DISTRIBUTION OF AQUATIC MACROPHYTES IN 15 LAKES AND STREAMS IN SOUTH CAROLINA, 1985

By Glenn G. Patterson and Bruce A. Davis

U.S. GEOLOGICAL SURVEY

Water-Resources Investigations Report 89-4132

Prepared in cooperation with the

SOUTH CAROLINA AQUATIC PLANT MANAGEMENT COUNCIL and

SOUTH CAROLINA WATER RESOURCES COMMISSION

Columbia, South Carolina

1991

DEPARTMENT OF THE INTERIOR

MANUEL LUJAN, JR., Secretary

U.S. GEOLOGICAL SURVEY

Dallas L. Peck, Director

For additional information
write to:

District Chief
U.S. Geological Survey
720 Gracern Road
Suite 129
Columbia, South Carolina 29210

Copies of this report may be
purchased from:

U.S. Geological Survey
Books and Open-File Reports Section
Federal Center, Bldg. 810
Box 25425
Denver, Colorado 80225

CONTENTS

ILLUSTRATIONS

TABLES

DISTRIBUTION OF AQUATIC MACROPHYTES IN 15 LAKES AND STREAMS IN SOUTH CAROLINA

By Glenn G. Patterson and Bruce A. Davis

ABSTRACT

South Carolina, like other Southeastern States, is experiencing problems caused by excessive growth of submerged and emergent herbaceous aquatic macrophytes in lakes and streams. The primary problem is interference with boat travel, although water quality problems also occur. Six problem species have been introduced into the State from other continents. The distribution of the most abundant aquatic plants was mapped for 15 lakes and streams in the State in 1985 using a combination of remote sensing techniques and field surveys. In the 15 lakes and streams mapped, the areas most affected by aquatic macrophytes were the Cooper River, Back River Reservoir, Stevens Creek Reservoir, the Savannah River, and Lake Moultrie. The most abundant aquatic macrophytes were Brazilian elodea (Egeria densa), Smartweed (Polygonum densiflorum), Slender naiad (Najas minor), Pickerelweed (Pontederia cordata), and Water Primrose (Ludwigia uruguayensis).

INTRODUCTION

South Carolina, like other Southeastern States, is experiencing problems caused by excessive growth of submerged and emergent herbaceous aquatic macrophytes in lakes and streams. These aquatic macrophytes, often called aquatic plants or aquatic weeds, are non-woody plants larger than microscopic size that grow in water. Aquatic macrophytes may be free-floating or rooted in bottom sediment. The plants may be entirely submerged or may protrude from the water.

The primary problem posed by these plants is interference with boat travel. Many boat launching areas, docks, river channels, and preferred fishing areas become overgrown with aquatic macrophytes in summer, preventing or greatly hindering access by boat. Another problem associated with excessive growth of aquatic macrophytes is deterioration of water quality. Although the green parts of aquatic macrophytes produce oxygen through photosynthesis during daylight hours, this occurs primarily near or above the water surface. The oxygen-consuming process of respiration takes place throughout the plant, both day and night, and frequently causes depletion of dissolved oxygen in the water column below the photosynthetic zone. Also, senescense and decay of the plants during hot weather in summer and at the end of the growing season exerts an additional demand for dissolved oxygen. A significant fish kill in upper Lake Marion, South Carolina during August 1986 was apparently caused by movement of anoxic water from beneath aquatic macrophytes to an area where fish were congregated (Jim Bulak, South Carolina Wildlife and Marine Resources Department, oral commun., May 1987). Other problems that have been attributed to excessive growth of aquatic macrophytes are stunting of fish growth and deterioration of aesthetics.

Aquatic macrophytes are a natural part of aquatic ecosystems, especially where water is relatively shallow, clear, and warm. Macrophyte growth and sedimentation are the primary processes that are responsible for filling lakes and reservoirs. A moderate level of macrophyte growth is often considered beneficial to a lake or stream, providing cover and food for fish and other aquatic organisms upon which fish feed. Problems arise when the macrophyte growth becomes excessive.

Several factors appear to contribute to the excessive growth of aquatic macrophytes in some lakes and streams of South Carolina (Harvey and others, 1987). One factor is the gradual decrease in the rate of sediment transport in recent years in many southeastern streams. Originally quite low during colonial times, the rate of sediment transport increased greatly during the eighteenth and early nineteenth centuries due to erosion related to farming practices in the Piedmont (Patterson and Cooney, 1986). During this period, growth of aquatic macrophytes was probably inhibited by turbidity-induced reductions in light penetration and by unstable substrates. A reduction in acreage of cropland since about 1920, along with improved farming practices and the construction of reservoirs, has begun to reduce the rate of sediment transport. This has resulted in reduced turbidity and greater light penetration in the water column, which has been accompanied by an increase in macrophyte growth, particularly in shallow areas.

Another factor in the excessive growth of aquatic macrophytes is the introduction of exotic species of aquatic macrophytes into South Carolina. Many of these species have little competition and few native herbivores feed upon these plants. Some of the exotic aquatic macrophytes introduced into South Carolina lakes and streams are listed in table 1.

One of the primary means of introduction of exotic macrophytes is the release of aquarium plants purchased commercially. Once introduced, plants rapidly spread to other water bodies by natural means and by transport of plant fragments on boats, motors, and trailers.

Aquatic macrophytes can be controlled to some extent through the use of herbicides, biological control, mechanical harvesting, and water-level fluctuations; however, the control measures are expensive (S.C. Aquatic Plant Management Council, 1984). Surveys of the locations and extent of aquatic macrophyte problems in waters of the State, and of the species distribution within the problem areas are needed if State and local agencies are to make the most effective use of available control measures. Periodic surveys are also needed to determine the effectiveness of control programs and to monitor natural changes in the distribution of aquatic macrophytes.

Table 1.--Aquatic macrophytes introduced into South Carolina

Common name	Scientific name	Origin
Brazilian elodea	*Egeria densa*	South America
Hydrilla	*Hydrilla verticillata*	Eurasia
Slender naiad	*Najas minor*	Eurasia
Parrot-feather	*Myriophyllum aquaticum*	South America
Alligator-weed	*Alternanthera philoxeroides*	South America
Water hyacinth	*Eichhornia* spp.	South and Central America

Purpose and Scope

The South Carolina Water Resources Commission, which is the lead agency on the South Carolina Aquatic Plant Management Council, and the U.S. Geological Survey began a cooperative investigation to survey aquatic macrophytes in State waters in 1985. The objectives of the investigation were to determine the areal extent of the significant aquatic macrophyte problems in the public waters of South Carolina, to determine the dominant species in the problem areas, and to document the information on maps that would assist the State and local agencies responsible for the management and control of aquatic macrophytes. The study involved field surveys by boat and remote sensing using aerial photography to map the aquatic macrophytes in 15 lakes and streams in South Carolina. This report presents the results of that investigation.

Study areas

By agreement among the U.S. Geological Survey, the South Carolina Water Resources Commission, and the South Carolina Aquatic Plant Management Council, 15 lakes and streams were selected for inclusion in this investigation. The lakes and streams selected were relatively large, publically-owned water bodies with significant aquatic plant problems. Certain public water bodies were excluded. State Park lakes were excluded because they were generally too small. Lake Marion, the water body with the best-known aquatic macrophyte problems in the State, was excluded because the distribution of aquatic macrophytes in that lake was being determined as part of the Santee-Cooper River Basin Water-Quality Study by the South Carolina Department of Health and Environmental Control (Welch and others, 1985; Welch and Remillard, 1986). The lakes and streams selected for inclusion in this study are listed in table 2 and their locations are shown in figure 1.

Table 2.--Lakes and streams included in the study

Map reference number	Lake or stream name	Remark
1	Cooper River	From vicinity of Lake Moultrie tailrace canal to vicinity of Back River Dam, including adjacent old rice fields with public access from river
2	Back River Reservoir	
3	Goose Creek Reservoir	
4	Saluda Lake	
5	Lake William C. Bowen	
6	Savannah River	From Stevens Creek Dam to just downstream of Augusta
7	Stevens Creek Reservoir	On Savannah River
8	Lake Prestwood	On Black Creek
9	Lake Murray	Small cove on north side of lake
10	Lake Greenwood	Cane Creek arm
11	Lake Moultrie	Plants confined to perimeter
12	Black Creek	From Hartsville to Darlington
13	North Fork Edisto River	From Orangeburg to the confluence with the South Fork
14	Little Pee Dee River	From US Highway 378 to the confluence with the Pee Dee River
15	Waccamaw, Black, and Pee Dee Rivers	Primarily smaller interconnecting channels among old rice fields in the area between Sandy Island and the mouth of the Black River

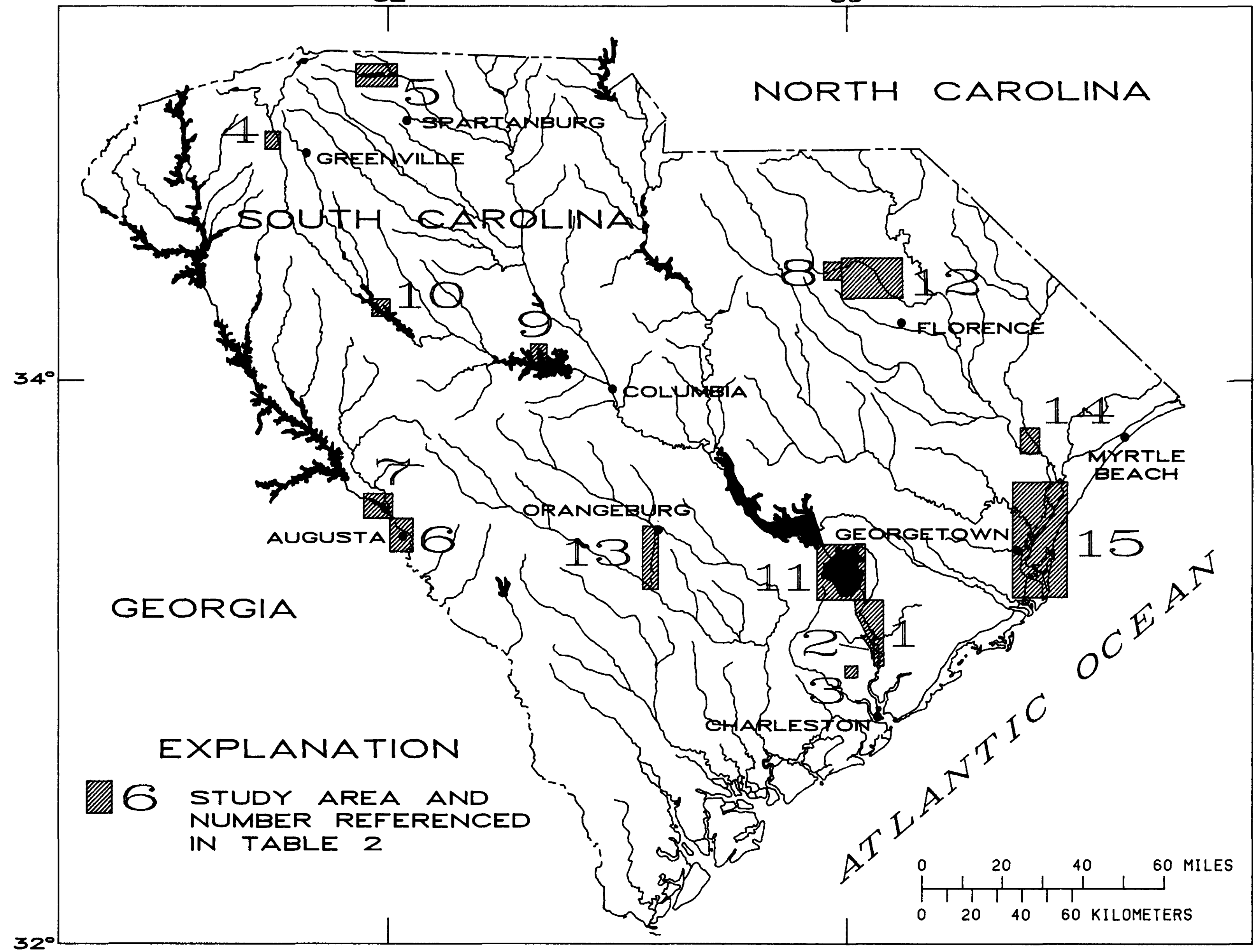

Figure 1.--Locations of study areas.

