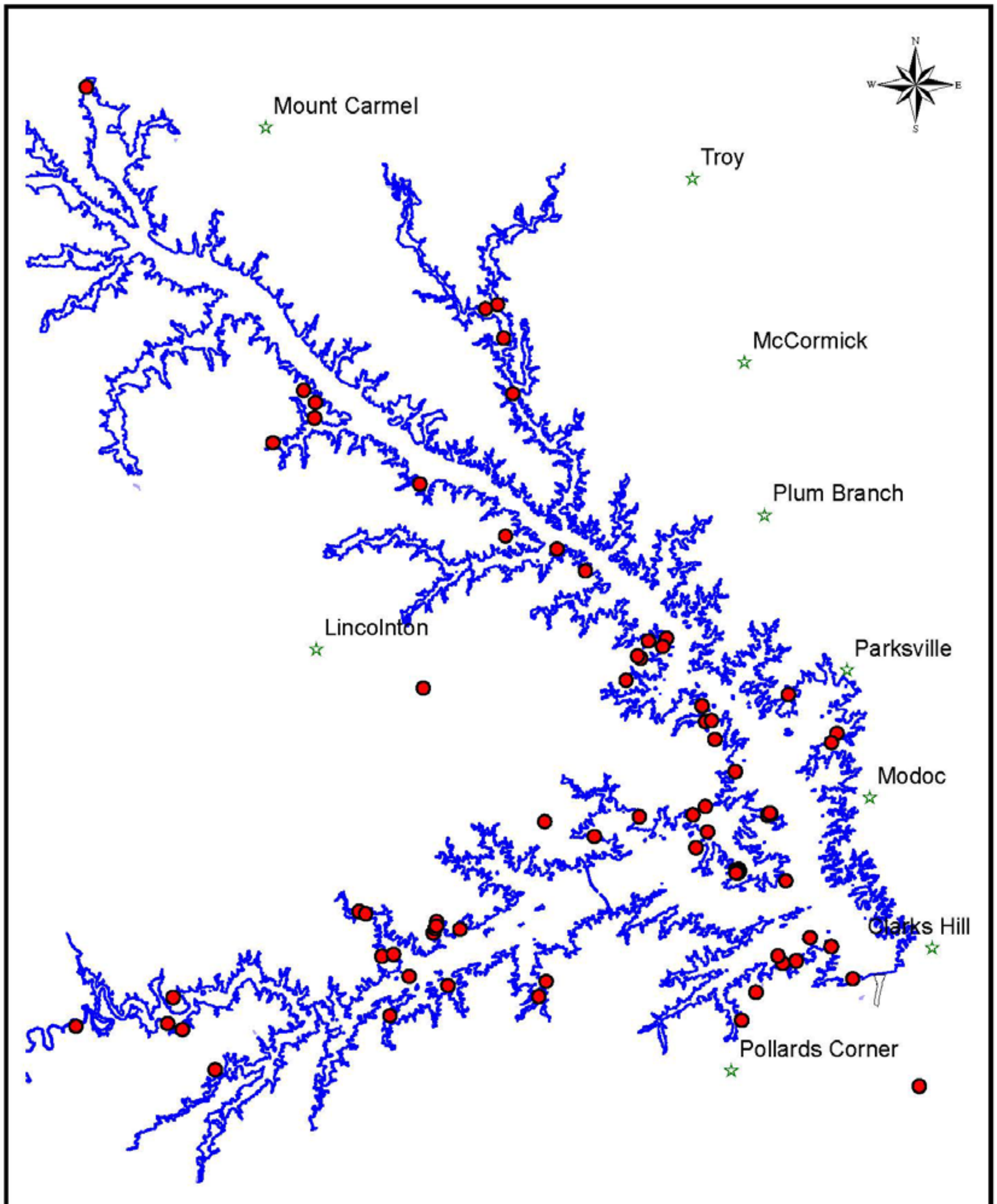
## Plant Survey 2015

| **Total Points Surveyed** | **2319** | |
|---|---|---|
| | **Frequency** | **Percent** |
| Hydrilla Present | 1312 | 56.6% |
| Hydrilla Absent | 1007 | 43.4% |
| | | |
| **Submersed/Floating** | | |
| Chara | 560 | 24.15% |
| Illinois Pondweed | 7 | 0.30% |
| Naiads | 364 | 15.70% |
| Nitella | 161 | 6.94% |
| Slender Pondweed | 226 | 9.75% |
| Variable-leaf Pondweed | 16 | 0.69% |
| American Pondweed | 2 | 0.09% |
| Duckweed | 14 | 0.60% |
| Parrot-feather | 1 | 0.04% |
| **Shoreline** | | |
| Alligatorweed | 27 | 1.16% |
| Arrowheads | 2 | 0.09% |
| Cattail | 6 | 0.26% |
| Creeping Burhead | 8 | 0.34% |
| Maidencane | 442 | 19.06% |
| Pennywort | 2 | 0.09% |
| Road Grass / Spikerush (Eleocharis) | 87 | 3.75% |
| Rushes | 84 | 3.62% |
| Sedges | 35 | 1.51% |
| Water Primrose | 49 | 2.11% |
| Water Willow | 3 | 0.13% |
| Cut Grass | 2 | 0.09% |
| American Lotus | 2 | 0.09% |
| Luziola (southern watergrass) | 1 | 0.04% |
| **Invasives** | | |
| Giant Reed | 1 | 0.04% |
| Tallow Tree | 11 | 0.47% |

# APPENDIX C

# BALD EAGLE MORTALITY MAP

# Bald Eagle Mortality
1998-2015




● Recovery Locations

1 in = 4 miles

**J. Strom Thurmond Lake**
**U.S. Army Corps of Engineers**
**Savannah District**