Draft
Amendment to
Environmental Assessment
for the Use of the White Amur
to Control Hydrilla and Other Submersed Aquatic Plants
In South Carolina

U. S. Army Corps of Engineers
Charleston District

and

The South Carolina Department of
Natural Resources

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TABLE OF CONTENTS

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I. BACKGROUND, PURPOSE AND AUTHORITY

In the late 1980's, an environmental assessment (EA) was completed on the use of sterile grass carp (*Ctenopharyngodon idella*), formerly referred to as white amur, to control nuisance aquatic vegetation in the Santee Cooper Lake System and in other water bodies located throughout the state. That report found that submersed aquatic plants could be controlled by sterile (triploid) grass carp without significant adverse environmental impacts. Since that study was conducted 15 years ago, numerous water bodies in South Carolina have been stocked with grass carp providing a much greater experience base to assess environmental and economic impacts. Also, extensive monitoring of the Santee Cooper Lake System has been conducted before and after the stocking of triploid grass carp, which provides valuable information regarding the stocking of other public waters in South Carolina.

The purpose of this amendment is to review available new information regarding the use of sterile grass carp in South Carolina in order to update the existing environmental assessment. This amendment will not reiterate information already presented in the original EA, but will provide updated information concerning the stocking and subsequent monitoring of sterile grass carp that have been stocked in South Carolina lakes since 1985, particularly in the Santee Cooper Lake System. The original EA is available in Appendix A. Information presented in the original EA is hereby incorporated by reference. Use of the term "sterile grass carp" in this amendment refers specifically to genetically modified triploid grass carp.

The Federal Aquatic Plant Control Program provides cost-share funding to the state for the management of nuisance aquatic vegetation in public waters. It is authorized under the following authorities:

- Section 104, 1958 RHA (Public Law 85-500), as amended.
- Sections 103(c)(6) ad 941, of the Water Resources Development Act of 1986 (Public Law 99-662). This is a continuing authority.
- Sections 225 and 540 of the Water Resources Development Act of 1996 (Public Law 104-303).

II. ALTERNATIVES TO THE PROPOSED ACTION

Alternatives for control of nuisance aquatic vegetation include:

A. Chemical Control. A number of herbicides are available and designed specifically to control aquatic vegetation. These products are tested and approved by the Environmental Protection Agency and state agencies for use in water. When used as directed on the labels, these products are environmentally safe and effective in controlling the growth of a variety of plant species. However, control by herbicides is generally short-term and repeated treatments are usually needed. Most herbicides carry water use restrictions related to fishing, drinking, and irrigation. The selection of which herbicide to use is based on the effectiveness on the target species, the cost, and environmental and water use constraints in the waterway. Consequently, each water body must be examined individually to determine where herbicides are feasible and where they are not.

B. Biological Control. The advantages of biological control agents are long-term control, cost effectiveness, and the avoidance of potential toxic effects to aquatic life and water users that can be associated with misuse of chemical control agents. Another advantage is that some biocontrol agents control only the target species of concern. The major disadvantage is that currently there are not many biological control agents available to control aquatic plant species in general and few that are specific for certain species, and achieving control can take a long time. Biological control agents that have been effective in South Carolina include the alligatorweed flea beetle, (*Agasicles hygrophila*), alligatorweed thrip (*Amynothrips andersonii*), alligatorweed stem borer moth (*Vogtia malloi*), as well as the fish Tilapia (*Tilapia sp.*), and sterile grass carp. The climate in South Carolina is too cool for use of the water hyacinth weevil (*Neochetina* spp.), and control agents specific for hydrilla (*Hydrellia spp.)* have not proven effective on a large scale.

C. Mechanical Harvesting. Physical removal of aquatic vegetation from the water body using harvesting machines can be quite beneficial, particularly where 1) the vegetation is dense and composed of a variety of species, 2) immediate results are needed, and 3) the acreage is small. Disadvantages to this method of control include:1) the need for a disposal site for harvested vegetation, 2) this type of control is expensive, 3) it is not applicable in areas where there are stumps or downed timber, and 4) it is not recommended for control of vegetatively reproducing species like hydrilla because increased fragmentation further spreads the species (UF, 2003).

D. No Action. Depending on the severity of the aquatic plant infestation and its current and potential impact on water use activities and/or the aquatic environment, control may or may not be necessary. Each water body is evaluated depending on a number of factors including but not limited to the type of plant species present, the potential of spreading, the number and degree of impaired uses, the type of treatment proposed, the cost of the treatment, and the availability of funds.

III. HISTORICAL AND EXISTING CONDITIONS

A. Hydrilla in South Carolina

Hydrilla is a non-native submersed aquatic plant that roots in the bottom and grows to the water surface where it forms thick mats. Hydrilla grows in shallow water up to approximately 28 feet deep depending on the clarity of the water. It is extremely prolific, forming dense mats that clog water intakes, impair navigation, hinder recreational activities, degrade water quality, displace desirable native plant species, and provide breeding habitat for mosquitoes and other pests (de Kozlowski, 1998). The dense mats shade underlying plants reducing survivability of other plant species thereby restricting biodiversity. These thick mats can also cause fluctuations in dissolved oxygen levels, pH and water temperature (UF, 2003). Because of its well-recognized adverse impacts to waterways, a number of federal and state laws and regulations prohibit the possession, importation, sale, and distribution of hydrilla in the United States and South Carolina and encourage its control.

Hydrilla was first identified in South Carolina in 1982 near Elliotts Landing in upper Lake Marion. It is now present in ten other water bodies extending from the coast to the upstate. These include Lake Moultrie, Back River Reservoir, Goose Creek Reservoir, Lake Murray, Lake Keowee, Lake Wateree, Lake Thurmond, Lake Richard B. Russell, Lake Greenwood, and the Cooper River.

To date the greatest impacts from hydrilla have occurred on the Santee Cooper Lake System (Lake Marion and Lake Moultrie). Following its discovery in 1982, hydrilla expanded to over 3000 acres in Lake Marion by 1987 despite extensive treatment with aquatic herbicides. Based on depth, the potential area of infestation by hydrilla was estimated to be about 85,000 acres or 50% of the lake system and included the entire shoreline area. Public access was severely impaired in the upper lake area and fish camp owners in this area were concerned about going out of business.

In 1991, large mats of hydrilla floated into the intake canals of the St. Stephen Hydroelectric Plant and impinged on the intake screens. The plant was shut down for weeks at a cost of over $4 million in lost power generation and associated expenses. Furthermore, the depletion of oxygen in the tailrace below the project caused one of the largest fish kills in South Carolina history with the loss of $526,000 in game fish. By 1995, it had infested over 48,000 acres of the Santee Cooper Lake System and represented the largest single infestation in the southeast.

More recently, Lake Murray, a 48,500-acre reservoir near Columbia, has experienced a substantial increase in hydrilla coverage. Lake Murray supports extensive residential development, a wide range of recreational activities, and serves as a major source of drinking water for the City of Columbia, West Columbia, Newberry County and numerous lakeside residents. Hydrilla was first discovered in the lake in 1993 and spread to over 6,700 acres by 2002, doubling in acreage in the past year. Water use impacts

include impaired public access, boating, and swimming and threatened drinking water withdrawals. Based on water depth, hydrilla could potentially spread to about 18,000 acres or 38% of the lake.
Not all effects of hydrilla are negative. Hydrilla provides attractive foraging habitat for some migratory waterfowl and provides protective cover for fish. Consequently, some waterfowl hunters and anglers benefit from the presence of moderate levels of hydrilla because it is easier to harvest ducks and catch certain game fish.

B. Grass Carp Use Statewide

In 1985, South Carolina legalized the use of sterile grass carp for the control aquatic vegetation. At that time, the state established a program with the S.C. Wildlife and Marine Resources Department (now the S.C. Department of Natural Resources) to inspect all grass carp shipments to ensure sterility. That program is still operational and remains one of the only state programs that checks all sterile grass carp shipments coming into the state to ensure the sterility of all grass carp stocked in public waters.

Since 1985, about 908,000 sterile grass carp have been stocked in 41 public water bodies in South Carolina. Most of these water bodies (36) were stocked to provide general control of aquatic vegetation to improve public access and use. However, five water bodies, Lake Marion, Lake Moultrie, Lake Murray, Back River Reservoir and Goose Creek Reservoir, were stocked specifically to control the growth of the aquatic weed hydrilla (*Hydrilla verticillata*). In general, grass carp successfully controlled target plant growth in these lakes with no apparent adverse impacts. Lake Murray was stocked in 2003 and preliminary surveys indicate a reduction in hydrilla. The Santee Cooper Lakes (Lake Marion and Lake Moultrie) have received the most intensive study. Results of these studies provide the basis for this assessment.

C. Grass Carp Stocking in the Santee Cooper Lakes

By 1987, it became apparent that the use of aquatic herbicides alone was not sufficient to control the spread of hydrilla in the Santee Cooper Lakes (Lakes Marion and Moultrie). After reviewing all alternatives, the South Carolina Aquatic Plant Management Council developed a management strategy that included the stocking of sterile grass carp. Initially developed for Lake Marion the plan was expanded to include both Lake Marion and Lake Moultrie after Hurricane Hugo spread the plants in 1989. The plan was to stock 100,000 grass carp per year until a stocking rate of 15 fish per vegetated acre was achieved, but no more than 3 fish per total surface acre. A total of 776,000 grass carp were released into the lake between 1989 and 1996 (de Kozlowski, 1998). However, grass carp population studies indicate that due to annual mortality the actual population of grass carp never exceeded 300,000.

Hydrilla control from the stocking occurred in two stages. The first results were apparent in upper Lake Marion when about 10,000 acres of hydrilla came under control in 1992. A second stage occurred in 1996 when hydrilla populations (38,000 acres) in lower Lake

Marion and Lake Moultrie were controlled. Hydrilla coverage continued to decline in 1997 and has remained low ever since. Presently, there are approximately 500 acres of hydrilla widely scattered throughout the Santee Cooper Lake System. No grass carp have been stocked since 1996 and the current population estimate is about 6,900 with an estimated annual mortality of 28%. The stocking density of grass carp during 2004 was approximately one fish per seven formerly vegetated acres (Kirk, 2005). The system is being closely monitored to determine the best time to initiate low-level maintenance stocking of additional grass carp.

Because the stocking of the Santee Cooper lakes represented one of the largest grass carp stockings ever, a number of studies and monitoring efforts were planned and implemented. Studies included annual monitoring of aquatic plant (primarily hydrilla) populations, grass carp population estimate and movement studies, routine water quality monitoring, hydrilla regrowth studies, and native fish population studies.

The control of hydrilla in the Santee Cooper Lake System has been quite successful. However, some groups, particularly duck hunters and some anglers, have voiced concerns that the control has been too successful. While grass carp have controlled hydrilla, they have also controlled the growth of desirable plant species in the past few years. Consequently, management objectives have been modified to encourage the regrowth of native plant species. The S.C. Department of Natural Resources and Santee Cooper are working together to achieve a diverse assemblage of native aquatic vegetation in ten percent of the total surface area of the lake while effectively controlling non-native invasive species.