The selected water bodies represent the diversity of freshwater aquatic habitats in South Carolina. The Savannah River is large, with some rocky substrates and rapids. Black Creek and the Little Pee Dee and North Fork Edisto rivers are small, meandering, Coastal Plain streams. Saluda Lake and Lake Prestwood are small Piedmont reservoirs, while Stevens Creek Reservoir and Lakes Bowen, Greenwood, and Murray are much larger. Goose Creek and Back River Reservoirs are small reservoirs in the Coastal Plain, while Lake Moultrie is much larger. The Cooper, Waccamaw, Black, and Pee Dee Rivers are Coastal-Plain rivers with large adjoining wetlands dominated by old rice fields. The old rice fields are impounded freshwater marshes situated where tidal action could be used to provide periodic controlled flooding. Used for rice cultivation during colonial times, the fields now are dominated by submerged and emergent aquatic macrophytes such as Egeria densa, Zizaniopsis miliacea, Spartina cynosuroides, Typha latifolia, Polygonum densiflorum, Pontederia cordata, and Sagittaria. All of the areas are used for various recreational activities including fishing, hunting, water-skiing, pleasure boating, and canoeing.

Acknowledgments

The authors wish to thank Danny Johnson and Steven DeKozlowski of the South Carolina Water Resources Commission for general guidance and encouragement, Cynthia Aulbach-Smith of the University of South Carolina Herbarium for identifying plants, John Jensen of the University of South Carolina Department of Geography for advice on remote sensing, Lynn Shirley of the University of South Carolina Social and Behavioral Sciences Laboratory for assistance in software development and data manipulation, and Mark Perry of the South Carolina Budget and Control Board, Division of Research and Statistical Services, for obtaining aerial photographs.

METHODS

A variety of methods have been used to map the distribution of aquatic macrophytes in South Carolina. Mapping is often done by simple field survey, marking locations of large stands of aquatic macrophytes on a map while in the field, using landmarks for determining position. The field survey provides opportunities for positive identification of all plants encountered. To determine the distribution of submerged plants growing too deep to be seen from the surface, survey crews often use fathometer traces or grab samples obtained with a tool such as a lawn dethatching rake tied to a rope (Harvey and others, 1988). On large lakes where determination of position is difficult, an automatic positioning system has been used to improve the accuracy of maps (Harvey and others, 1988). Remote sensing using infrared aerial photography has been shown to be useful in mapping emergent plants and some submerged plants as long as some ground truth is available for identifying plants (Welch and others, 1985). The landsat satellite thematic mapper has also been tried, and found to be of some value for large emergent stands of aquatic macrophytes (Jensen and Davis, 1986).

In this study positioning problems were minimal because the aquatic macrophytes generally were near landmarks along the shores. Some stands of aquatic macrophytes were too small to be discerned by the thematic mapper and many areas contained submerged as well as emergent plants. Therefore the mapping was done using a combination of simple field surveys and infrared aerial photography.

Field Surveys

Field surveys were conducted in each study area during the 1985 growing season. Most of the field surveys were made from an airboat, but canoes were used on the rivers and an 18-foot inboard-outdrive boat was used for some of the rougher waters of Lake Moultrie. During each field survey, locations of macrophyte beds were marked on maps using landmarks for positioning. A dethatching rake on a rope was used to obtain samples of submerged plants. Samples of all reported species were taken to the University of South Carolina Herbarium for identification using a standard reference (Godfrey and Wooten, 1979). The curator of the Herbarium participated in several surveys. The dates on which field surveys were conducted are listed in table 3.

Table 3.--Dates of field surveys and remote sensing

Study area	(All dates are during 1985) Field survey	Remote sensing
Cooper River	June 11, 12	June 6, 13
Back River Reservoir	June 3	June 13
Goose Creek Reservoir	June 3	June 13
Saluda Lake	June 20	July 10
Lake William C. Bowen	June 5	July 10
Savannah River	August 6	September 9
Stevens Creek Reservoir	July 3	--
Lake Prestwood	May 8	--
Lake Murray	June 18	--
Lake Greenwood	June 18	--
Lake Moultrie	September 10, 11, 17	--
Black Creek	August 14, 15	--
North Fork Edisto River	August 28, 29	--
Little Pee Dee River	August 13	--
Waccamaw, Black, Pee Dee Rivers	June 24	--

Remote Sensing

Infrared aerial photographs were taken of six study areas within a few days to a few weeks of the dates of the field surveys. The dates of the aerial photography and the field surveys for these sites are listed in table 3. The six study areas in which remote sensing was used were:

1. Cooper River
2. Back River Reservoir
3. Goose Creek Reservoir
4. Saluda Lake
5. Lake William C. Bowen
6. Savannah River

The photographs were taken by the Research and Statistical Services Division of the South Carolina Budget and Control Board using Eastman Kodak[1] Aerochrome infrared film (EK 2443) and a Fairchild T-12 camera with a Plantronics 6-inch focal length lens. All photographic data were acquired with 60 percent end-lap and 30 percent side-lap for complete stero coverage of each area. Geographical reference and control were maintained by acquiring data at 10,000 feet above ground level while detailed coverage of each reservoir was obtained at 5,200 feet above ground level.

To construct an accurate map of aquatic vegetation, it was necessary to eliminate the radial distortion inherent in the aerial photography. This was accomplished by drawing a grid at a predetermined scale on drafting film which represented the Universal Transverse Mercator map projection. Selected physical features from the U.S. Geological Survey 7.5 minute topographic quadrangle map pertaining to areas being mapped were transferred onto this grid. These physical features served as control points to register the photographs and facilitated the transfer of polygonal data. This process was repeated for each area.

Interpretation of aerial photography consisted of a two-pass approach. In the first pass, variations in hue, intensity, and texture were used to delineate polygons on drafting film taped to the individual photos. A second pass was performed to assign each polygon to a species category based on field surveys performed at or near the time of photo acquisition.

Polygonal data from the aerial photographs were transferred to the base map using a reflecting projector. Physical features identified on the photographs were registered to the same features on the base map and the polygonal aquatic vegetation data were transferred to the map. To minimize the effect of optical distortion only a small area at the center of the reflecting projector was used to transfer polygonal data during a single map setup.

Converting the polygonal base map into a digital form was accomplished through the use of an Earth Resources Data Analysis System (ERDAS) or Summagraphics digitizing tablet with a resolution of 0.001 inch. Digital polygon data were verified and edited for missing or incorrect arcs.

---

[1]The use of brand names in this report is for the purpose of identification only and does not constitute endorsement by the U.S. Geological Survey.

Digital files of these data were created in a format which could be read by Statistical Analysis Software (SAS). SAS was used to distinguish areas which formed line segments from chains belonging to polygons. The data were entered into the University of South Carolina computer in a form which was readable by the mapping software.

The final maps were plotted using the Geographic Information Mapping and Management System (GIMMS) mapping software. Numerical codes identifying each polygon with a particular species were developed and input into the GIMMS program. Text and statistical information were specified and the polygonal data were retrieved from the computer. Shading patterns were developed for each area which allowed the best visual discrimination between species. Because it is difficult to develop more than eight or nine shading patterns which can be distinguished by the human eye, aggregation of some species categories was necessary for the more complex areas. Aggregation was also performed on mixed categories which had a common dominant species and several minor species in common. The detail of the original interpretation was retained in the unique numerical value assigned to each species. The aggregation was merely an assignment of shading patterns to more than one species category. Geographic area was calculated for each polygon and aggregated to form totals for the species categories which appear on the final maps.

DISTRIBUTION OF AQUATIC MACROPHYTES

The combination of field surveys and remote sensing proved to be an effective means of determining the distribution of aquatic macrophytes in the study area. The field surveys provided detailed information on the species present and information that varied from general to specific on the distribution of those species. Remote sensing was not used in some areas because of extensive tree cover or the inability to obtain aerial photography due to problems with the weather or the airplane. In these areas, the field surveys alone provided sufficient data for mapping the aquatic macrophytes.

The remote sensing provided additional detailed information on the areal extent of aquatic plant problems. The combination of remote sensing and computer graphics provided a useful tool for preparing high-quality maps showing the aquatic macrophyte problems in the lakes and streams surveyed.

Detection of emergent aquatic macrophytes on aerial photographs was accomplished using a variety of techniques. Spectral signatures based on the hue, intensity, and texture of various plants were determined in conjunction with the field survey data. The submergent aquatic macrophytes had a limited range of spectral signatures from dull black with almost smooth texture to reddish brown with a slightly rough texture. The controlling factor for the variation of these plant signatures was the depth of submergence. As the plant reached the surface, the signature became more brown and the texture became more coarse due to exposure of the plant to the wind and increased sunlight which caused die-back of some leaves. Only those beds which contained submerged plants at or near the surface were detected. This is similar to findings by Welch (1985) and Jensen and Davis (1986) and is due primarily to turbidity limiting the penetration of the visible light. Reliance on field survey data was necessary for differentiation of submerged species. Although physiological differences exist between submerged species, these differences cannot be detected with infrared photography. However, it was generally found that submerged species developed in a homogeneous manner. If heterogeneity existed within an area and was not apparent in the remotely sensed data nor accounted for in the field survey data, species representation would be misstated. This is important to the inventory of aquatic vegetation using remotely sensed data because field survey data are normally collected on a point sampling basis.

Emergent aquatic macrophytes had a greater range of spectral signatures than did the submerged vegetation, ranging from the bright pink, smooth texture of Ludwigia uruguayensis to the deep red, rough texture of Zizaniopsis miliacia. This variation is caused by differing heights above the water surface and physiological factors relating primarily to leaf characteristics such as area, shape, and orientation. Furthermore, the number of species in the emergent category influenced its spectral variation. While the submergent plants included only 3 dominant species, the emergent category contained 11 dominant species and 5 minor species. The greater number of emergent species, combined with the greater detail visible from the air, produced a greater range of spectral signatures for emergent as opposed to submerged species. However, differentiation of emergent species with subtle spectral differences was still difficult.

Knowledge of plant ecology aided the classification. Aquatic plants which depend primarily on roots established in soil are expected to grow in shallow water whereas aquatic plants which float free may be found in shallow or deep, but not swift water. Furthermore, knowing the shape in which beds of various species develop was valuable. Rooted plants such as Ludwigia uruguayensis and Pontederia cordata grow along the banks in a curvilinear strip pattern. Free floating plants such as Nymphaea odorata and Eichhornia were usually arranged into circular or semicircular clusters.

The ability to classify areas using spectral signature extension from aerial photography was useful only on Saluda Lake and small areas of Lake Bowen and Goose Creek Reservoirs where water-quality conditions did not change dramatically. In the larger water bodies such as the Cooper and Savannah Rivers, extension of spectral signatures developed from a limited number of point sources would have resulted in gross errors of species inventory. Continuous field survey data collection throughout the study area was necessary to document the changing species composition of aquatic plant communities in these dynamic ecosystems.

As an aid to the identification of plants mentioned in this report, the scientific and common names of the plants are listed in table 4. Also listed are the water bodies in which each plant was found.

Table 4.--Names and areas of occurrence of aquatic plants in the study areas, 1985

Scientific name	Common name	Location
Alnus spp.	Alder	Saluda Lake Stevens Creek Reservoir Lake Murray
Alternanthera philoxeroides	Alligator-weed	Lake Prestwood North Fork Edisto River Black Creek Little Pee Dee River
*Aneilema keisak**	Nearshore plant	Savannah River Waccamaw River
Ceratophyllum demersum	Coon-tail	Cooper River Back River Reservoir Goose Creek Reservoir Stevens Creek Reservoir Lake Moultrie Waccamaw River
Chara spp.	Stonewort (Algae)	Lake William C. Bowen Lake Murray Lake Moultrie
Egeria densa	Brazilian elodea	Cooper River Back River Reservoir Saluda Lake Savannah River Stevens Creek Reservoir Waccamaw River Lake Moultrie Goose Creek Reservoir
Eichhornia spp.	Water hyacinth	Cooper River Back River Reservoir Goose Creek Reservoir
Eleocharis equisetoides	Spike rush (Sledge)	Lake Prestwood Black Creek Waccamaw River
Hydrocotyle spp	Marsh pennywort	Goose Creek Reservoir
Hydrilla verticillata	Hydrilla	Back River Reservoir Goose Creek Reservoir

*Also known as *Murdannia keisak* (Godfrey and Wooten, 1979).

Table 4.--Names and area of occurrence of aquatic plants in the study areas, 1985--Continued

Scientific name	Common name	Location
Juncus spp.	Rush	Saluda Lake Stevens Creek Reservoir Lake Murray Lake Greenwood
Justicia americana	Water willow	Stevens Creek Reservoir
Leersia spp.	Cut grass	Waccamaw River
Ludwigia spp.	Primrose	Back River Reservoir Goose Creek Reservoir Lake Moultrie Waccamaw River
Ludwigia uruguayensis	Water primrose	Cooper River Back River Reservoir Goose Creek Reservoir Savannah River Lake Moultrie Waccamaw River
Myriophyllum aquaticum	Parrot-feather	Savannah River Stevens Creek Reservoir Waccamaw River
Myriophyllum heterophyllum	Parrot-feather	Saluda Lake Stevens Creek Reservoir Lake Prestwood Savannah River
Najas spp.		Lake William C. Bowen
Najas guadalupensis	Southern naiad	Savannah River
Najas minor	Slender naiad	Saluda Lake Lake William C. Bowen Lake Murray Lake Greenwood Lake Moultrie
Nelumbo spp.	Lotus	Lake Prestwood Lake Moultrie
Nitella spp.	Muskgrass (Algae)	Savannah River Lake Murray
Nuphar luteum	Spatterdock	Waccamaw River Lake William C. Bowen

Table 4.--Names and areas of occurrence of aquatic plants in the study areas, 1985--Continued

Scientific name	Common name	Location
Nymphaea odorata	White water-lily	Goose Creek Reservoir Lake Prestwood Little Pee Dee River
Nymphoides aquatica	Banna lily, Floating heart	Lake Moultrie
Nyssa spp.	Water tupelo	Lake Moultrie Lake Prestwood Little Pee Dee River North Fork Edisto River Black Creek
Peltandra virginica	Arrow arum or Green arum	Cooper River Saluda Lake Stevens Creek Reservoir North Fork Edisto River
Polygonum spp.	Smartweed	Goose Creek Reservoir Lake Greenwood Black Creek North Fork Edisto River Little Pee Dee River
Polygonum densiflorum	Smartweed	Cooper River Back River Reservoir Goose Creek Reservoir
Pontederia cordata	Pickerelweed	Cooper River Back River Reservoir Saluda Lake Stevens Creek Reservoir Lake Moultrie North Fork Edisto River Waccamaw River
Potamogeton diversifolius	Pondweed	Stevens Creek Reservoir Lake Moultrie Lake Prestwood
Potamogeton pulcher	Pondweed	Savannah River
Potamogeton pusillus	Pondweed	Lake William C. Bowen

Table 4.--Names and areas of occurrence of aquatic plants in the study areas, 1985--Continued

Scientific name	Common name	Location
Salix spp.	Willow	Saluda Lake
Sagittaria	Common arrowhead	Cooper River Back River Reservoir
Scirpus spp.	Bulrush	Stevens Creek Reservoir
Sparganium spp.	Bur reed	Savannah River
Spartina cynosuroides	Big cordgrass	Cooper River Back River Reservoir
Taxodium spp.	Bald cypress	Lake Moultrie Lake Prestwood Little Pee Dee River North Fork Edisto River Black Creek
Typha latifolia	Cat tail	Cooper River Back River Reservoir Lake Greenwood Lake Moultrie North Fork Edisto River Goose Creek Reservoir
Utricularia biflora	Bladderwort	Savannah River Lake Prestwood Lake Moultrie
Utricularia inflata	Bladderwort	Stevens Creek Reservoir Lake Moultrie
Zizaniopsis miliacea	Giant cutgrass	Cooper River Waccamaw River Little Pee Dee River

Cooper River

The main channel of the Cooper River is sufficiently deep and swift to restrict plant growth to narrow shallow areas along the banks. The small tributary channels and old rice fields adjacent to the river, however, provide suitable habitat for a variety of plants. *Egeria densa* was the most prevalent aquatic macrophyte, covering 2,460 acres in the study area.

The shallower parts of the old rice fields contained large amounts of *Polygonum densiflorum*, *Zizaniopsis miliacea*, *Ludwigia uruguayensis*, *Pontederia cordata*, *Spartina cynosuroides*, and *Typha latifolia*. In previous years *Eichhornia* and *Alternanthera philoxeroides* had been reported to be abundant in the Cooper River area (Steven DeKozlowski, South Carolina Water Resources Commission, oral commun., 1985; White, 1980), but relatively little was found during 1985. The 2,460 acres of *Egeria densa* found in the Cooper River in 1985 appears to repesent a decline in abundance compared to the 4,020 acres reported for 1979 (White, 1980). The distribution of aquatic macrophytes in the Cooper River is depicted in figures 2-5. Acreages of dominant macrophytes in the area are given in table 5.

Table 5.--Acreage of dominant aquatic macrophytes in Cooper River, June 1985

Aquatic macrophyte or vegetation type	Area (acres)
Miscellaneous plants in old rice fields	828.80
Mixed tall grasses	93.08
Miscellaneous Emersed aquatic macrophytes	10.12
Zizaniopsis miliacea	656.92
Egeria densa	2,459.55
Ludwigia uruguayensis	247.79
Ludwigia uruguayensis and mixed emergent grasses	108.84
Ludwigia uruguayensis, *Ceratophyllum demersum* and *Pontederia cordata*	266.77
Pontederia cordata	78.15
Eichhornia	118.19
Polygonum densiflorum, *Pontederia cordata*, and *Sagittaria* dominant	2,044.78
Spartina cynosuroides and *Typha latifolia* dominant	2,872.43

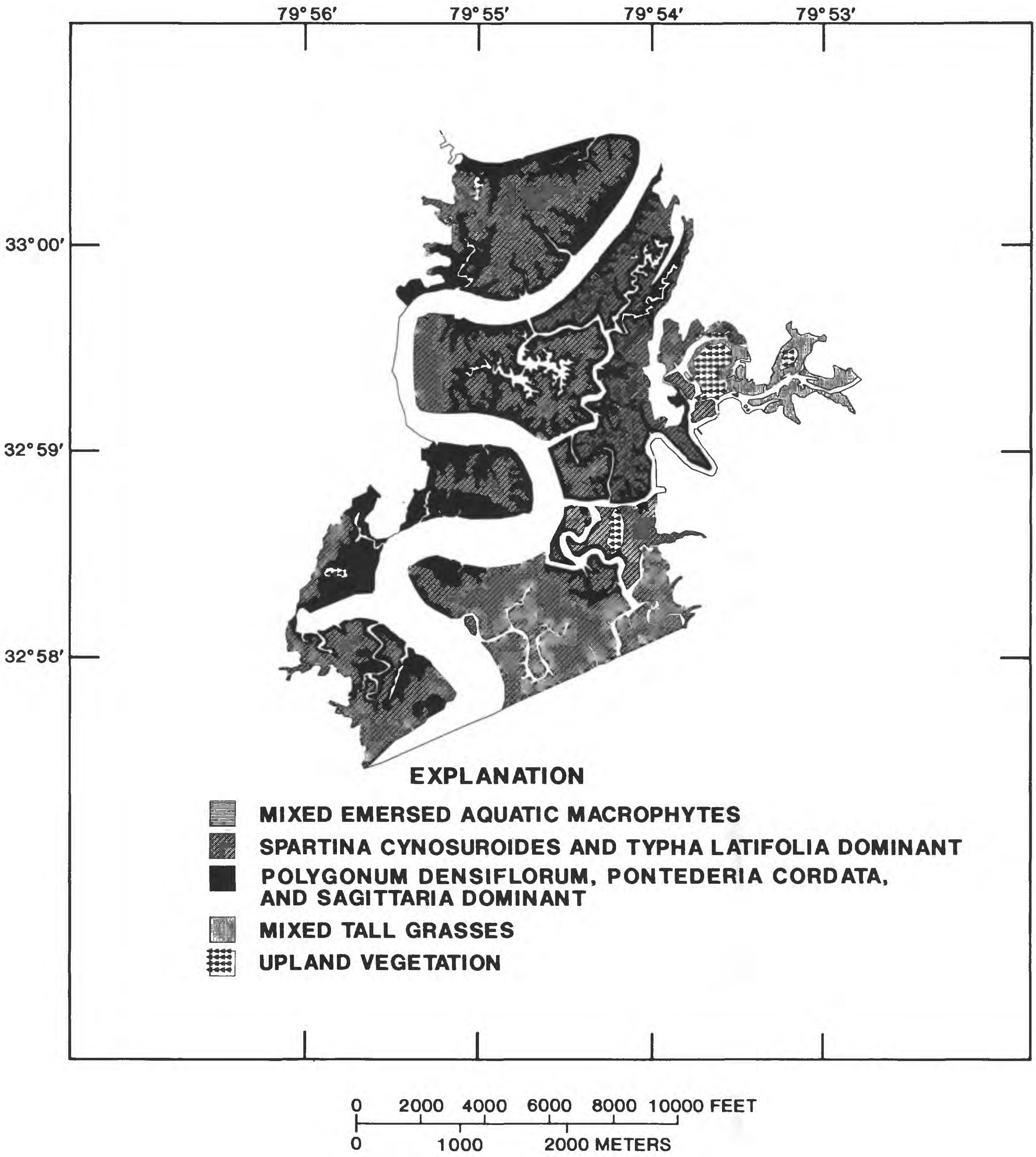

Figure 2.--Distribution of aquatic macrophytes in section 1 of Cooper River, June 1885.