IV. THREATENED AND ENDANGERED SPECIES

A list of threatened or endangered species for South Carolina counties under the jurisdiction of the U.S. Department of the Interior, Fish and Wildlife Service and a State of South Carolina listing of threatened and endangered species in Berkeley, Calhoun, Clarendon, Orangeburg, and Sumter are available in Appendix B.

The stocking of grass carp will not have unacceptable adverse effects on saline species, and/or the listed reptiles or amphibians that may exist throughout the state. None of the listed vegetation is expected to be found within the lake systems where the grass carp feed, and as such would not be affected by the stocking. The only freshwater fish species listed include the shortnose sturgeon (*Acipenser brevirostrum*), which is anadromous, the broadtail madtom (*Noturus sp.*), the Carolina darter (*Etheostoma collies*), the Carolina pygmy sunfish (*Elassoma boehlkei*), and the robust redhorse (*Moxostoma robustum*). None of these species are endangered or threatened, but are listed as species of concern. The gradual removal of the hydrilla by the grass carp may remove areas of cover for all fish species, but as motile species, they would move to alternate areas of cover. Also, the hydrilla removal is actually returning the water bodies to pre-hydrilla conditions. Mussels would not be affected since the grass carp do not feed on mussels. Lastly, avian species listed throughout the state that may be affected by the grass carp stocking include

the bald eagle (*Haliaeetus leucocephalus*), and the wood stork (*Mycteria americana*). Removal of the hydrilla may open up areas for foraging that were previously impossible for either species to use, particularly the bald eagle since it is a sight feeder. Overall, there do not appear to be any unacceptable adverse effects on any species listed, and some potentially advantageous effects for the avian species.

Widespread control of hydrilla by grass carp may in fact save bald eagles from a deadly neurological disease that has already killed 26 eagles on Lake Thurmond on the South Carolina-Georgia border. Avian Vacuolar Myelinopathy (AVM) breaks down the central nervous system and causes brain lesions that result in death of the birds. The disease appears to be limited to eagle populations living near man-made impoundments with an abundance of hydrilla. In South Carolina, the disease has been confirmed on Lake Thurmond, Lake Murray, Par Pond, and lakes on the Savannah River Site. Although studies are not complete, the cause seems to be related to biotoxins produced by an alga that grows on aquatic vegetation and is especially abundant on hydrilla. Waterfowl eating this vegetation contract the disease, which is passed on to eagles that consume the sick birds (Dr. Susan Wilde, personal communication, 2002). Controlling the growth of hydrilla could reduce the exposure of bald eagles to the toxin.

V. ENVIRONMENTAL IMPACTS

A. Native Fish Population Studies

A seven-year study of native fish populations in upper Lake Marion from 1988-1994 indicate that the loss of hydrilla from this portion of the lake in 1992 had little or no negative effects on the fish assemblage (Kilgore, et al, 1998). Although hydrilla coverage was reduced during this period from 50% cover to less than 10% cover, littoral species, especially Centrachids, increased in number.

B. Water Quality Studies

A detailed analysis of water quality data from the Santee Cooper Lakes indicates that water quality conditions in the Santee Cooper Lakes have remained the same or improved following hydrilla control by sterile grass carp (GEC, 2001). There was no significant change in turbidity after hydrilla control, pH levels decreased in both lakes, dissolved oxygen levels increased in both lakes, and chlorophyll-a levels decreased in both lakes following the removal of hydrilla.

C. Aquatic Plant Population Studies

Annual surveys of aquatic plant populations by Santee Cooper indicate that grass carp seemed to prefer hydrilla over other vegetation. Approximately 48,000 acres of hydrilla were consumed between 1989 and 1997. Following control hydrilla, grass carp began to consume other submersed vegetation such as fanwort, naiads, and pondweed followed by floating leaf species such as watershield, waterlily, and American lotus. Emergent aquatic plant species, such as alligatorweed, water primrose, and maidencane, as well as

floating species like water hyacinth were generally unaffected. Grass carp have consumed more non-target plant species than first anticipated following the removal of hydrilla. However, as the grass carp population declines from natural mortality, regrowth of less palatable plant species is anticipated followed by more palatable species.

VI. SOCIO-ECONOMICS

A. Hydrilla Control Efforts

As noted previously, biological controls are cost effective and usually provide longer-term control than the seasonal control provided by herbicidal treatments. For example, sterile grass carp were stocked annually in the Santee Cooper Lake System from 1989 to 1996. The hydrilla coverage continued to expand until 1994 when it peaked at 38,000 acres. Since that time, hydrilla coverage has decreased and now is estimated to be less than 500 acres, which is approximately the same coverage level as in 1985. Costs per acre for chemical treatment of the hydrilla from 1992 – 1995 ranged from $1.2 million to $1.7 million per year to treat less than 6,350 acres. This averages out to approximately $269 per acre. The eight-year sterile grass carp stocking effort totaled approximately $3 million for an average cost of $62 per acre for one year of control of 48,000 acres. Each year that control is maintained, the cost per acre is considerably reduced. By 2003, the effective cost was about $9 per acre. Furthermore, the use of chemical control and the associated costs have also been reduced saving on average $1.45 million per year in public funds (de Kozlowski, 2004).

B. Tourism

Concerns regarding loss of tourism as a result of either the presence or control of hydrilla encouraged a review of revenues related to tourism. Hotel use and accommodation revenues reflect general trends in tourism. A review of accommodations tax revenues collected by hotels in the counties surrounding the Santee Cooper Lakes (Berkeley, Calhoun, Clarendon, Orangeburg, and Sumter) indicates a 135% increase between 1988 and 2002 (Figure 1). On average for the region, accommodations tax revenues increased steadily by 12% per year for the 15 year period, with the greatest increase of 24% in Berkeley County and the smallest increase of 7% in Clarendon County. These revenues suggest that the presence or absence of hydrilla is not adversely impacting visitation by tourists to the Santee Cooper Lakes Region.

C. Recreation

1. Fishing: Fishing interest in a region is reflected by the number of non-resident (out-of–state) and resident (in-state) fishing license sales. A review of this data seems to indicate increasing interest in fishing the Santee Cooper Lakes by out-of-state fishermen throughout the period of hydrilla control by grass carp. In-state angler interest remained level during this same period.

The seven-day non-resident fishing license sales show a 1.8% average annual change between 1992 and 2002 for the Santee Cooper Counties, compared to an average annual change of 1.9% for the State of South Carolina (Figure 2). The peak year for these license sales was 1999 with a corresponding trend throughout the State. During 1999, 47% of all seven-day non-resident fishing license sales in the state occurred in the five counties surrounding the Santee Cooper Lakes. In 2002, this percentage was at 45% suggesting that the Santee Cooper Lake System has been and continues to be a popular destination for out-of-state anglers.

The annual non-resident fishing license sales indicate there was a decline in sales between 1992 and 1996 during the heaviest hydrilla coverage (Figure 3). A rising trend in sales peaked between 1996 and 1998 following the greatest reduction in hydrilla. The sales have stabilized over the last four years with an annual average difference of only 2.0%.

The annual resident fishing license sales for the Santee Cooper Counties between 1992 and 2002 indicates that there have been fairly minor fluctuations in sales over the 10-year period (Figure 4). The greatest variation between 1992, which had peak sales and 2001, which had the lowest sales was found to be only approximately 2.0%. The ten-year sales trend has been quite stable and corresponds with sales for the State. This suggests that the presence or absence of hydrilla has not affected the long-term use of the lake system by in-state or out-of-state anglers.

2. Hunting: Waterfowl hunting is a popular activity on the Santee Cooper Lakes. In addition to three SCDNR managed Wildlife Management Areas (WMA) located on the lakes, the public also hunts in undeveloped areas of the lake system. Hunting data collected by the DNR from the WMAs provides the best indication of waterfowl hunting trends on the Santee Cooper Lake System. The total number of hunters increased during the years hydrilla was abundant on the lakes and declined following control of hydrilla by grass carp to pre-hydrilla levels (Figure 5). If taken alone, this relationship suggests that the number of hunters could be related to the presence of hydrilla, and that may be partially true. However, the trend line for the number of hunters on the Santee Cooper WMAs is virtually the same as the trend line for the number of hunters at all WMAs statewide. This latter relationship suggests that the increase of hunters from 1989 to 1995 and the decline after that year is probably related to factors other than hydrilla because hydrilla coverage during those years was limited primarily to the Santee Cooper Lakes yet the increases and decreases occurred in WMAs all over the state.

A similar relationship is apparent when total duck harvest on the Santee Cooper Lakes WMAs is compared to hydrilla growth and statewide duck harvests at all other WMAs (Figure 6). There appears to be a correlation between duck harvest at the Santee Cooper Lakes WMAs and hydrilla growth until it is compared to duck harvests statewide. The similarity of duck harvest trends between the Santee Cooper Lake WMAs and all WMAs statewide suggest that factors other than or in addition to hydrilla coverage is affecting harvest rates. In either case, the number of hunters and ducks harvested after hydrilla control by grass carp is similar to pre-hydrilla levels.

Another indicator of the interest of waterfowl hunting in the Santee Cooper Lakes area is the sale of duck stamps. Duck stamp sales in the counties surrounding the Santee Cooper Lakes have steadily increased 51% from 1992 and 2002 (Figure 7). The rate of increase is in line with statewide duck stamp sales, which have increased 47% during the same time frame. Based on this trend, the control of hydrilla by grass carp has had no affect on the sale of duck stamps in the counties around the Santee Cooper Lakes.

3. Boating: Dense hydrilla mats interfere with the use of boat landings, navigation channels and, in general, restrict the use of recreational boating traffic wherever the mats are present.

VII. CONCLUSIONS

The use of the sterile grass carp for control of nuisance aquatic vegetation has become an accepted alternative, especially in man-made reservoirs throughout the United States. The long-term control provided by grass carp reduces the cost of aquatic plant treatments by reducing or eliminating the need for annual chemical or mechanical control efforts. Further, in areas where chemical and mechanical treatment is not possible or is too expensive, grass carp are the only viable solution.

On-going environmental studies on the Santee Cooper Lakes indicate that while some types of fishing is more difficult due to the loss of vegetative cover, adverse impacts to native fish populations are not apparent and water quality continues to be the same or better than prior to the occurrence of hydrilla. Prior to 1982 when hydrilla was not present in South Carolina, fishing and hunting pressures were affected by other environmental and socio-economic factors. The spread of hydrilla impacted a wide range of interests, including hunting, fishing, swimming, recreational boating, and water withdrawals. The information presented in this amendment indicates that while there have certainly been fluctuations in the fishing and hunting pressures on the Santee Cooper Lake System that appear to be related to the presence of hydrilla, statewide factors in addition to localized factors like hydrilla coverage are probably influencing these activities. Regardless of whether it is localized influences from hydrilla coverage or broader statewide influences, it appears that the removal of hydrilla by grass carp has simply returned this particular lake system to the conditions that existed prior to the spread of hydrilla. Numerous other water bodies in the state that have been stocked with grass carp over the past 17 years, including many DNR managed fishing lakes, appear to support this conclusion.