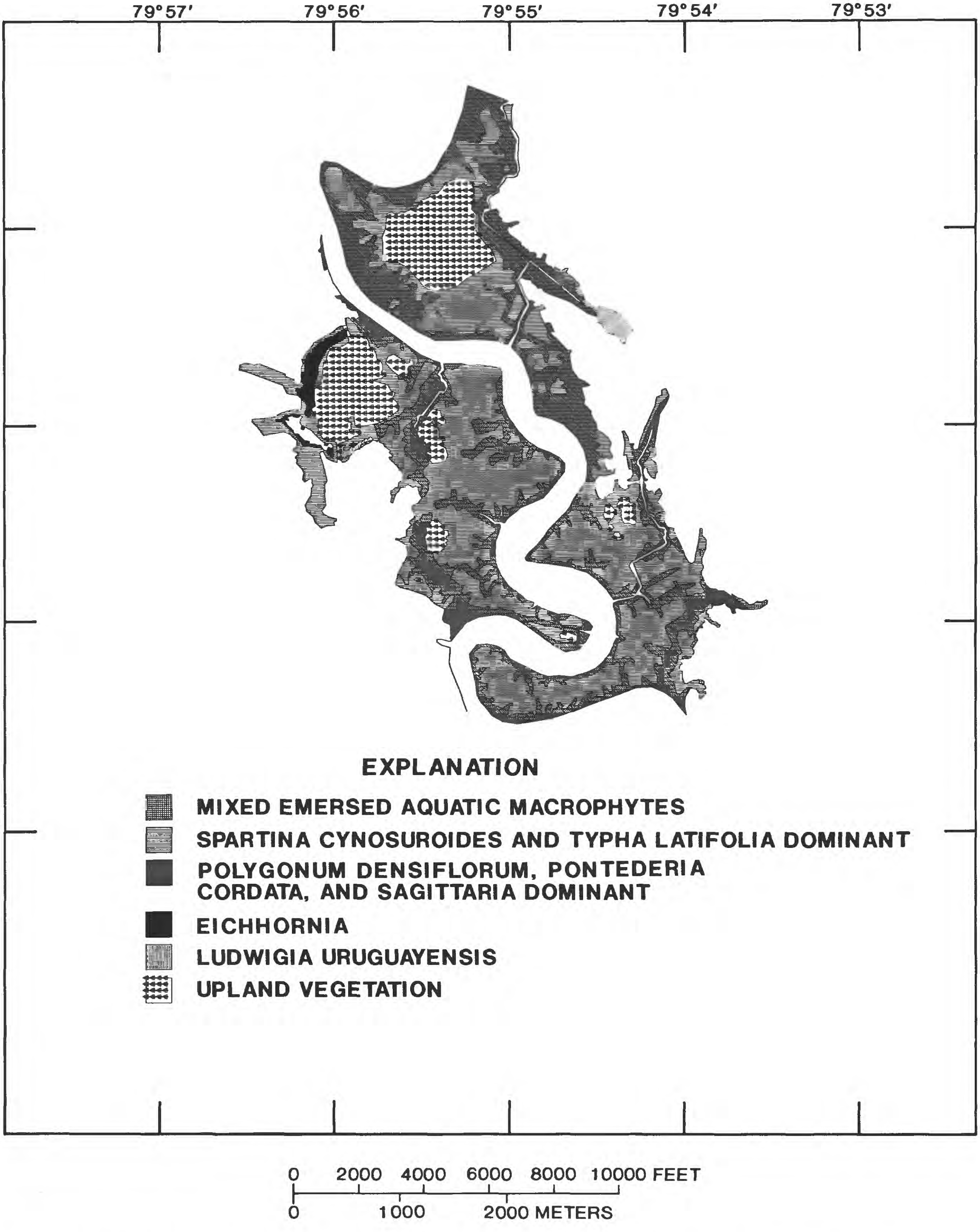

Figure 3.--Distribution of aquatic macrophytes in section 2 of Cooper River, June 1985. (Source: Dr. J.R. Jensen and B.A. Davis, Department of Geography, the University of South Carolina. Photographic data acquired June 13, 1985.)

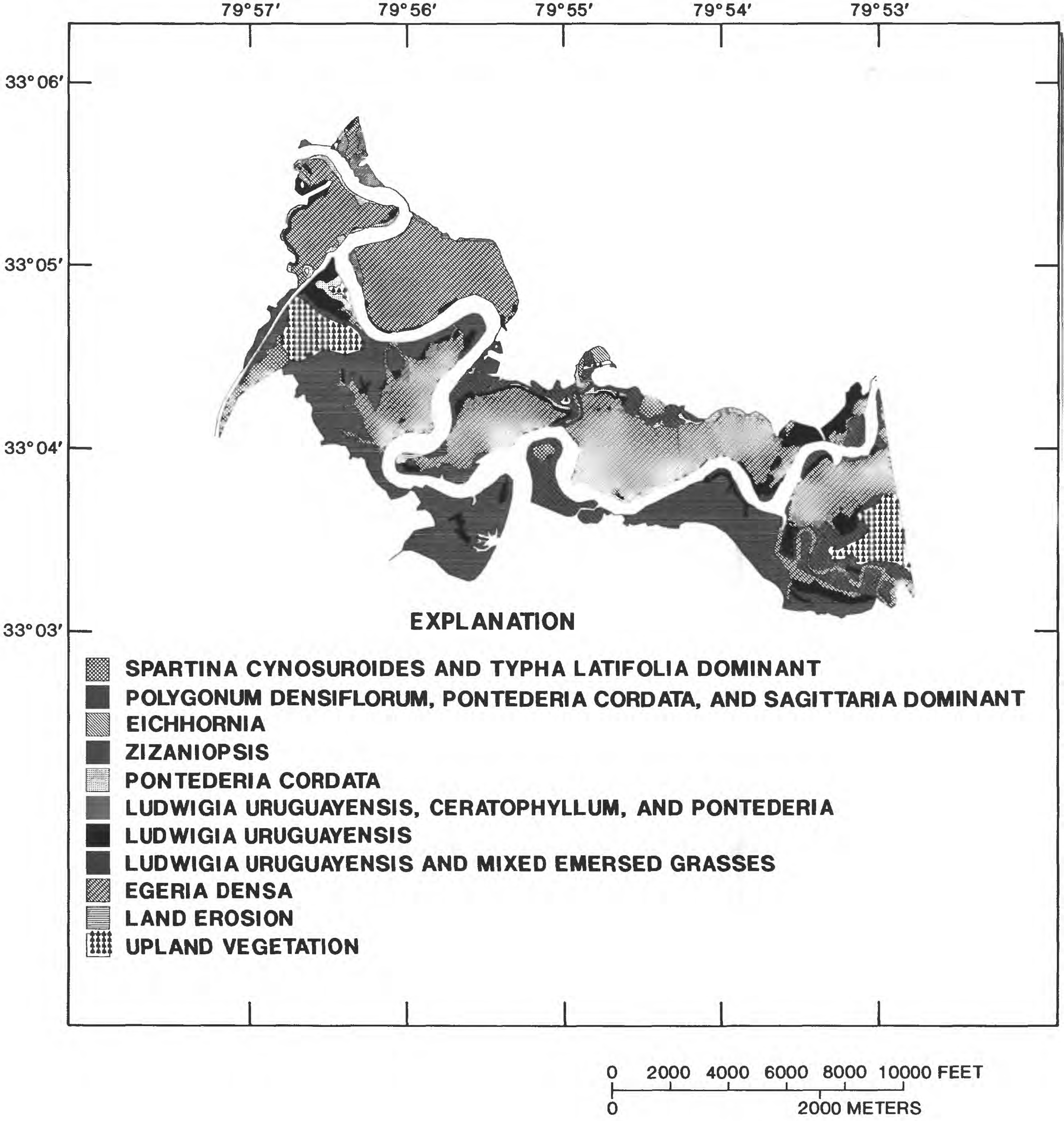

Figure 4.--Distribution of aquatic macrophytes in section 3 of Cooper River, June 1985. (Source: Dr. J.R. Jensen and B.A. Davis, Department of Geography, the University of South Carolina. Photographic data acquired June 13, 1985.)

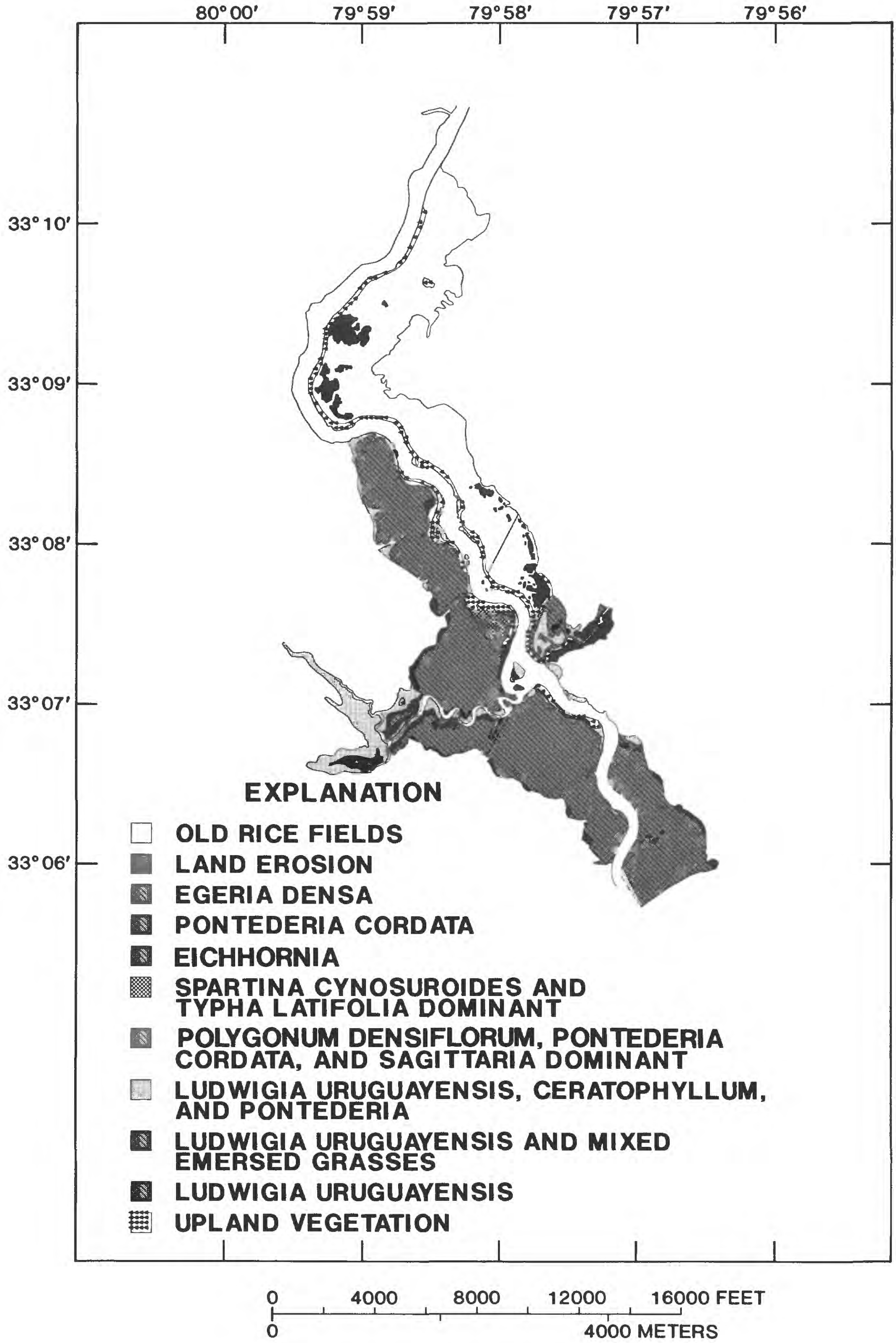

Figure 5.--Distribution of aquatic macrophytes in section 4 of Cooper River, June 1985. (Source: Dr. J.R. Jensen and B.A. Davis, Department of Geography, the University of South Carolina. Photographic data acquired June 13, 1985.)