Based on past experience, sterile grass carp provide a safe, cost effective means of controlling nuisance aquatic vegetation in South Carolina. They are especially effective in controlling the growth of the aquatic weed hydrilla in large public reservoirs where, if left unchecked, it could infest 30% to 50% of the lake and the entire shoreline zone. The reduction of submersed aquatic vegetation by grass carp may temporarily impair the use of public waters for some fishing activities and waterfowl hunting; however, that is offset

by broader public benefits of improved public access and use for other water recreation, water supply, hydropower production, improved water quality, and flood control.

VIII. FINDING OF NO SIGNIFICANT IMPACT (FONSI)

Based upon the attached Environmental Assessment and in consideration of other pertinent documents, I conclude that the environmental effects resulting from the use of the White Amur are not substantial, and that there are not significant new circumstances or information relevant to environmental concerns that warrant the preparation of an Environmental Impact Statement. Specific factors considered in making this Finding of No Significant Impact include the following:

1. Water quality is not significantly affected.

2. Wetlands are not significantly affected.

3. No cultural resource is affected.

4. No significant adverse impacts to threatened or endangered species will occur.

5. No significant land use changes will occur.

6. Air and noise quality will not be significantly affected.

7. Fish and wildlife are not significantly affected.

8. Benthic invertebrate communities are not significantly affected.

Date _____

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VIII. References

de Kozlowski, Steven 1998. Summary of Hydrilla Management on the Santee Cooper Lakes. S.C. Department of Natural Resources, Columbia, SC.

de Kozlowski, Steven. 2004. Hydrilla: History, Concerns, and Control in South Carolina. S.C. Department of Natural Resources, Columbia, SC.

GEC. 2001. Interpretation of Existing Water Quality Data for the Santee Cooper Lake System, South Carolina. U.S. Army Corps of Engineers Contract No: DACW60-98-D-0001, Delivery Order No. 0008.

Kilgore, K. Jack, James P. Kirk, and Jeff W. Foltz. 1998. Response of Littoral Fishes in Upper Lake Marion, South Carolina Following Hydrilla Control by Triploid Grass Carp. Journal of Aquatic Plant Management 36: 82-67.

Kirk, James P., James V. Morrow, K. Jack Kilgore, Steven J. de Kozlowski, and James W. Preacher. 2000. Population Response of Triploid Grass Carp to Declining Levels of Hydrilla in the Santee Cooper Reservoirs. South Carolina. Journal of Aquatic Plant Management, 38: 14-17.

Kirk, James P. 2005. Population Monitoring of Triploid Grass Carp in the Santee Cooper Reservoirs, South Carolina during 2004. Environmental Laboratory, U.S. Army Engineer Research and Development Center, Vicksburg, MS. Prepared for U.S. Army Engineer District, Charleston, SC.

S.C. Department of Natural Resources. Undated document. Response to Concerns of Economic Loss in the Santee Cooper Lakes Region Due to Hydrilla Control.

U.S. Army Corps of Engineers. Environmental Assessment for the Use of the White Amur to Control Hydrilla and Other Submersed Aquatic Plants in South Carolina.

University of Florida, Center for Aquatic and Invasive Plants, Non-indigenous Aquatic Plants. 2003. Hydrilla (*Hydrilla verticillata*).

APPENDIX A

ENVIRONMENTAL ASSESSMENT
for
The Use of the White Amur
to
Control Hydrilla and other Submersed Aquatic Plants
in
South Carolina

I BACKGROUND

a. Santee Cooper Project.

South Carolina has an abundance of water resources. Many are relatively shallow and provide suitable growing conditions for a variety of aquatic plants. The biggest aquatic plant problem in the State is in Lake Marion, which is one of two lakes comprising the Santee Cooper Lakes, a State hydroelectric project.

Lake Marion is a 110,600-acre impoundment on the Santee River, one of the larger rivers on the Atlantic coast. Its average depth is only 13 feet although it is 9 miles in width. The lake was only partially cleared before impoundment so it contains many logs, stumps, standing dead tree trunks and live cypress trees. It is connected to Lake Moultrie, 60,400 acres, by a 7.5 mile diversion canal.

b. Aquatic Plant Problems

The first aquatic plant control efforts in South Carolina were directed at alligatorweed in the Santee Cooper Lakes. Alligatorweed has since become a lesser problem in comparison with elodea, hydrilla, hyacinth and water primrose. Elodea became established in Lake Marion during the 1960's and soon infested a large part of the upper lake. Treatment with herbicides began in 1981 and has continued through the 1988 growing season. Elodea is now widespread throughout much of South Carolina.

Hydrilla was first discovered in late Marion in 1982 and it is continuing to spread into previously uninfested areas. It is also displacing the more easily controlled elodea. Since 1982 it has also become established in other water bodies and will probably spread to others.

c. The White Amur (Ctenopharyngodon idella)

The U.S. Army Engineer Waterways Experiment Station (WES) conducted a Large-Scale Operations Management Test on the use of

Encl 7

the white amur for the control of aquatic plants in Lake Conway, Florida. This test was designed to adapt laboratory and small-scale research results to the field and to integrate them into an operations program. This study confirmed the results of earlier studies which indicated that the white amur can control submersed aquatic plants without significant adverse environmental impact.

Following the completion of studies in Lake Conway and the commercial availability of sterile white amur, the State of South Carolina legalized the stocking of sterile white amur under a permit system in 1985. The permitting system has been discontinued, but only sterile white amur can legally be brought into the State. These fish have been used extensively by private pondowners.

Beginning in 1985, the State has also stocked sterile white amur in various public waters infested with submersed aquatic plants. These water bodies have ranged in size from a 1-acre pond in a State Park to Lake Bowen near Spartanburg which covers 1,600 acres. Results have been generally good.

d. Compliance with the National Environmental Policy Act

A final EIS for the Cooperative Aquatic Plant Control Program in South Carolina was filed with the Environmental Protection Agency (EPA) in May 1981. This EIS covered the control of alligatorweed, Brazilean elodea, and water primrose. With regard to herbicides, it covered the use of 2,4-dichlorophenoxyacetic acid, diquat dibromide, copper triethanolamine or copper ethlenediamine, and endothall. The only biological control agents covered were the three species of insects previously released for the control of alligatorweed.

A Supplemental Information Report providing for the control of other aquatic plants and the use of any herbicide certified by the EPA was filed with the EPA in May 1986.

This Environmental Assessment is prepared specifically to address the proposed use of white amur in Lake Marion on a larger scale than previously tested. In general, it also will serve to address the use of these fish in other public waters.

II NEED FOR THE PROPOSAL

Hydrilla and other submerged aquatic plants characteristically become so dense that they interfere with almost all beneficial uses of water. They cause water quality problems, reduce or adversely affect fish production, interfere with hydropower production by impeding the flow of water,

interfere with all waterbased recreation, and obstruct the movement of boats for whatever purpose. The control of these plants is essential to maintain an acceptable level of public use.

The results achieved to date with herbicides vary with the species of plant and with factors such as the movement of water. Results with herbicides are relatively short lived so the need for frequent treatment can increase the costs to an unacceptable level. Hydrilla is one of the most difficult plants to control, and in Lake Marion where there is some water movement, herbicidal control has proven to be unsatisfactory from almost any viewpoint.

Experience to date with the white amur indicate it is the best means presently available to control hydrilla and other submerged aquatic plants in Lake Marion and other similar situations.

III ALTERNATIVES

Except for the white amur, all alternatives presently available were covered in the final EIS. The EIS predates the testing and legal sanction of the white amur as a control agent for submersed aquatic plants.

The EIS discussion of alternatives continues to be applicable for the most part. While specific costs for some alternatives may have increased, the relative difference in costs between various alternatives is unchanged. The reconsideration of alternatives to include the use of white amur follows:

a. Mechanical Removal

Included in this category are various harvestors, rotovators, and hand removal. Any or all of these may be appropriate in specific situations. However, none are practical in large areas with logs, stumps, and standing trees. All are also much more expensive than herbicides and biological control agents. Cost has always limited the extent we have been able to use even the cheaper control methods.

b. Environmental Manipulation

This technique may be appropriate for certain situations, but is not feasible as a control method in Lake Marion. The lake is so shallow in relation to its area that water drawdown to control aquatic plants might be ineffective and could even favor the spread of hydrilla into deeper water. Also, any

drawdown sufficient to have any beneficial effect on weed reduction would be incompatible with power production and the maintenance of lake levels needed for important fishery resources.

c. Biological Control

This is often the preferred control method because there is no potential for any acute or chronic toxic effects. Many potential control agents are presently under study by Federal and State research organizations and some may eventually be approved for general use. The white amur has been tested extensively to confirm that it will control submerged aquatic plants without adversely affecting other resources. The cost is approximately $100 per acre when the normal stocking rate of 25 fish per acre is used.

Because the proposed use of these fish in Lake Marion is on a larger scale than ever tried before and also involves some variation from procedures previously tested, the possibility exists that the overall effect may differ from results of other tests. This unpredictability relates mainly to the effectiveness of the proposal and not to possible adverse impacts. For example, if the fish tend to move away from weed infested areas and become dispersed into the large noninfested areas available to them, the desired control of weeds may not be achieved.

d. No Action.

Prolific growths of submersed aquatic plants can interfere with practically all water uses. This condition was reached in the upper part of Lake Marion when herbicidal treatment of elodea began in 1982. Now that hydrilla is established and spreading rapidly, the potential area for infestation has probably been increased substantially. No action would clearly result in the rapid expansion of the aquatic plant infestation and a concomitant reduction in public use of such areas.

IV ENVIRONMENTAL IMPACTS

A major anticipated environmental impact is the reduction of the infestation of submersed aquatic plants because of feeding by the white amur. The broad and general interference by dense infestations of submersed aquatic plants with normal water uses would be reduced to the extent such infestations are reduced.

One of the concerns about introducing a new species is that they will become permanently established in their new environment to the overall detriment of the ecosystem. The use

of only sterile fish precludes this potential impact.

The white amur will not compete with native fish. It does not muddy the water when feeding as does the common carp, another introduced species.

Submersed aquatic plants are a food source for migratory waterfowl. However, a reduction of these plants would not significantly affect water fowl because wintering habitat is more than sufficient to accommodate the normal waterfowl population. It is nesting habitat that is the limiting factor on waterfowl abundance.

The use of white amur in a variety of situations shows that submersed aquatic plants can be controlled by the white amur without significant adverse environmental impact.

V PUBLIC REVIEW

The S. C. Aquatic Plant Management Council was created by Executive Order in 1982 to develop and implement a program for control and management of aquatic plants. It is comprised of a representative from each of nine State agencies having an interest in natural resources and one representative from the Governor's Office. When it became obvious that herbicides were not achieving the desired level of weed control in Lake Marion, the Council created an ad hoc committee of four State representatives including the Chief of the Fisheries Section of the S. C. Wildlife & Marine Resources Department (SCWMRD) to consider and develop a plan for using white amur.

The ad hoc committee prepared and presented a plan to the Council. The Council then approved the draft plan for public review and comment. The S. C. Water Resources Commission held public meetings in Pinewood on Feb. 11 and in Santee State Park on Feb. 18, 1988 to explain the plan and to receive public comment. These meetings and the proposed plan were well publicized in the news media. The proposed plan was also sent directly to environmental and user groups such as BASS Clubs and marinas and to agencies including the SCWMRD and the U. S. Fish and Wildlife Service.