Back River Reservoir

Back River Reservoir is a former tributary of the Cooper River that has been dammed at the mouth. The Durham Canal carries water from the Cooper River into the reservoir. During June 1985 virtually the entire shoreline was fringed with about 30 feet of Eichhornia and Ludwigia uruguayensis. In the deeper water Egeria densa was abundant and Hydrilla verticillata was found locally. Several significant changes in distribution of plants were noted in comparison to an aquatic vegetation study conducted during 1977 (Lagman, Nelson, and Richardson, 1980). Since 1977 Eichhornia and Hydrilla verticillata have become established in Back River Reservoir, and Alternanthera philoxeroides has virtually disappeared. The distribution of aquatic macrophytes in Back River Reservoir is depicted in figure 6. Acreages of dominant aquatic macrophytes in the area are given in table 6.

Table 6.--Acreage of dominant aquatic macrophytes in Back River Reservoir, June 1985

Aquatic macrophyte or vegetation type	Area (acres)
Upland vegetation	89.33
Miscellaneous marsh vegetation	188.56
Ludwigia uruguayensis and mixed aquatic macrophytes	61.35
Ludwigia uruguayensis	365.22
Eichhornia	21.12
Polygonum densiflorum, Pontederia cordata, and Sagittaria dominant	561.34
Spartina cynosuroides and Typha latifolia dominant	1,047.13
Egeria densa	303
Hydrilla verticillata	<10

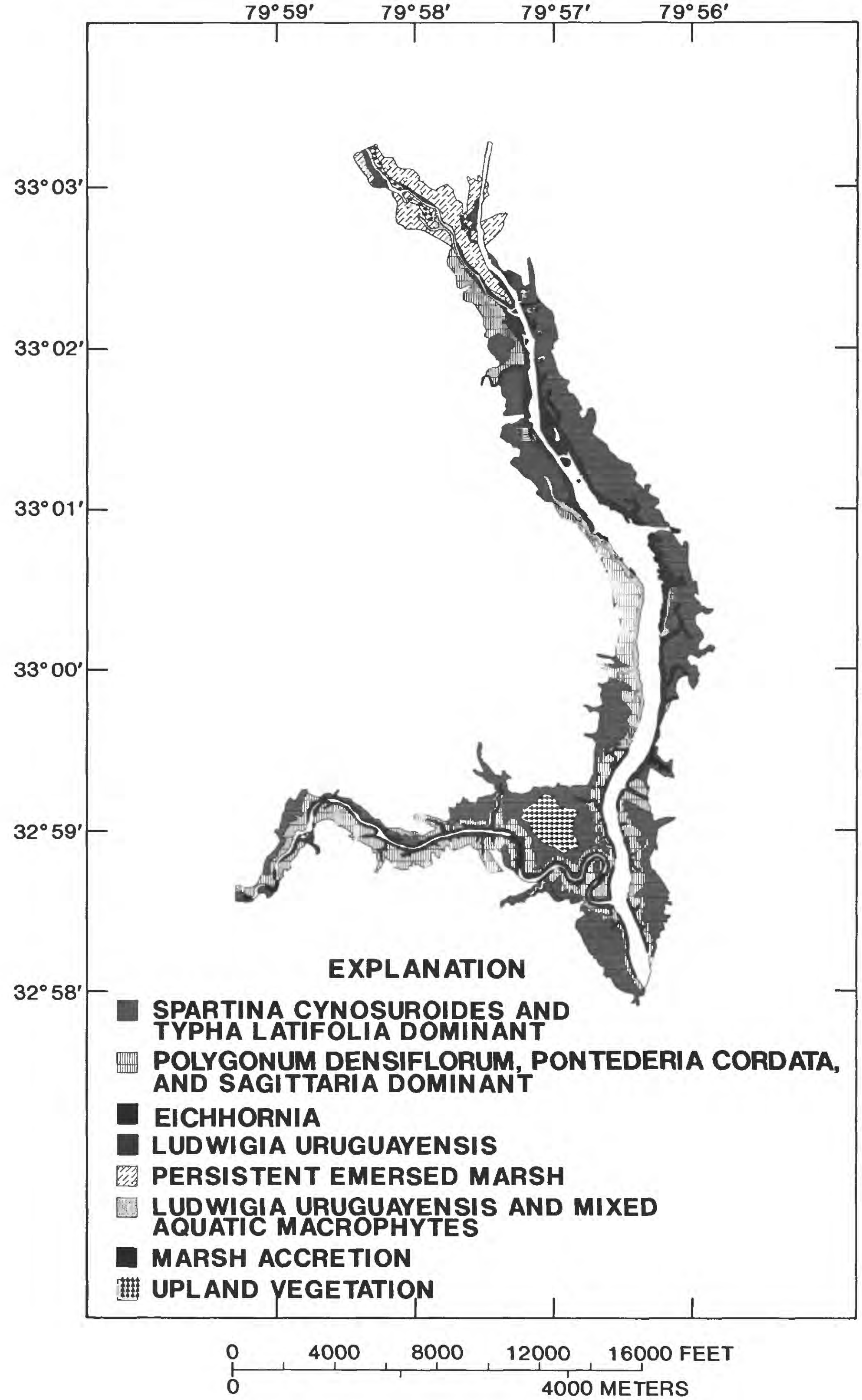

Figure 6.--Distribution of aquatic macrophytes in Back River Reservoir, June 1985. (Source: Dr. J.R. Jensen and B.A. Davis, Department of Geography, the University of South Carolina. Photographic data acquired June 13, 1985.)

Goose Creek Reservoir

The shore of Goose Creek Reservoir was fringed with about 30 feet of *Polygonum densiflorum*. The field survey coincided with a chemical control program for this plant, conducted by Berkeley County. Farther on shore were *Typha* and other marsh plants. Mixed in with the *Polygonum* were minor amounts of *Ludwigia uruguayensis*, *Eichhornia*, *Hydrocotyle*, and *Ceratophyllum demersum*. In the deeper water were minor amounts of *Egeria densa* and *Nymphaea odorata*. The distribution of aquatic macrophytes in Goose Creek Reservoir is depicted in figure 7. Acreages of dominant aquatic macrophytes in the area are given in table 7.

Table 7.--Acreage of dominant aquatic macrophytes in Goose Creek Reservoir, June 1985

Aquatic macrophytes or vegetation type	Area (acres)
Upland vegetation	209.46
Polygonum densiflorum dominant and *Ludwigia uruguayensis*	87.53
Polygonum densiflorum dominant and mixed aquatic macrophytes	5.39
Egeria densa	6.59
Miscellaneous marsh vegetation	1,813.61
Polygonum densiflorum (living plants)	70.06
Polygonum densiflorum (30-100 percent dead plants)	72.07
Nymphaea ordorata	9.79
Eichhornia	9.15

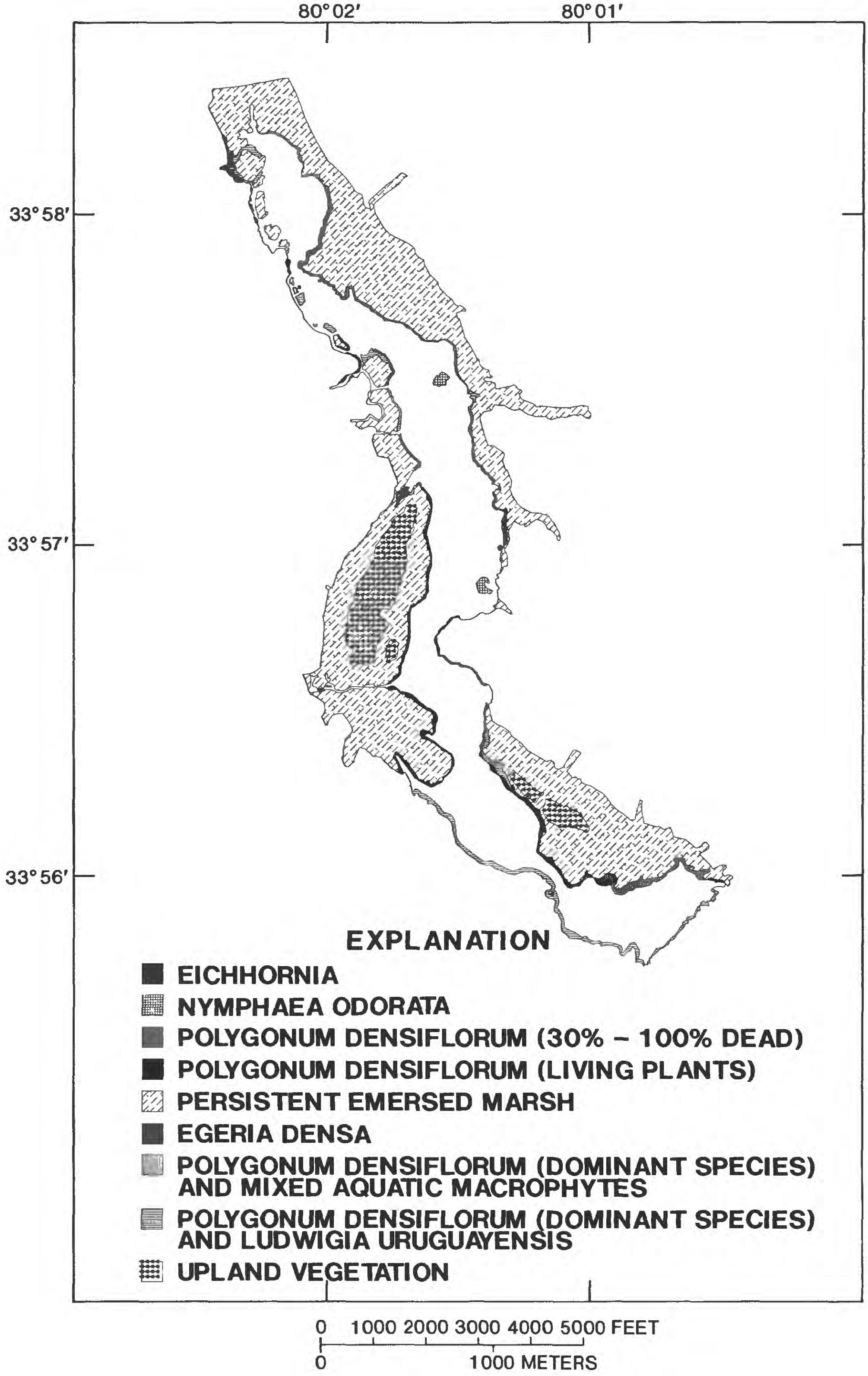

Figure 7.--Distribution of aquatic macrophytes in Goose Creek Reservoir, June 1985. (Source: Dr. J.R. Jensen and B.A. Davis, Department of Geography, the University of South Carolina. Photographic data acquired June 13, 1985.)

Saluda Lake

Saluda Lake is a small reservoir on the Saluda River just west of Greenville. Shallow water in coves and in the upper end of the lake provided habitat for 82 acres of Egeria densa and 4.4 acres of Najas minor. Egeria and Myriophyllum heterophyllum covered 17.5 acres in the middle of the large open area in the upper end of the lake (fig. 8, table 8).

Table 8.--Acreage of dominant aquatic macrophytes in Saluda Lake, June 1985

Aquatic macrophyte or vegetation type	Area (acres)
Egeria densa	82.23
Najas minor	4.43
Mixed emergent aquatic macrophytes, including Juneus, Salix, Alnus spp.	10.16
Egeria densa and Myriophyllum heterophyllum	17.52
Pontederia cordata and Peltanda virginica	1.03

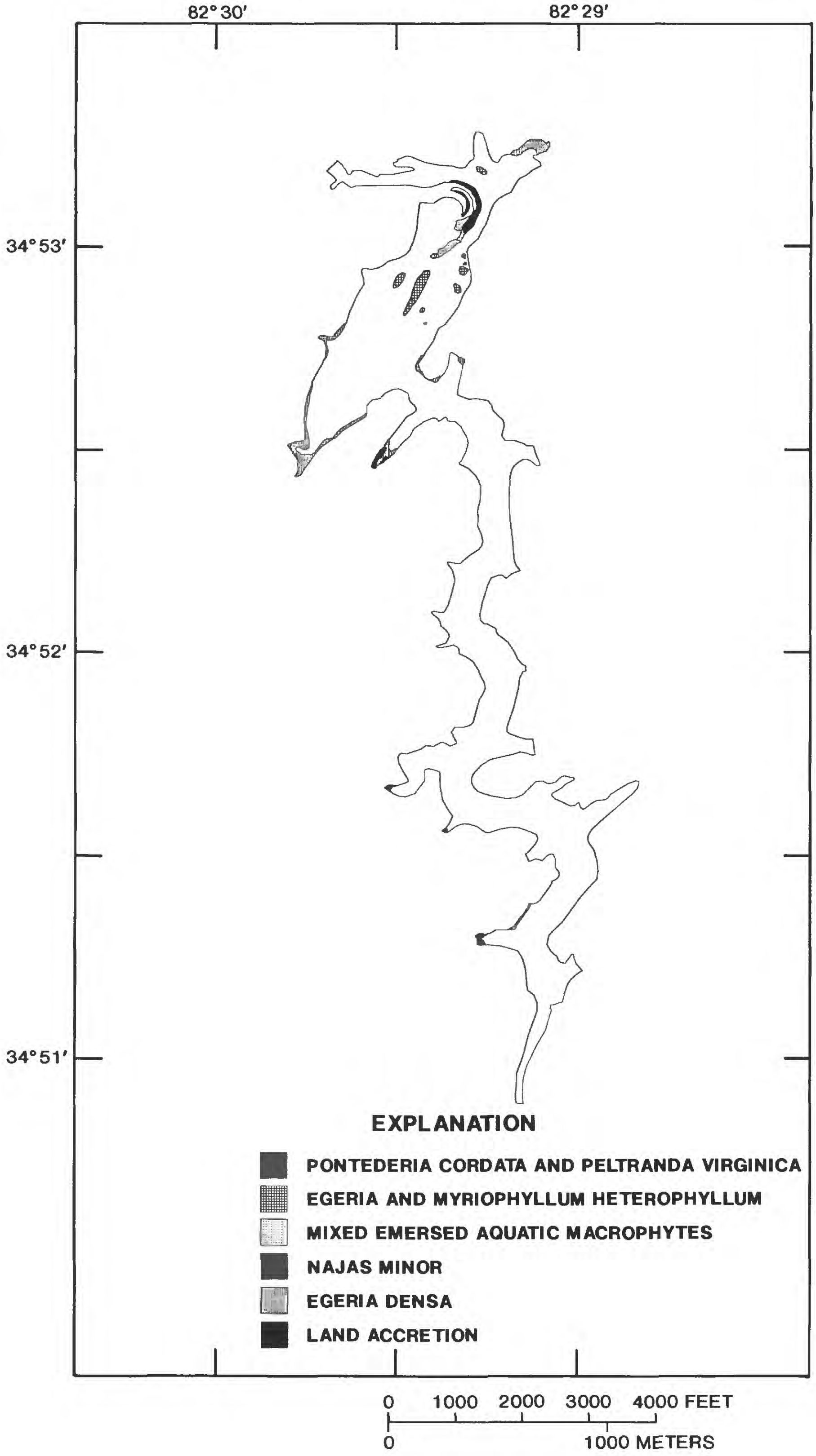

Figure 8.--Distribution of aquatic macrophytes in Saluda Lake, June 1985. (Source: Dr. J.R. Jensen and B.A. Davis, Department of Geography, the University of South Carolina. Photographic data acquired July 10, 1985.)

Lake William C. Bowen

This reservoir on the South Pacolet River supplies water to the city of Spartanburg. Sterile triploid white amur fish were introduced into the reservoir in 1985 by the South Carolina Water Resources Commission to control aquatic macrophytes. This report documents conditions just prior to the release of the fish.

The dominant aquatic macrophyte was *Najas minor* covering 212 acres in coves and in the shallows at the upper end of the reservoir (fig. 9, table 9).

Table 9.--Acreage of dominant aquatic macrophytes in Lake William C. Bowen, June 1985

Aquatic macrophyte or vegetation type	Area (acres)
Najas minor	211.69
Najas minor and *Potamogeton pusillus*	5.73
Nuphar luteum subsp. *macrophyllum*	27.87

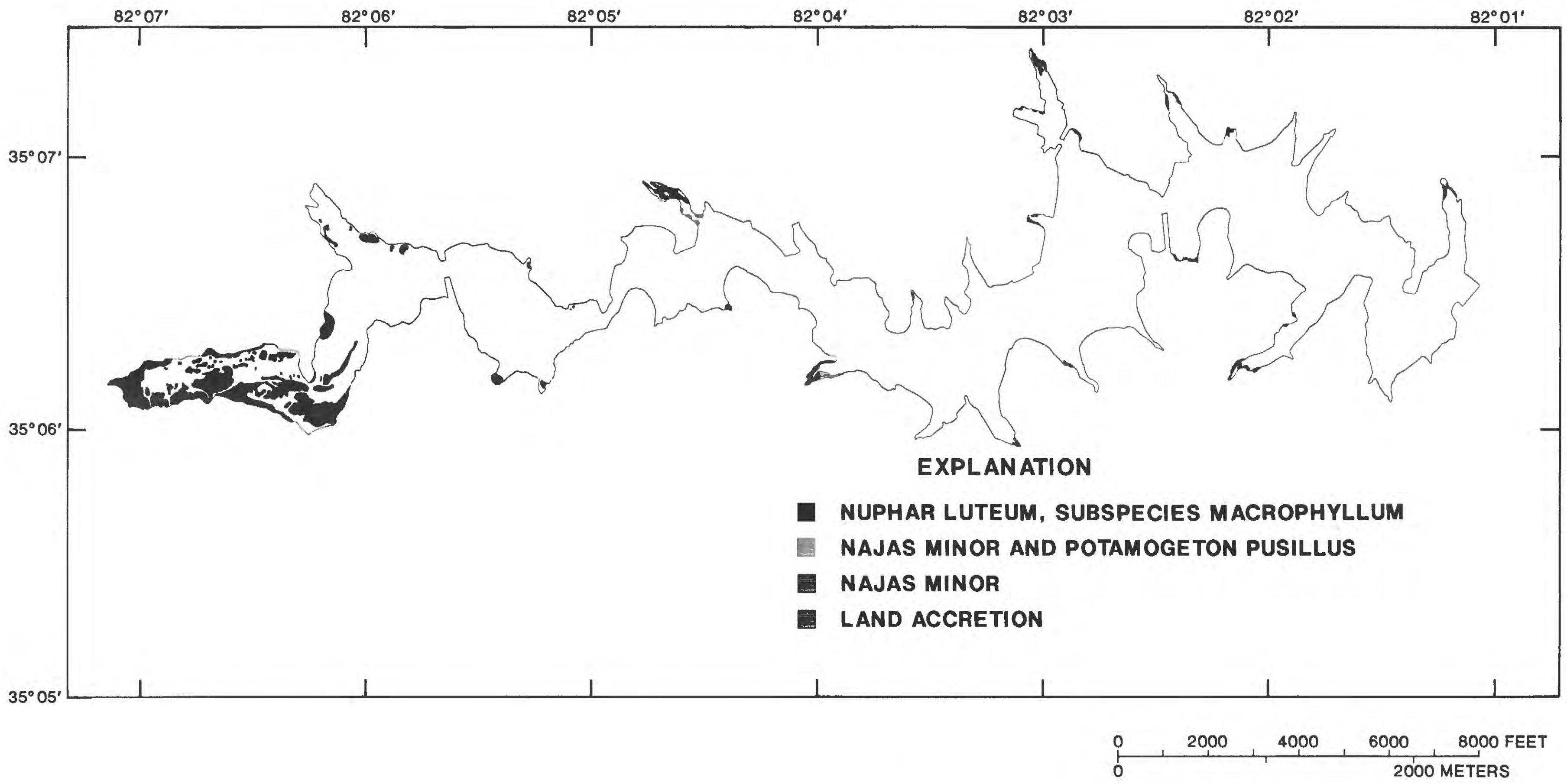

Figure 9.--Distribution of aquatic macrophytes in Lake William C. Bowen, June 1985. (Source: Dr. J.R. Jensen and B.A. Davis, Department of Geography, the University of South Carolina. Photographic data acquired July 10, 1985.)

Savannah River

Various aquatic macrophytes grow in the Savannah River downstream of Stevens Creek Dam. Beds of *Egeria densa* growing in cascading rapids near the Fall Line at Augusta demonstrated that aquatic plants can survive in strong currents as long as they are rooted in a stable substrate such as a crack in bedrock. The dominant species in the reach were *Egeria densa* and *Myriophyllum aquaticum* (figs. 10, 11; table 10).