The plan was well received with no significant problems revealed during this extensive public coordination. Upon completion of this public review process, the Council gave its final approval of the plan.

APPENDIX B

U.S. Fish and Wildlife Service

South Carolina Distribution Records of
Endangered, Threatened, Candidate and Species of Concern
March 1, 2003

E	Federally endangered
T	Federally threatened
P	Proposed in the Federal Register
CH	Critical Habitat
C	The U.S. Fish and Wildlife Service or the National Marine Fisheries Service has on file sufficient information on biological vulnerability and threat(s) to support proposals to list these species
S/A	Federally protected due to similarity of appearance to a listed species
SC	Federal Species of concern. These species are rare or limited in distribution but are not currently legally protected under the Endangered Species Act.
*	Contact the National Marine Fisheries Service for more information on this species.

County	Common Name	Scientific Name	Status	Occurrence
Berkeley				
	West Indian manatee	*Trichechus manatus*	E	Possible
	Bald eagle	*Haliaeetus leucocephalus*	T	Known
	Wood stork	*Mycteria americana*	E	Known
	Red-cockaded woodpecker	*Picoides borealis*	E	Known
	Loggerhead sea turtle	*Caretta caretta*	T	Known
	Flatwoods salamander	*Ambystoma cingulatum*	T	Known
	Shortnose sturgeon	*Acipenser brevirostrum**	E	Known
	Pondberry	*Lindera melissifolia*	E	Known
	Canby's dropwort	*Oxypolis canbyi*	E	Known
	Chaff-seed	*Schwalbea americana*	E	Known
	Southern Dusky Salamander	*Desmognathus auriculatus*	SC	Possible
	Gopher frog	*Rana capito*	SC	Known
	Incised groovebur	*Agrimonia incisa*	SC	Known
	Wagner's spleenwort	*Asplenium heteroresiliens*	SC	Known
	Chapman's sedge	*Carex chapmanii*	SC	Known
	Ciliate-leaf tickseed	*Coreopsis integrifolia*	SC	Known
	Angiosperm (no common name)	*Elytraria caroliniensis*	SC	Known
	Pondspice	*Litsea aestivalis*	SC	Known
	Boykin's lobelia	*Lobelia boykinii*	SC	Known
	Pineland plantain	*Plantago sparsiflora*	SC	Known
	False coco	*Pteroglossaspis ecristata*	SC	Known
	Awned meadowbeauty	*Rhexia aristosa*	SC	Known
	Brown beaked-rush	*Rhynchospora pleiantha*	SC	Known
	Sun-facing coneflower	*Rudbeckia heliopsidis*	SC	Known

County	Common Name	Scientific Name	Status	Occurrence
Berkeley (cont.)				
	Biltmore green briar	*Smilax biltmoreana*	SC	Known
	Reclined meadow-rue	*Thalictrum subrotundum*	SC	Known
	Least trillium	*Trillium pusillum* var. *pusillum*	SC	Known
	Bachman's sparrow	*Aimophila aestivalis*	SC	Possible
	Henslow's sparrow	*Ammodramus henslowii*	SC	Known
	Black-throated green warbler	*Dendroica virens*	SC	Possible
	Swallow-tailed kite	*Elanoides forficatus forficatus*	SC	Known
	American kestrel	*Falco sparverius*	SC	Possible
	Loggerhead shrike	*Lanius ludovicianus*	SC	Possible
	Painted bunting	*Passerina ciris ciris*	SC	Possible
	Rafinesque's big-eared bat	*Corynorhinus rafinesquii*	SC	Known
	Southeastern myotis	*Myotis austroriparius*	SC	Known
	Southern hognose snake	*Heterodon simus*	SC	Known
Calhoun				
	Bald eagle	*Haliaeetus leucocephalus*	T	Known
	Red-cockaded woodpecker	*Picoides borealis*	E	Possible
	Shortnose sturgeon	*Acipenser brevirostrum* *	E	Known
	Southern Dusky Salamander	*Desmognathus auriculatus*	SC	Possible
	Least trillium	*Trilium pusillum var. pusillum*	SC	Known
	Bachman's sparrow	*Aimophila aestivalis*	SC	Possible
	Henslow's sparrow	*Ammodramus henslowii*	SC	Known
	American kestrel	*Falco sparverius*	SC	Possible
	Loggerhead shrike	*Lanius ludovicianus*	SC	Possible
	Painted bunting	*Passerina ciris ciris*	SC	Possible
Clarendon				
	Bald eagle	*Haliaeetus leucocephalus*	T	Known
	Red-cockaded woodpecker	*Picoides borealis*	E	Known
	Shortnose sturgeon	*Acipenser brevirostrum* *	E	Known
	Canby's dropwort	*Oxypolis canbyi*	E	Known
	Chaff-seed	*Schwalbea americana*	E	Known
	Southern Dusky Salamander	*Desmognathus auriculatus*	SC	Possible
	Elliott's croton	*Croton elliottii*	SC	Known
	Dwarf burhead	*Echinodorus parvulus*	SC	Known
	Creeping St. John's wort	*Hypericum adpressum*	SC	Known
	Southern bog-button	*Lachnocaulon beyrichianum*	SC	Known
	Boykin's lobelia	*Lobelia boykinii*	SC	Known
	False coco	*Pteroglossaspis ecristata*	SC	Known
	Awned meadowbeauty	*Rhexia aristosa*	SC	Known
	Spring-flowering goldenrod	*Solidago verna*	SC	Known
	Bachman's sparrow	*Aimophila aestivalis*	SC	Possible
	Henslow's sparrow	*Ammodramus henslowii*	SC	Known
	American kestrel	*Falco sparverius*	SC	Possible
	Loggerhead shrike	*Lanius ludovicianus*	SC	Possible
	Painted bunting	*Passerina ciris ciris*	SC	Possible

County	Common Name	Scientific Name	Status	Occurrence
Orangeburg				
	Bald eagle	*Haliaeetus leucocephalus*	T	Known
	Red-cockaded woodpecker	*Picoides borealis*	E	Known
	Flatwoods salamander	*Ambystoma cingulatum*	T	Known
	Shortnose sturgeon	*Acipenser brevirostrum* *	E	Known
	Canby's dropwort	*Oxypolis canbyi*	E	Known
	Southern Dusky Salamander	*Desmognathus auriculatus*	SC	Possible
	Gopher frog	*Rana capito*	SC	Known
	Incised groovebur	*Agrimonia incisa*	SC	Known
	Wagner's spleenwort	*Asplenium heteroresiliens*	SC	Known
	Pondspice	*Litsea aestivalis*	SC	Known
	Boykin's lobelia	*Lobelia boykinii*	SC	Known
	Carolina bogmint	*Macbridea caroliniana*	SC	Known
	Awned meadowbeauty	*Rhexia aristosa*	SC	Known
	Bachman's sparrow	*Aimophila aestivalis*	SC	Known
	Henslow's sparrow	*Ammodramus henslowii*	SC	Known
	American kestrel	*Falco sparverius*	SC	Possible
	Loggerhead shrike	*Lanius ludovicianus*	SC	Possible
	Painted bunting	*Passerina ciris ciris*	SC	Possible
	Buff-breasted sandpiper	*Tryngites subruficollis*	SC	Possible
	Southeastern myotis	*Myotis austroriparius*	SC	Known
	Florida pine snake	*Pituophis melanoleucus mugitus*	SC	Known
Sumter				
	Bald eagle	*Haliaeetus leucocephalus*	T	Known
	Red-cockaded woodpecker	*Picoides borealis*	E	Known
	Shortnose sturgeon	*Acipenser brevirostrum**	E	Known
	Canby's dropwort	*Oxypolis canbyi*	E	Known
	Chaff-seed	*Schwalbea americana*	E	Known
	Southern Dusky Salamander	*Desmognathus auriculatus*	SC	Possible
	Dwarf burhead	*Echinodorus parvulus*	SC	Known
	Boykin's lobelia	*Lobelia boykinii*	SC	Known
	Pineland plantain	*Plantago sparsiflora*	SC	Known
	Awned meadowbeauty	*Rhexia aristosa*	SC	Known
	Biltmore greenbrier	*Smilax biltmoreana*	SC	Known
	Bachman's sparrow	*Aimophila aestivalis*	SC	Known
	Henslow's sparrow	*Ammodramus henslowii*	SC	Known
	American kestrel	*Falco sparverius*	SC	Possible
	Loggerhead shrike	*Lanius ludovicianus*	SC	Possible
	Painted bunting	*Passerina ciris ciris*	SC	Possible
	Madtom, broadtail	*Noturus* sp. 2	SC	Possible

South Carolina Rare, Threatened & Endangered Species Inventory

Species Found In Berkeley County

Data Last Updated June 9th, 2003.

SCIENTIFIC NAME	COMMON NAME	GLOBAL RANK	STATE RANK	LEGAL STATUS
ACIPENSER BREVIROSTRUM	SHORTNOSE STURGEON	G3	S3	FE/SE
AGALINIS APHYLLA	COASTAL PLAIN FALSE-FOXGLOVE	G3G4	S?	SC
AGRIMONIA INCISA	INCISED GROOVEBUR	G3	S1	NC
AMBYSTOMA CINGULATUM	FLATWOODS SALAMANDER	G2G3	S1	FT/SE
AMBYSTOMA TIGRINUM TIGRINUM	EASTERN TIGER SALAMANDER	G5T5	S2S3	SC
AMPHIANTHUS PUSILLUS	POOL SPRITE	G2	S1	FT/ST
AMPHICARPUM MUEHLENBERGIANUM	BLUE MAIDEN-CANE	G4	S?	SC
ANDROPOGON MOHRII	BROOMSEDGE	G4?	S?	SC
ANDROPOGON PERANGUSTATUS	NARROW LEAVED BLUESTEM	G5T3T4	S1	SC
ANTHAENANTIA RUFA	PURPLE SILKYSCALE	G5	S?	SC
ARISTIDA BEYRICHIANA	BEYRICH'S THREE-AWN	G5?	S?	SC
ASPLENIUM HETERORESILIENS	WAGNER'S SPLEENWORT	G2Q	S1	NC
ASPLENIUM RESILIENS	BLACK-STEM SPLEENWORT	G5	S1S2	SC
BACOPA CYCLOPHYLLA	COASTAL-PLAIN WATER-HYSSOP	G3G5	S1	SC
BURMANNIA BIFLORA	NORTHERN BURMANNIA	G4G5	S?	SC
CALOPOGON BARBATUS	BEARDED GRASS-PINK	G4?	S?	SC
CALOPOGON MULTIFLORUS	MANY-FLOWER GRASS-PINK	G2G3	SR	SC
CAREX BASIANTHA		G5	SR	SC
CAREX CHAPMANII	CHAPMAN'S SEDGE	G3	S1	NC

CAREX CHEROKEENSIS	CHEROKEE SEDGE	G4G5	SR	SC
CAREX CRUS-CORVI	RAVENFOOT SEDGE	G5	S?	SC
CAREX ELLIOTTII	ELLIOTT'S SEDGE	G4?	S?	SC
CAREX GRANULARIS	MEADOW SEDGE	G5	S?	SC
CARYA MYRISTICIFORMIS	NUTMEG HICKORY	G4	S1	RC
CASTILLEJA COCCINEA	SCARLET INDIAN-PAINTBRUSH	G5	S2	RC
CHAMAEDAPHNE CALYCULATA	LEATHERLEAF	G5	S?	SC
CLEMMYS GUTTATA	SPOTTED TURTLE	G5	S5	ST
COLONIAL WATERBIRD		G?	S?	SC
COREOPSIS GLADIATA	SOUTHEASTERN TICKSEED	G3G5	S?	SC
COREOPSIS INTEGRIFOLIA	CILIATE-LEAF TICKSEED	G1G2	SR	SC
CORYNORHINUS RAFINESQUII	RAFINESQUE'S BIG-EARED BAT	G3G4	S2?	SE
ELANOIDES FORFICATUS	AMERICAN SWALLOW-TAILED KITE	G5	S2	SE
ELEOCHARIS ROBBINSII	ROBBINS SPIKERUSH	G4G5	S?	SC
ELEOCHARIS TRICOSTATA	THREE-ANGLE SPIKERUSH	G4	SR	SC
EPIDENDRUM CONOPSEUM	GREEN-FLY ORCHID	G4	S?	SC
ERYNGIUM AQUATICUM VAR RAVENELII	MARSH ERYNGO	G4T2T4Q	S?	SC
EUPATORIUM RECURVANS	COASTAL-PLAIN THOROUGH-WORT	G3G4Q	SR	SC
HABENARIA QUINQUESETA	LONG-HORN ORCHID	G4G5	S?	SC
HALIAEETUS LEUCOCEPHALUS	BALD EAGLE	G4	S2	FT/SE
HELENIUM PINNATIFIDUM	SOUTHEASTERN SNEEZEWEED	G4	S?	SC
HETERODON SIMUS	SOUTHERN HOGNOSE SNAKE	G2	S?	SC
IRIS HEXAGONA	WALTER'S IRIS	G4G5	S?	SC
LACHNOCAULON MINUS	SMALL'S BOG BUTTON	G3G4	SR	SC
LINDERA MELISSIFOLIA	PONDBERRY	G2	S1	FE/SE
LISTERA AUSTRALIS	SOUTHERN TWAYBLADE	G4	S?	SC
LITSEA AESTIVALIS	PONDSPICE	G3	S3	SC
LOBELIA BOYKINII	BOYKIN'S LOBELIA	G2G3	S?	SC
LYSIMACHIA HYBRIDA	LANCE-LEAF LOOSESTRIFE	G5	S1	SC

MELANTHIUM VIRGINICUM	VIRGINIA BUNCHFLOWER	G5	S?	SC
MENISPERMUM CANADENSE	CANADA MOONSEED	G5	S?	SC
MYOTIS AUSTRORIPARIUS	SOUTHEASTERN MYOTIS	G3G4	S1	SC
MYRIOPHYLLUM LAXUM	PIEDMONT WATER-MILFOIL	G3	S2	RC
NEOTOMA FLORIDANA FLORIDANA	EASTERN WOODRAT	G5T5	S3S4	SC
NERODIA CYCLOPION	GREEN WATER SNAKE	G5	S2	SC
NERODIA FLORIDANA	FLORIDA GREEN WATER SNAKE	G5	S2	SC
OPHIOGLOSSUM PETIOLATUM	LONGSTEM ADDER'S-TONGUE FERN	G5	S?	SC
OXYPOLIS CANBYI	CANBY'S DROPWORT	G2	S1	FE/SE
PELTANDRA SAGITTIFOLIA	SPOON-FLOWER	G3G4	S?	SC
PHYSOSTEGIA LEPTOPHYLLA	SLENDER-LEAVED DRAGON-HEAD	G4?	S?	SC
PICOIDES BOREALIS	RED-COCKADED WOODPECKER	G3	S2	FE/SE
PILEA FONTANA	SPRINGS CLEARWEED	G5	S?	SC
PLANTAGO SPARSIFLORA	PINELAND PLANTAIN	G3	S?	SC
PLATANTHERA INTEGRA	YELLOW FRINGELESS ORCHID	G3G4	S2	SC
PLATANTHERA LACERA	GREEN-FRINGE ORCHIS	G5	S1	SC
PONTHIEVA RACEMOSA	SHADOW-WITCH ORCHID	G4G5	S?	SC
PTEROGLOSSASPIS ECRISTATA	CRESTLESS PLUME ORCHID	G2	S2	SC
QUERCUS SIMILIS	BOTTOM-LAND POST OAK	G4Q	S1	SC
RANA CAPITO	GOPHER FROG	G3	S1	SE
RHEXIA ARISTOSA	AWNED MEADOWBEAUTY	G3	S2	SC
RHYNCHOSPORA BREVISETA	SHORT-BRISTLE BALDRUSH	G3G4	S?	SC
RHYNCHOSPORA CAREYANA	HORNED BEAKRUSH	G4?Q	SR	SC
RHYNCHOSPORA CEPHALANTHA VAR ATTENUATA		G5T3?	SR	SC
RHYNCHOSPORA HARPERI	HARPER BEAKRUSH	G4?	S?	SC
RHYNCHOSPORA INUNDATA	DROWNED HORNEDRUSH	G3G4	S?	SC

RHYNCHOSPORA OLIGANTHA	FEW-FLOWERED BEAKED-RUSH	G4	S?	SC
RHYNCHOSPORA PLEIANTHA	BROWN BEAKED-RUSH	G2	S?	SC
RHYNCHOSPORA STENOPHYLLA	CHAPMAN BEAKRUSH	G4	S?	SC
RHYNCHOSPORA TRACYI	TRACY BEAKRUSH	G4	S?	SC
RUDBECKIA HELIOPSIDIS	SUN-FACING CONEFLOWER	G2	S1	NC
SARRACENIA RUBRA	SWEET PITCHER-PLANT	G3	S1	SC
SCHWALBEA AMERICANA	CHAFFSEED	G2	S2	FE/SE
SCLERIA BALDWINII	BALDWIN NUTRUSH	G4	S1S2	SC
SEMINATRIX PYGAEA	BLACK SWAMP SNAKE	G5	S?	SC
SMILAX BILTMOREANA	BILTMORE GREENBRIER	G4?	S?	SC
SPIRANTHES LACINIATA	LACE-LIP LADIES'-TRESSES	G4G5	S1	SC
SPOROBOLUS CURTISSII	PINELAND DROPSEED	G3	SR	SC
STERNA ANTILLARUM	LEAST TERN	G4	S3	ST
THALICTRUM SUBROTUNDUM	RECLINED MEADOW-RUE	G1G2Q	S1	SC
TRILLIUM PUSILLUM VAR PUSILLUM	LEAST TRILLIUM	G3T2	S1	NC
TRIPHORA TRIANTHOPHORA	NODDING POGONIA	G3G4	S2	SC
UTRICULARIA MACRORHIZA	GREATER BLADDERWORT	G5	SR	SC

Species Found In Calhoun County

Data Last Updated June 9th, 2003.

SCIENTIFIC NAME	**COMMON NAME**	**GLOBAL RANK**	**STATE RANK**	**LEGAL STATUS**
ACIPENSER BREVIROSTRUM	SHORTNOSE STURGEON	G3	S3	FE/SE
ARISTIDA CONDENSATA	PIEDMONT THREE-AWNED GRASS	G4?	S?	SC
CAMPANULA AMERICANA	TALL BELLFLOWER	G5	S1	SC
CAREX BASIANTHA		G5	SR	SC
CAREX DECOMPOSITA	CYPRESS-KNEE SEDGE	G3	S?	SC

DODECATHEON MEADIA	SHOOTING-STAR	G5	S?	SC
HALIAEETUS LEUCOCEPHALUS	BALD EAGLE	G4	S2	FT/SE
HETERANTHERA RENIFORMIS	KIDNEYLEAF MUD-PLANTAIN	G5	S?	SC
IPOMOPSIS RUBRA	RED STANDING-CYPRESS	G4G5	S?	SC
LYCOPUS COKERI	CAROLINA BUGLEWEED	G3	S?	SC
MAGNOLIA PYRAMIDATA	PYRAMID MAGNOLIA	G4	S1	RC
MELANTHIUM VIRGINICUM	VIRGINIA BUNCHFLOWER	G5	S?	SC
MENISPERMUM CANADENSE	CANADA MOONSEED	G5	S?	SC
NESTRONIA UMBELLULA	NESTRONIA	G4	S2	SC
PILEA FONTANA	SPRINGS CLEARWEED	G5	S?	SC
PONTHIEVA RACEMOSA	SHADOW-WITCH ORCHID	G4G5	S?	SC
RHODODENDRON EASTMANII	MAY WHITE	G2	S2	SC
SCIURUS NIGER	EASTERN FOX SQUIRREL	G5	S4	SC
TRILLIUM PUSILLUM VAR PUSILLUM	LEAST TRILLIUM	G3T2	S1	NC
URTICA CHAMAEDRYOIDES	WEAK NETTLE	G4G5	S?	SC

Species Found In Clarendon County

Data Last Updated June 9th, 2003.

SCIENTIFIC NAME	**COMMON NAME**	**GLOBAL RANK**	**STATE RANK**	**LEGAL STATUS**
AGALINIS APHYLLA	COASTAL PLAIN FALSE-FOXGLOVE	G3G4	S?	SC
AGRIMONIA PUBESCENS	SOFT GROOVEBUR	G5	S1	SC
BACOPA CYCLOPHYLLA	COASTAL-PLAIN WATER-HYSSOP	G3G5	S1	SC
CAREX DECOMPOSITA	CYPRESS-KNEE SEDGE	G3	S?	SC
CAROLINA BAY		G?	S?	SC
CLEMMYS GUTTATA	SPOTTED TURTLE	G5	S5	ST
COLONIAL WATERBIRD		G?	S?	SC

COREOPSIS GLADIATA	SOUTHEASTERN TICKSEED	G3G5	S?	SC
CUSCUTA INDECORA	DODDER; LOVE-VINE	G5	S?	SC
ECHINODORUS PARVULUS	DWARF BURHEAD	G3Q	S2	SC
GENTIANA AUTUMNALIS	PINE BARREN GENTIAN	G3	S2	SC
HALIAEETUS LEUCOCEPHALUS	BALD EAGLE	G4	S2	FT/SE
HELENIUM PINNATIFIDUM	SOUTHEASTERN SNEEZEWEED	G4	S?	SC
HYDROLEA CORYMBOSA	CORYMB FIDDLELEAF	G5	S1	SC
HYPERICUM ADPRESSUM	CREEPING ST. JOHN'S-WORT	G2G3	S1	RC
HYPERICUM HARPERI		G3	S?	SC
LACHNOCAULON BEYRICHIANUM	SOUTHERN BOG-BUTTON	G2G3	S?	SC
LILAEOPSIS CAROLINENSIS	CAROLINA LILAEOPSIS	G3G5	S1	NC
LOBELIA BOYKINII	BOYKIN'S LOBELIA	G2G3	S?	SC
OXYPOLIS CANBYI	CANBY'S DROPWORT	G2	S1	FE/SE
PICOIDES BOREALIS	RED-COCKADED WOODPECKER	G3	S2	FE/SE
PTEROGLOSSASPIS ECRISTATA	CRESTLESS PLUME ORCHID	G2	S2	SC
RHEXIA ARISTOSA	AWNED MEADOWBEAUTY	G3	S2	SC
RHYNCHOSPORA CAREYANA	HORNED BEAKRUSH	G4?Q	SR	SC
RHYNCHOSPORA INUNDATA	DROWNED HORNEDRUSH	G3G4	S?	SC
RHYNCHOSPORA TRACYI	TRACY BEAKRUSH	G4	S?	SC
SAGITTARIA ISOETIFORMIS	SLENDER ARROW-HEAD	G4?	S2	SC
SARRACENIA RUBRA	SWEET PITCHER-PLANT	G3	S1	SC
SCHWALBEA AMERICANA	CHAFFSEED	G2	S2	FE/SE
SCLERIA BALDWINII	BALDWIN NUTRUSH	G4	S1S2	SC
VALLISNERIA AMERICANA	EEL-GRASS	G5	S?	SC