Table 10.--Acreage of dominant aquatic macrophytes in Savannah River August 1985

Aquatic macrophyte vegetation type	Area (acres)
Upland vegetation	140.54
Egeria densa and *Myriophyllum* spp.	14.44
Egeria densa	86.64
Egeria densa and mixed aquatic macrophytes	378.81
Myriophyllum (*M. heterophyllum* and *M. aquaticum*)	149.18
Utricularia biflora	15.20
Mixed grasses and reeds	6.19
Ludwigia uruguayensis	5.26
Ludwigia uruguayensis, *Egeria densa*, and *Myriophyllum* spp.	6.94

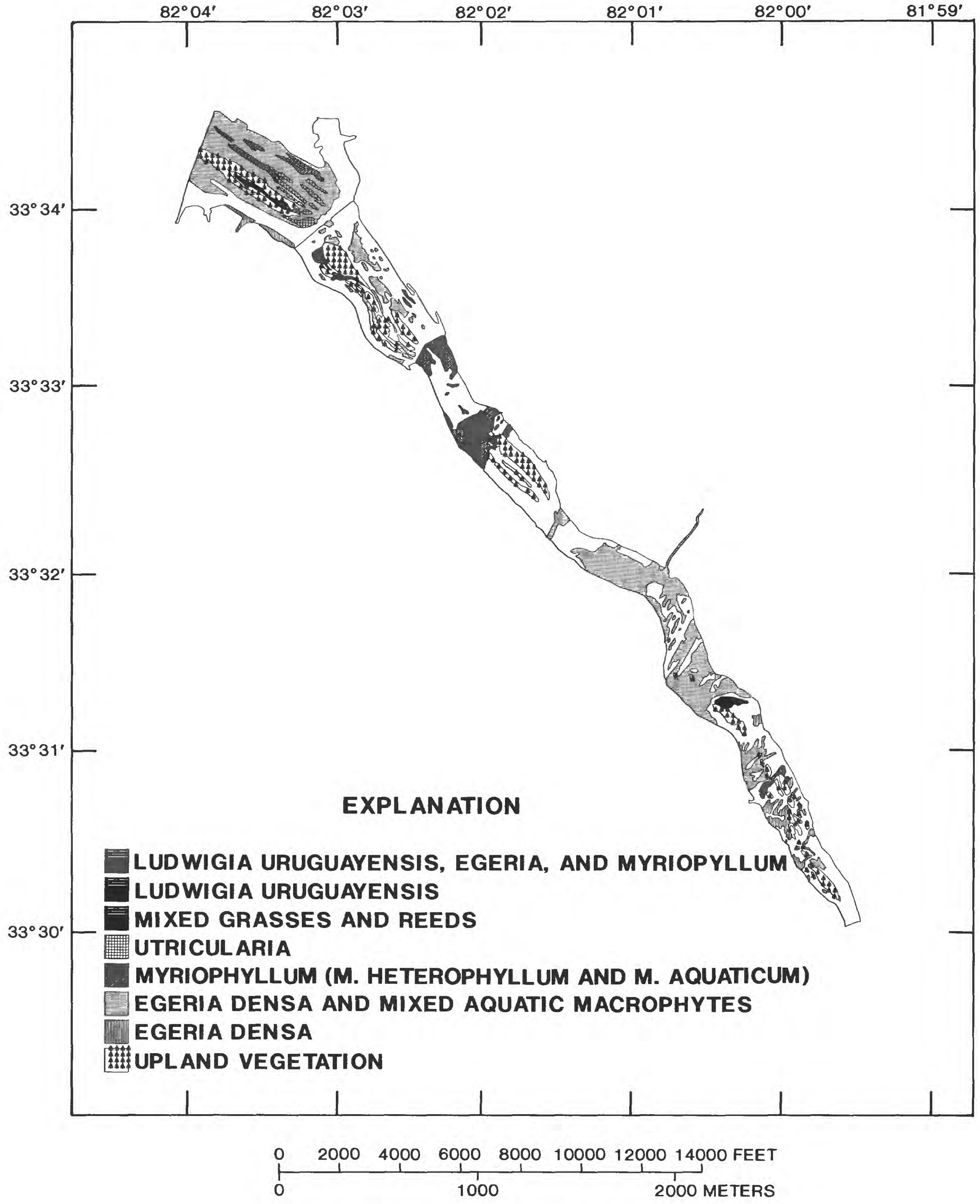

Figure 10.--Distribution of aquatic macrophytes in section 1 of Savannah River, August 1985. (Source: Dr. J.R. Jensen and B.A. Davis, Department of Geography, the University of South Carolina. Photographic data acquired September 9, 1985.)

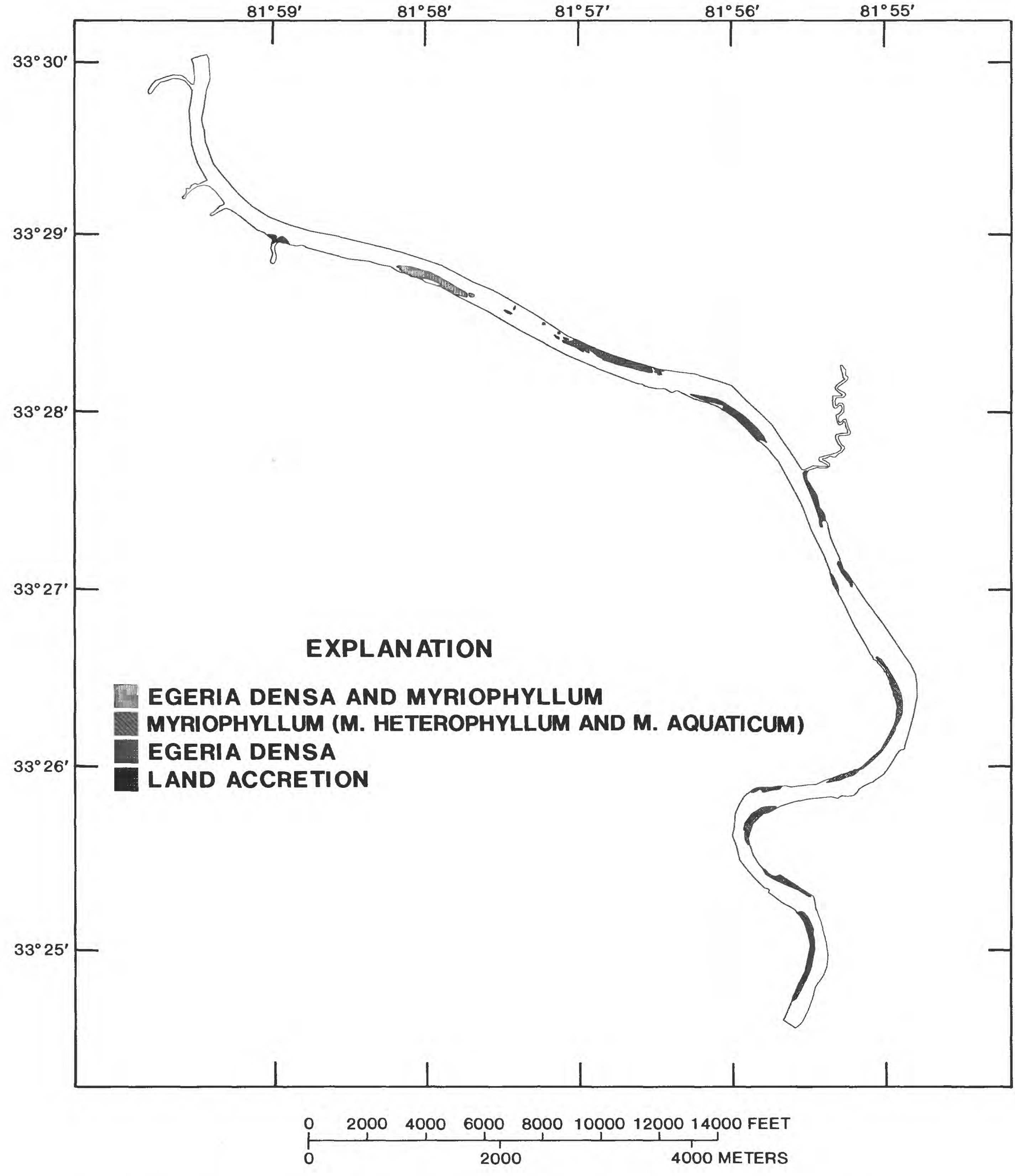

Figure 11.--Distribution of aquatic macrophytes in section 2 of Savannah River, August 1985. (Source: Dr. J.R. Jensen and B.A. Davis, Department of Geography, the University of South Carolina. Photographic data acquired September 9, 1985.)

Stevens Creek Reservoir

Much of this reservoir on the Savannah River has been filled with sediment, providing ideal habitat for a variety of plants. The Stevens Creek arm tends to be much more turbid than the rest of the reservoir, limiting light penetration and hence plant growth. Where the turbid water of Stevens Creek meets the relatively clear water of the Savannah River there is a noticeable change in turbidity, with thick beds of *Egeria densa* on the clear side. The dominant aquatic macrophytes in the reservoir include *Egeria*, *Myriophyllum aquaticum*, *Myriophyllum heterophyllum*, *Ceratophyllum demersum*, and *Utricularia inflata* (fig. 12, table 11).

Table 11.--Acreage of dominant aquatic macrophytes in Stevens Creek Reservoir, July 1985

Aquatic macrophyte or vegetation type	Area (acres)
Egeria densa	720
Myriophyllum spp.	130
Ceratophyllum demersum	30
Utricularia inflata	17
Mixture of the above four	290

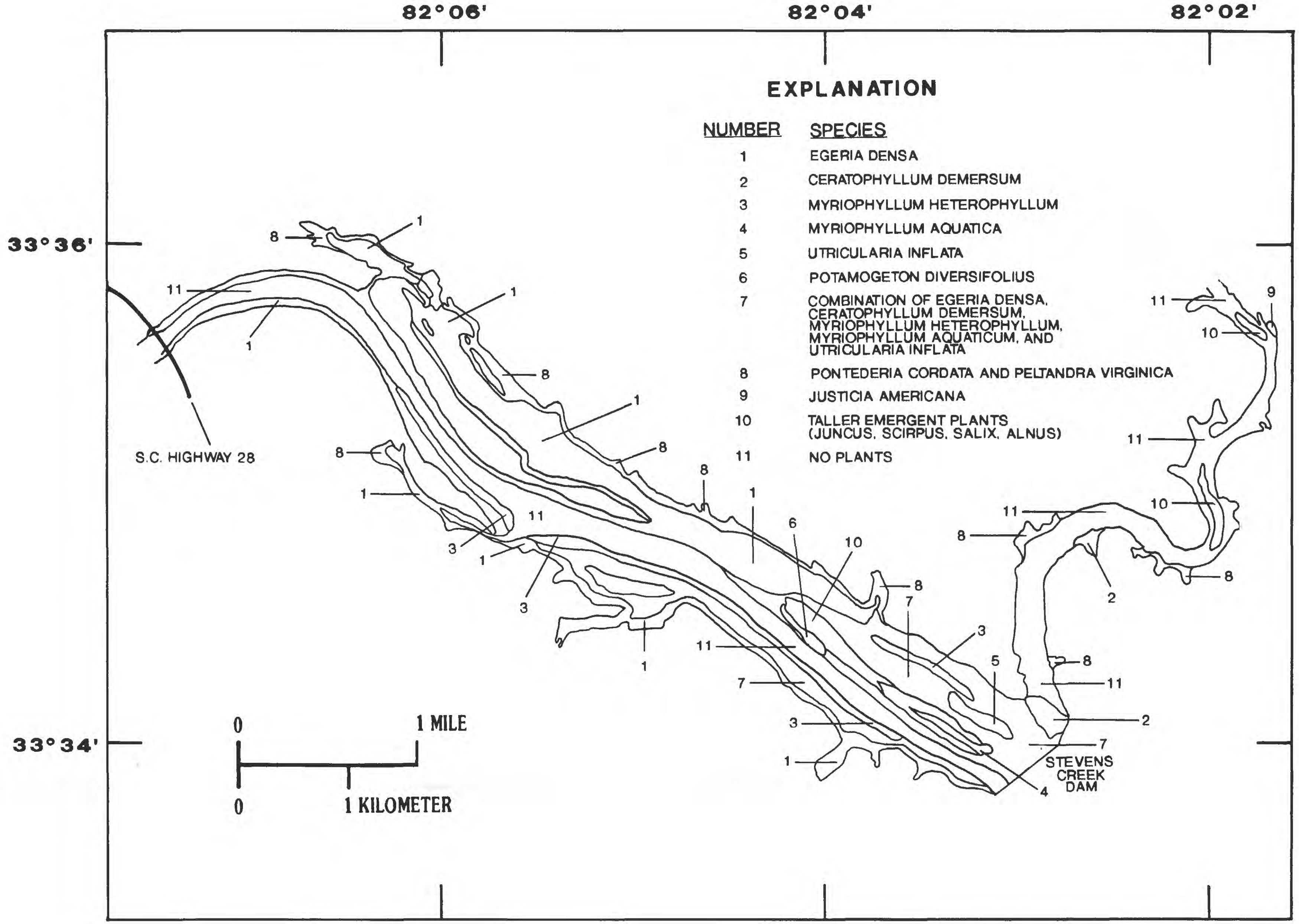

Figure 12.--Distribution of aquatic macrophytes in Stevens Creek Reservoir.