Species Found In Orangeburg County

Data Last Updated June 9th, 2003

SCIENTIFIC NAME	COMMON NAME	GLOBAL RANK	STATE RANK	LEGAL STATUS
ACIPENSER BREVIROSTRUM	SHORTNOSE STURGEON	G3	S3	FE/SE
AGRIMONIA INCISA	INCISED GROOVEBUR	G3	S1	NC
AMPHICARPUM MUEHLENBERGIANUM	BLUE MAIDEN-CANE	G4	S?	SC
ARISTIDA CONDENSATA	PIEDMONT THREE-AWNED GRASS	G4?	S?	SC
ASPLENIUM HETERORESILIENS	WAGNER'S SPLEENWORT	G2Q	S1	NC
ASPLENIUM RESILIENS	BLACK-STEM SPLEENWORT	G5	S1S2	SC
BACOPA CYCLOPHYLLA	COASTAL-PLAIN WATER-HYSSOP	G3G5	S1	SC
CAREX AMPHIBOLA	NARROWLEAF SEDGE	G5	S?	SC
CAREX BASIANTHA		G5	SR	SC
CAREX DECOMPOSITA	CYPRESS-KNEE SEDGE	G3	S?	SC
CAREX GRANULARIS	MEADOW SEDGE	G5	S?	SC
CAROLINA BAY		G?	S?	SC
COLONIAL WATERBIRD		G?	S?	SC
CORYNORHINUS RAFINESQUII	RAFINESQUE'S BIG-EARED BAT	G3G4	S2?	SE
ELLIPTIO CONGARAEA	CAROLINA SLABSHELL	G4	S?	SC
HALIAEETUS LEUCOCEPHALUS	BALD EAGLE	G4	S2	FT/SE
HELENIUM PINNATIFIDUM	SOUTHEASTERN SNEEZEWEED	G4	S?	SC
ILEX AMELANCHIER	SARVIS HOLLY	G4	S3	SC
ISOETES RIPARIA	RIVER BANK QUILLWORT	G5?	S1	SC
LITSEA AESTIVALIS	PONDSPICE	G3	S3	SC
LOBELIA BOYKINII	BOYKIN'S LOBELIA	G2G3	S?	SC
MYOTIS AUSTRORIPARIUS	SOUTHEASTERN MYOTIS	G3G4	S1	SC

MYRIOPHYLLUM LAXUM	PIEDMONT WATER-MILFOIL	G3	S2	RC
NOLINA GEORGIANA	GEORGIA BEARGRASS	G3G5	S?	SC
OXYPOLIS CANBYI	CANBY'S DROPWORT	G2	S1	FE/SE
PICOIDES BOREALIS	RED-COCKADED WOODPECKER	G3	S2	FE/SE
PITUOPHIS MELANOLEUCUS	PINE OR GOPHER SNAKE	G4	S3S4	SC
POTAMOGETON FOLIOSUS	LEAFY PONDWEED	G5	S?	SC
PSEUDOBRANCHUS STRIATUS	DWARF SIREN	G5	S2	ST
RANA CAPITO	GOPHER FROG	G3	S1	SE
RHEXIA ARISTOSA	AWNED MEADOWBEAUTY	G3	S2	SC
RHODODENDRON FLAMMEUM	PIEDMONT AZALEA	G3	S2	SC
RHYNCHOSPORA HARPERI	HARPER BEAKRUSH	G4?	S?	SC
RHYNCHOSPORA TRACYI	TRACY BEAKRUSH	G4	S?	SC
SCIRPUS ERISMANAE	A BULRUSH	G?Q	S?	SC
SCIURUS NIGER	EASTERN FOX SQUIRREL	G5	S4	SC
SCLERIA BALDWINII	BALDWIN NUTRUSH	G4	S1S2	SC
TRADESCANTIA VIRGINIANA	VIRGINIA SPIDERWORT	G5	S?	SC
TRIDENS CAROLINIANUS	CAROLINA FLUFF GRASS	G3	S?	SC
UTRICULARIA OLIVACEA	PIEDMONT BLADDERWORT	G4	S1	SC
VILLOSA DELUMBIS	EASTERN CREEKSHELL	G4	S?	SC

Species Found In Sumter County

Data Last Updated June 9th, 2003.

SCIENTIFIC NAME	**COMMON NAME**	**GLOBAL RANK**	**STATE RANK**	**LEGAL STATUS**
ACRIS CREPITANS CREPITANS	NORTHERN CRICKET FROG	G5T5	S5	SC
ARISTIDA CONDENSATA	PIEDMONT THREE-AWNED GRASS	G4?	S?	SC
CAREX DECOMPOSITA	CYPRESS-KNEE SEDGE	G3	S?	SC
CAROLINA BAY		G?	S?	SC

CARYA MYRISTICIFORMIS	NUTMEG HICKORY	G4	S1	RC
CHAMAEDAPHNE CALYCULATA	LEATHERLEAF	G5	S?	SC
COLONIAL WATERBIRD		G?	S?	SC
CORYNORHINUS RAFINESQUII	RAFINESQUE'S BIG-EARED BAT	G3G4	S2?	SE
CYPERUS LECONTEI	LECONTE FLATSEDGE	G4?	S?	SC
ECHINODORUS PARVULUS	DWARF BURHEAD	G3Q	S2	SC
ECHINODORUS TENELLUS	DWARF BURHEAD	G5?	S?	SC
ELEOCHARIS ROBBINSII	ROBBINS SPIKERUSH	G4G5	S?	SC
EUPATORIUM RECURVANS	COASTAL-PLAIN THOROUGH-WORT	G3G4Q	SR	SC
HALIAEETUS LEUCOCEPHALUS	BALD EAGLE	G4	S2	FT/SE
ICTINIA MISSISSIPPIENSIS	MISSISSIPPI KITE	G5	S4	SC
LOBELIA BOYKINII	BOYKIN'S LOBELIA	G2G3	S?	SC
MICRURUS FULVIUS	EASTERN CORAL SNAKE	G5	S2	SC
NESTRONIA UMBELLULA	NESTRONIA	G4	S2	SC
OXYPOLIS CANBYI	CANBY'S DROPWORT	G2	S1	FE/SE
PICOIDES BOREALIS	RED-COCKADED WOODPECKER	G3	S2	FE/SE
PLANTAGO SPARSIFLORA	PINELAND PLANTAIN	G3	S?	SC
RHEXIA ARISTOSA	AWNED MEADOWBEAUTY	G3	S2	SC
RHEXIA CUBENSIS	WEST INDIAN MEADOW-BEAUTY	G4G5	SR	SC
RHYNCHOSPORA SCIRPOIDES	LONG-BEAKED BALDRUSH	G4	SR	SC
RUELLIA CAROLINIENSIS SSP CILIOSA	A PETUNIA	G5T3T4	S?	SC
SAGITTARIA ISOETIFORMIS	SLENDER ARROW-HEAD	G4?	S2	SC
SCHWALBEA AMERICANA	CHAFFSEED	G2	S2	FE/SE
SCLERIA BALDWINII	BALDWIN NUTRUSH	G4	S1S2	SC
STERNA ANTILLARUM	LEAST TERN	G4	S3	ST
URSUS AMERICANUS	BLACK BEAR	G5	S3?	SC

KEY

GRANK – the Nature Conservancy rating of degree of endangerment world-wide:

G1 – Critically imperiled globally because of extreme rarity or because of some factor(s) making it especially vulnerable to extinction
G2 – Imperiled globally because of rarity or factor(s) making it vulnerable
G3 – Either very rare throughout its range or found locally in a restricted range, or having factors making it vulnerable
G4 – Apparently secure globally, though it may be rare in parts of its range
G5 – Demonstrably secure globally, though it may be rare in parts of its range
GH – Of historical occurrence throughout its range, with possibility of rediscovery
GX – Extinct throughout it range
G? – Status unknown

SRANK – the Nature Conservancy rating of degree of endangerment in South Carolina:

S1 - Critically imperiled state-wide because of extreme rarity or because of some factor(s) making it especially vulnerable to extirpation
S2 – Imperiled state-wide because of rarity or factor(s) making it vulnerable
S3 – Rare or uncommon in state
S4 – Apparently secure in state
S5 – Demonstrably secure in state
SA – Accidental instate (usually birds or butterflies that are far outside normal range)
SE – Exotic established in state
SH – Of historical occurrence in state, with possibility of rediscovery
SN – Regularly occurring in state, but in a migratory, non-breeding form
SR – Reported in state, but without good documentation
SX – Extirpated from state
S? – Status unknown

STATUS – legal status:

FE – Federal endangered
FT – Federal Threatened
PE – Proposed for Federal listing as Endangered
PT – Proposed for Federal listing as Threatened
C - Candidate for Federal listing
NC – Of Concern, National (unofficial – plants only)
RC – Of Concern, Regional (unofficial – plants only)
SE – State Endangered (official state list – animals only)
ST – State Threatened (official state list – animals only)
SC – Of Concern, State
SX – State Extirpated

Data was obtained from the S.C. Department of Natural Resources T&E species website (12/22/2003)

FIGURES

Figure 1. Santee Cooper Counties Accomodation Tax Summary by Year

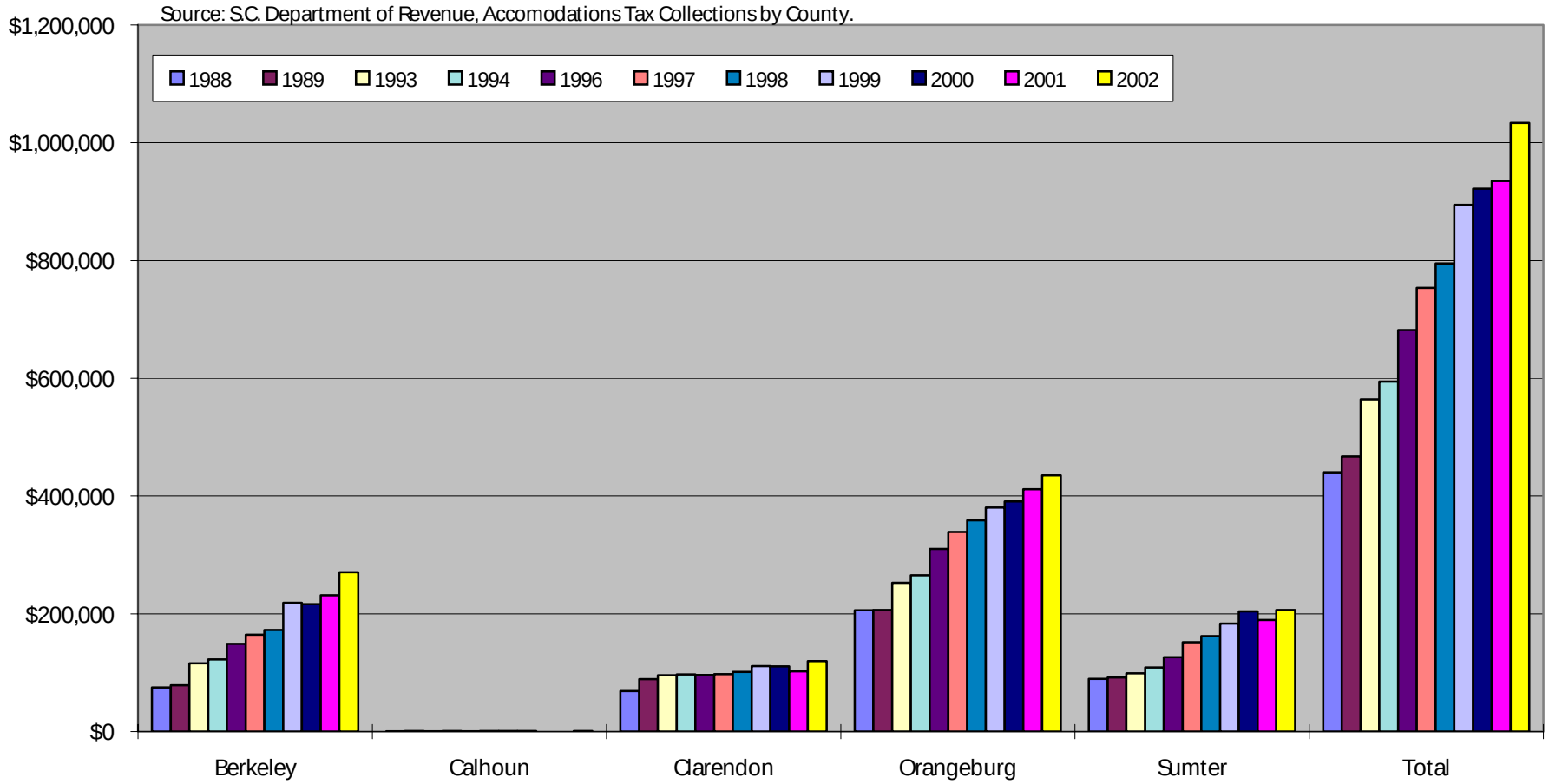

Figure 2. 7-Day Non-Resident Fishing License Sales
Santee Cooper Counties vs State Totals

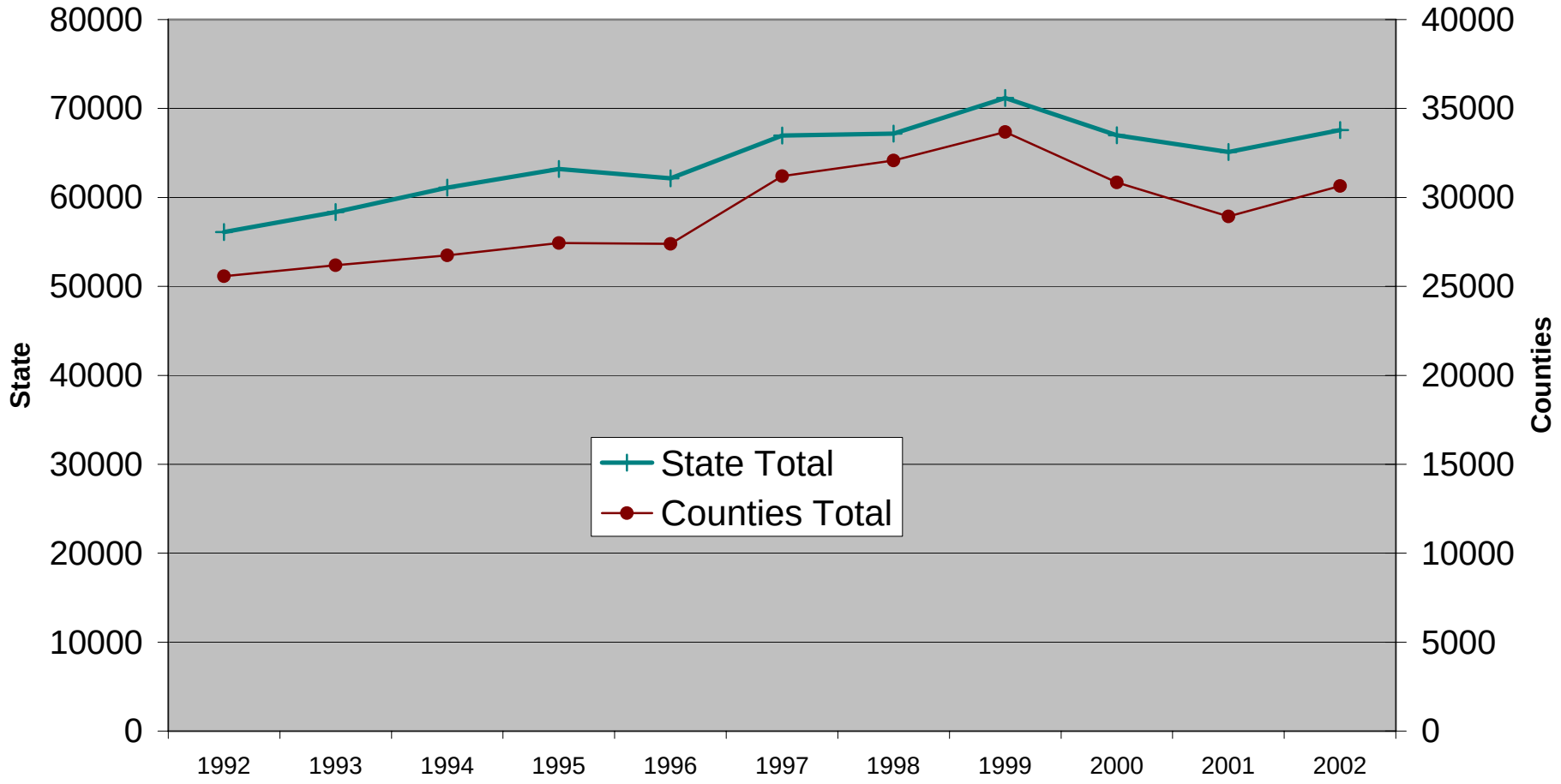

Figure 3. Annual Non-resident Fishing License Sales Santee Cooper Counties vs State Totals

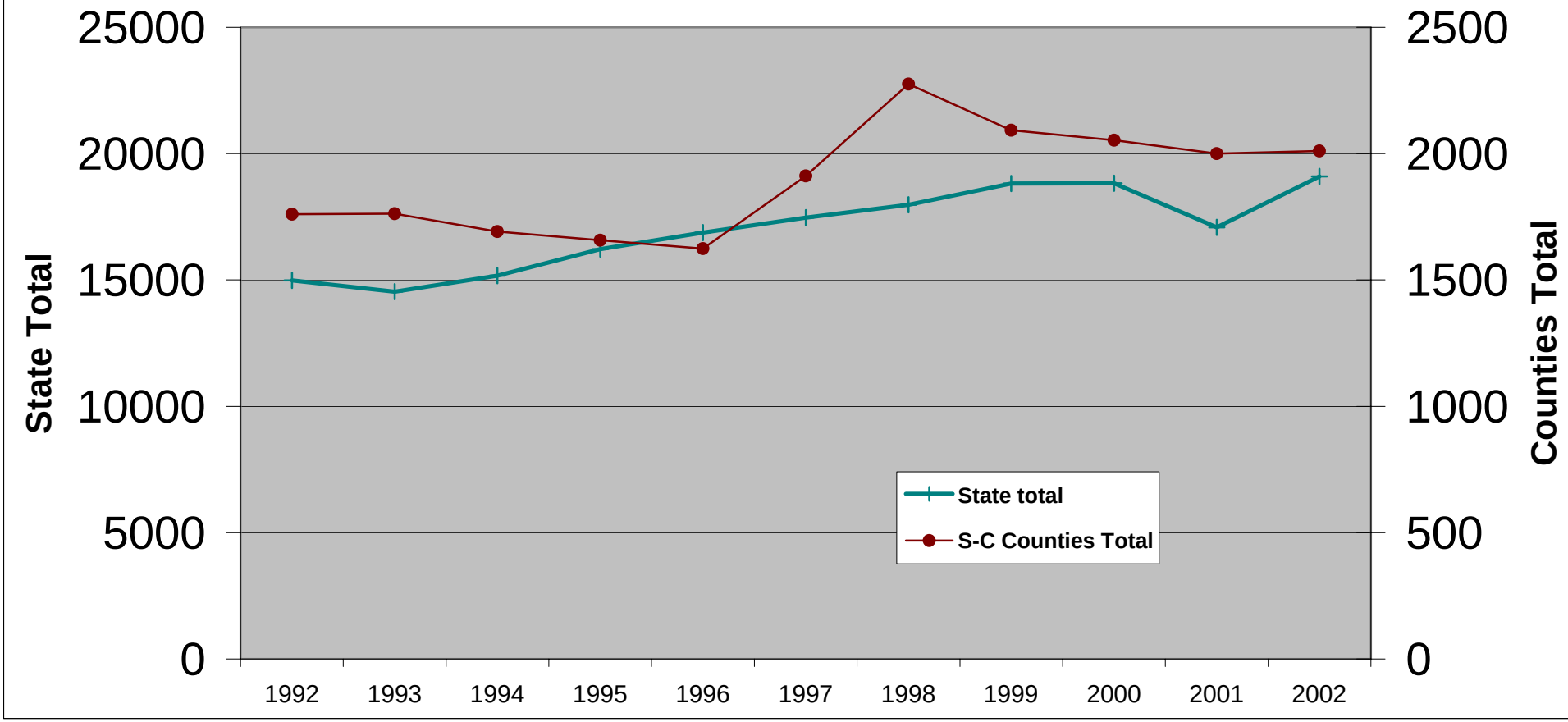

Figure 4. Annual Resident Fishing License Sales
Santee Cooper Counties vs. State Totals

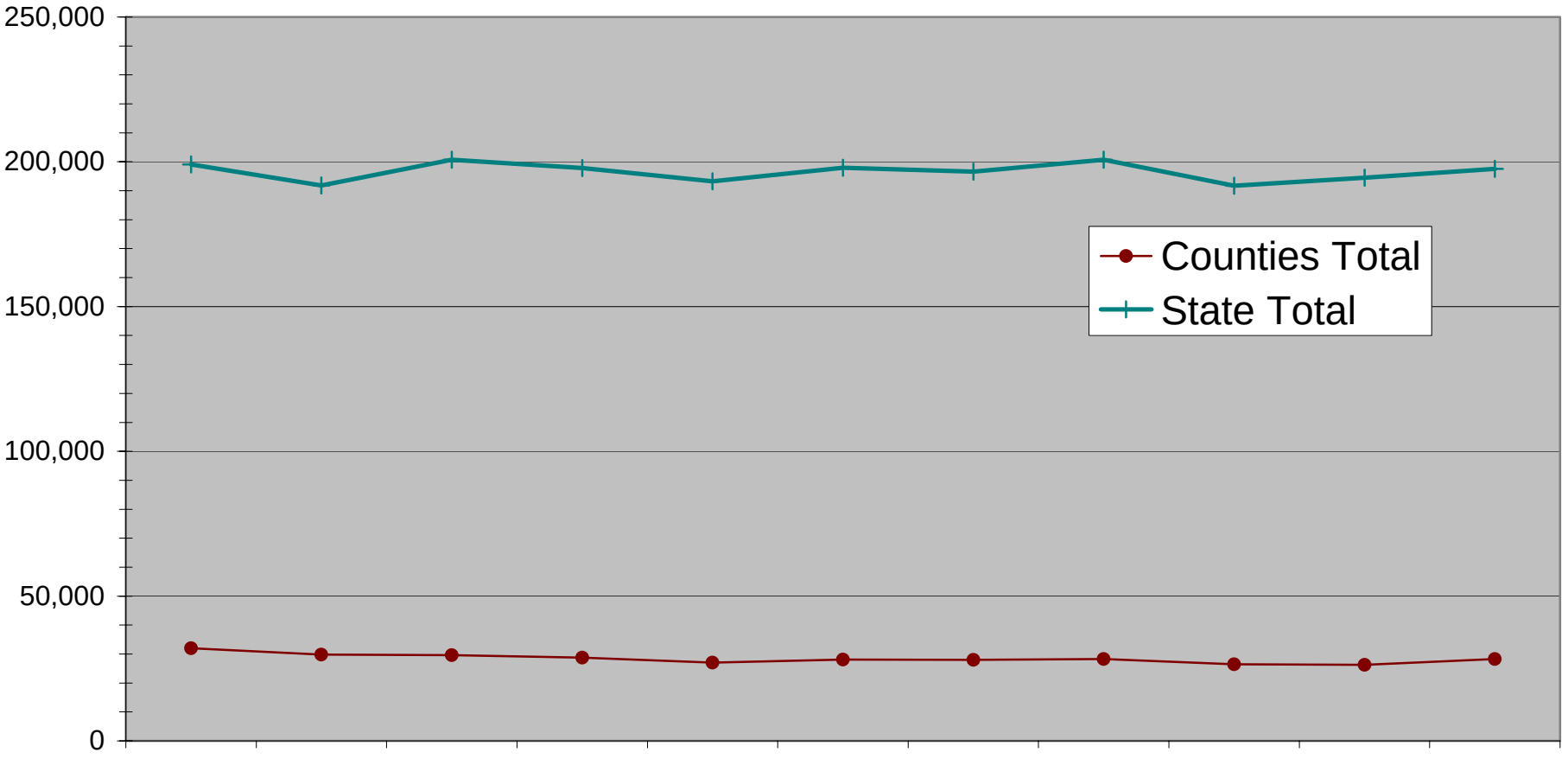

Figure 5. Total Number of Hunters at Santee Cooper WMA's and Statewide vs Hydrilla Coverage on the Santee Cooper Lakes

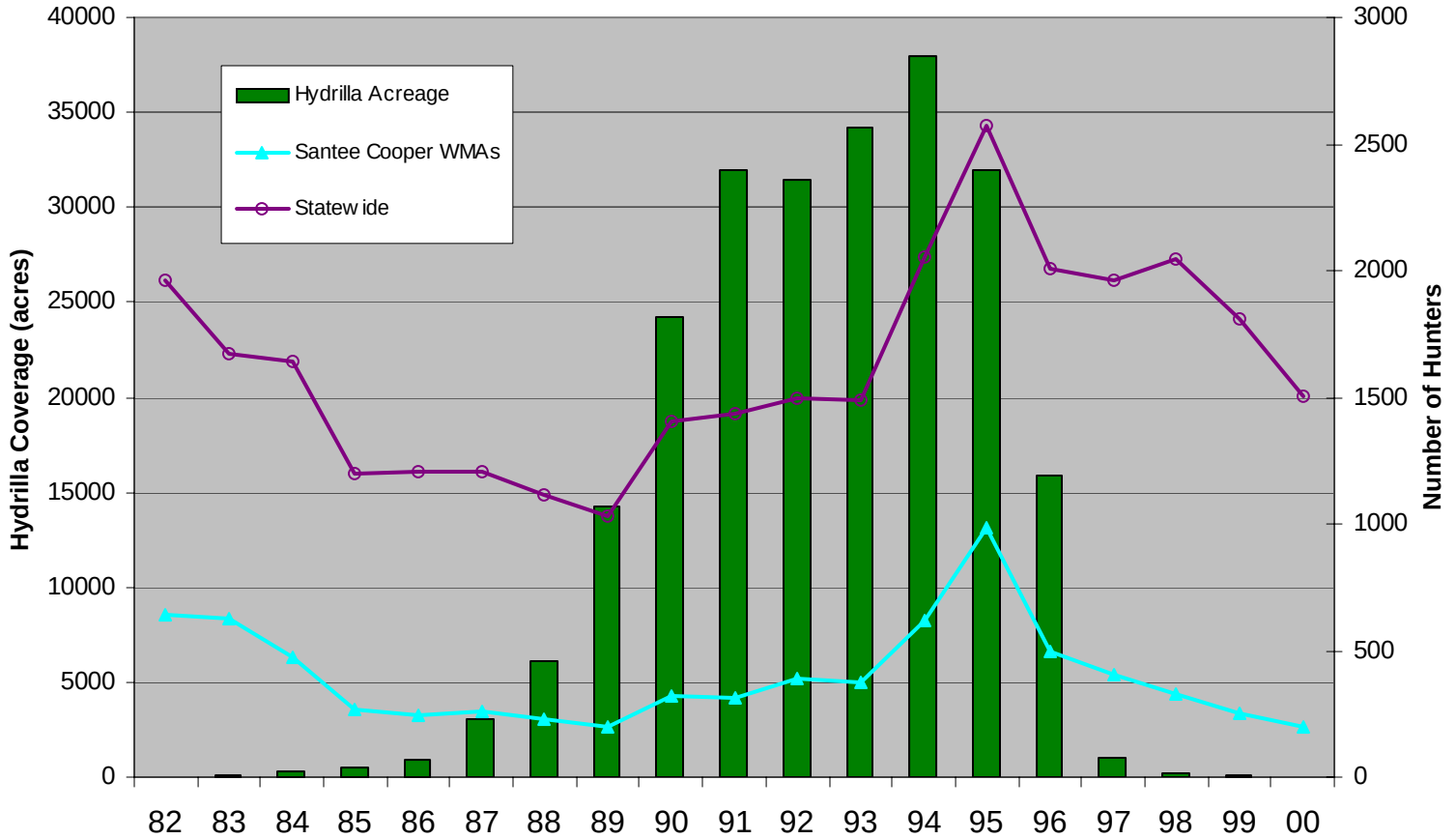

Figure 6. Total Duck Harvest Statewide and at Santee Cooper WMA's vs Hydrilla Coverage on the Santee Cooper Lakes

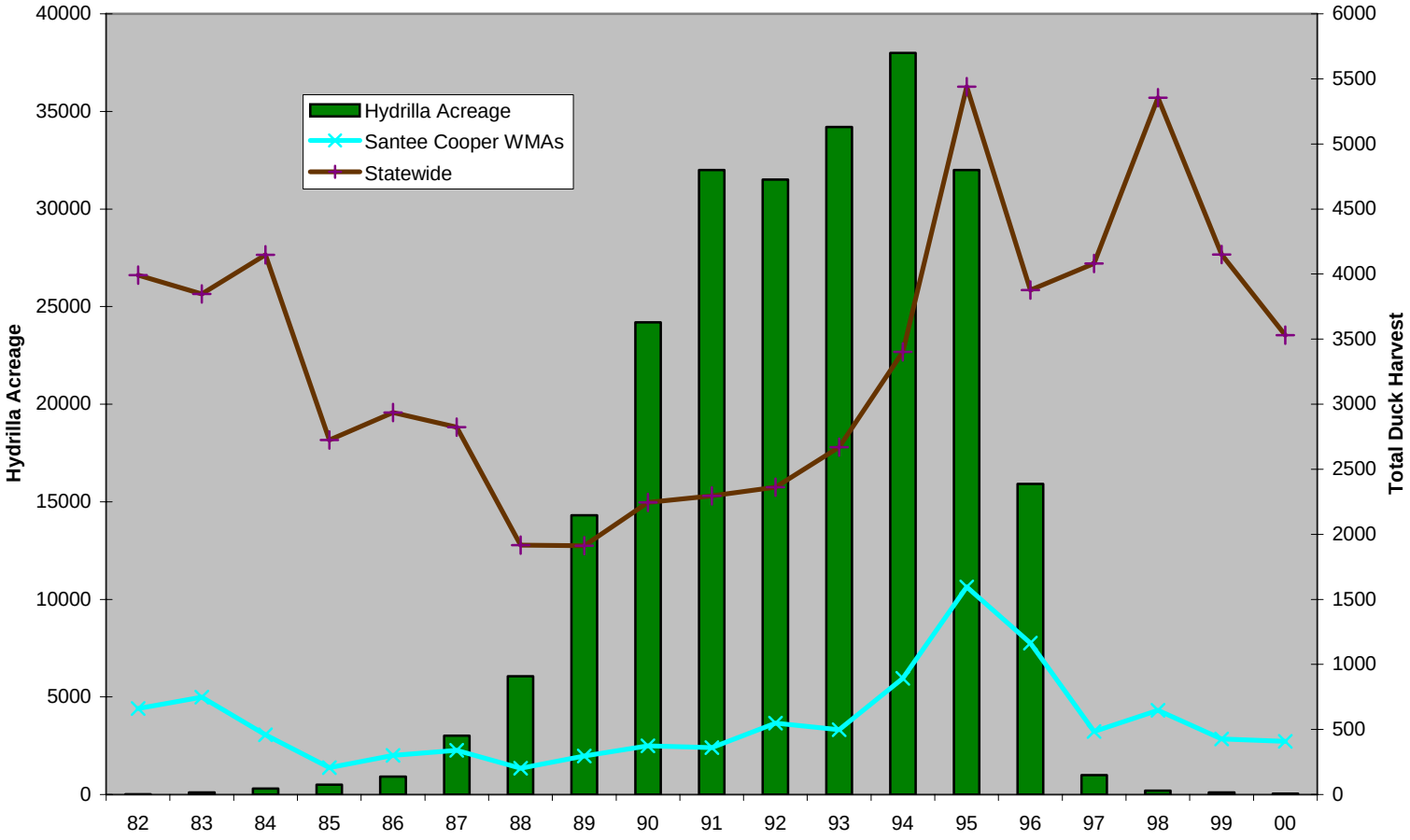

Figure 7. Duck Stamp Sales
Santee Cooper Counties vs State Totals