Lake Prestwood

Lake Prestwood is a small reservoir on Black Creek in Hartsville. Only the old channel of Black Creek in the lower part of the lake is deep enough to prevent growth of aquatic macrophytes. In the 1985 the rest of the lake was covered with *Myriophyllum heterophyllum* and *Utricularia biflora*, with a few other species mixed in near the upper end of the lake (fig. 13, table 12). Sterile triploid white amur fish were introduced into this lake immediately following the field survey in 1985.

Table 12.--Acreage of dominant aquatic macrophytes in Lake Prestwood, May 1985

Aquatic macrophyte or vegetation type	Area (acres)
Myriophyllum heterophyllum and *Utricularia biflora*	134
Above plus *Potomogeton diversifolius*	41
Above plus *Nymphaea odorata* and *Nelumbo* sp.	12
Above plus *Taxodium* and *Nyssa* sp.	87
Alternanthera philoxeroides	0.5
Eleocharis equisetoides	0.3
No plants	3.3

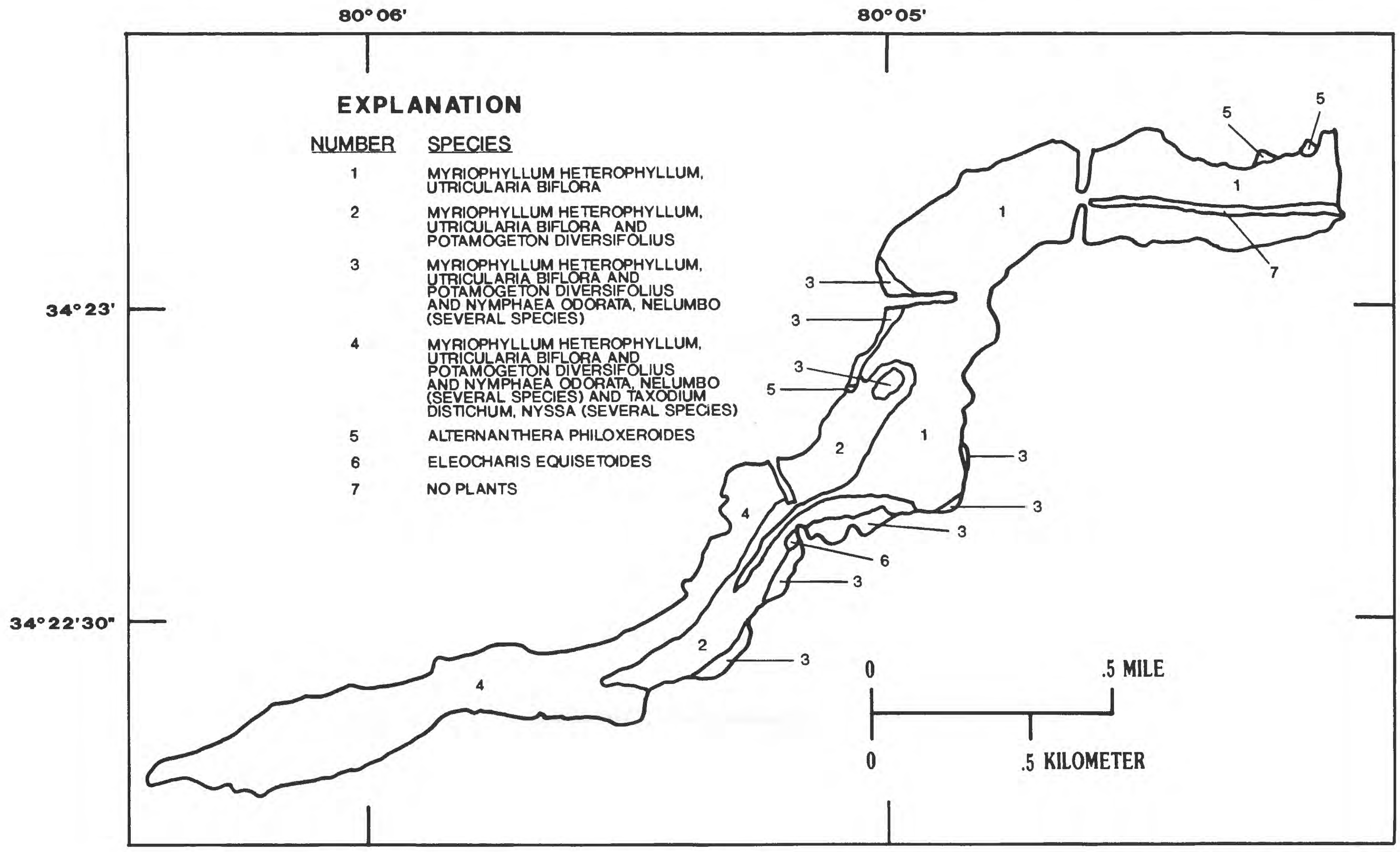

Figure 13.--Distribution of aquatic macrophytes in Lake Prestwood.

Lake Murray

Lake Murray is a large, deep reservoir on the Saluda River that in 1985 was nearly free of aquatic macrophytes. This study involved a cove formed by Millers Branch near the northernmost extension of the lake, between Smallwood Estates and the Lexington-Newberry County line. *Najas minor* grew along the shoreline of this cove, especially in the shallows of the smaller indentations. The shallows at the upper end of the cove were covered with taller marsh plants (fig. 14, table 13).

Table 13.--Acreage of dominant aquatic macrophytes in Lake Murray (Millers Creek Cove), June 1985

Aquatic macrophytes or vegetation type	Area (acres)
Najas minor	50
Juncus, *Salix*, *Alnus*	43

Lake Greenwood

Lake Greenwood is a large reservoir on the Saluda and Reedy Rivers. This study involved the Cane Creek arm, on the eastern side of the lake near State highway 72. *Najas minor* grows along the shoreline, mixed with *Polygonum* in some areas. Taller marsh plants grew in the shallow water in the upper end of the cove (fig. 15, table 14).

Table 14.--Acreage of dominant aquatic macrophytes in Lake Greenwood (Cane Creek arm), June 1985

Aquatic macrophyte or vegetation type	Area (acres)
Najas minor	46
Polygonum	4
Typha, Juncus, other tall marsh plants	14

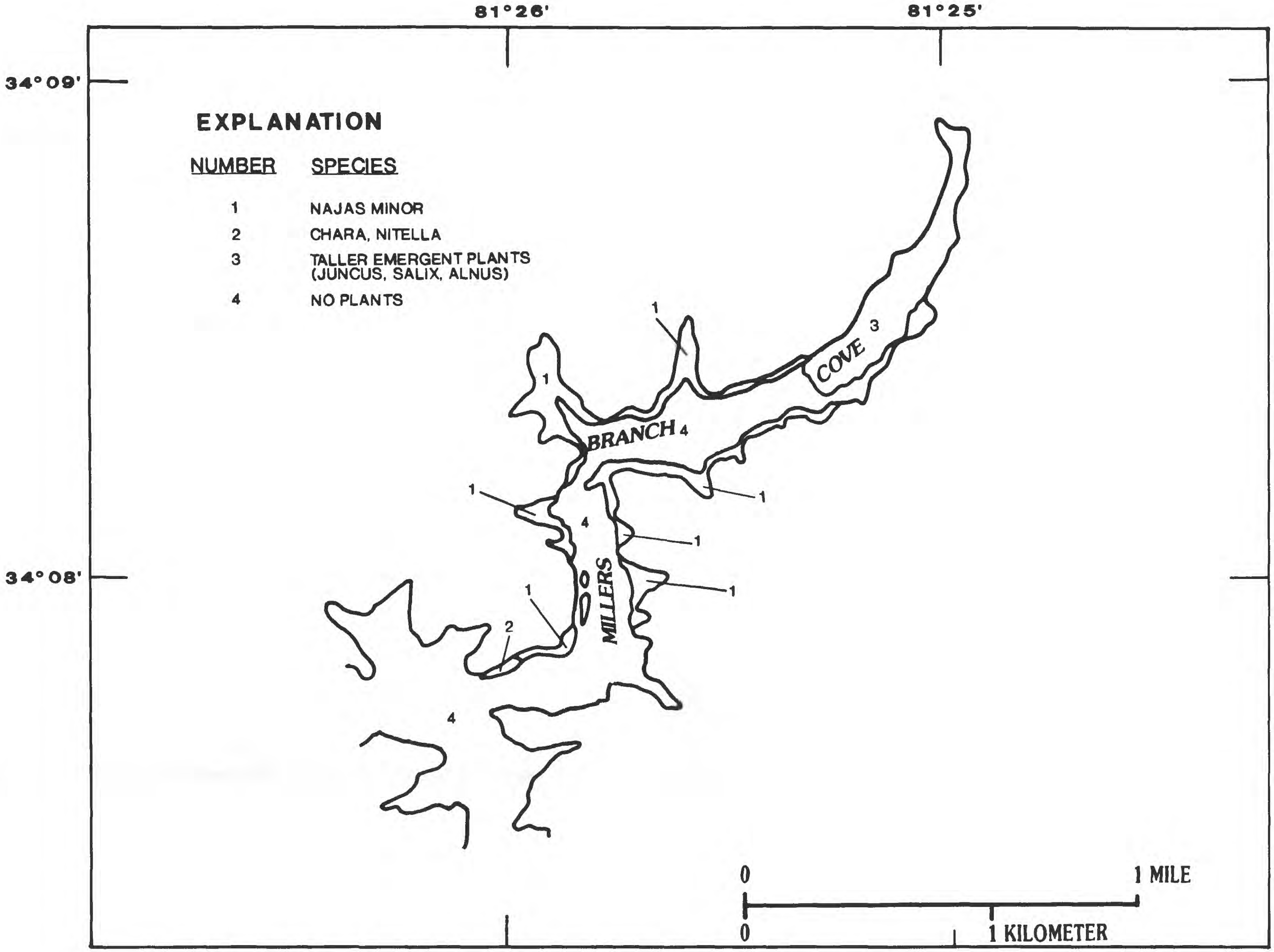

Figure 14.--Distribution of aquatic macrophytes in Lake Murray.

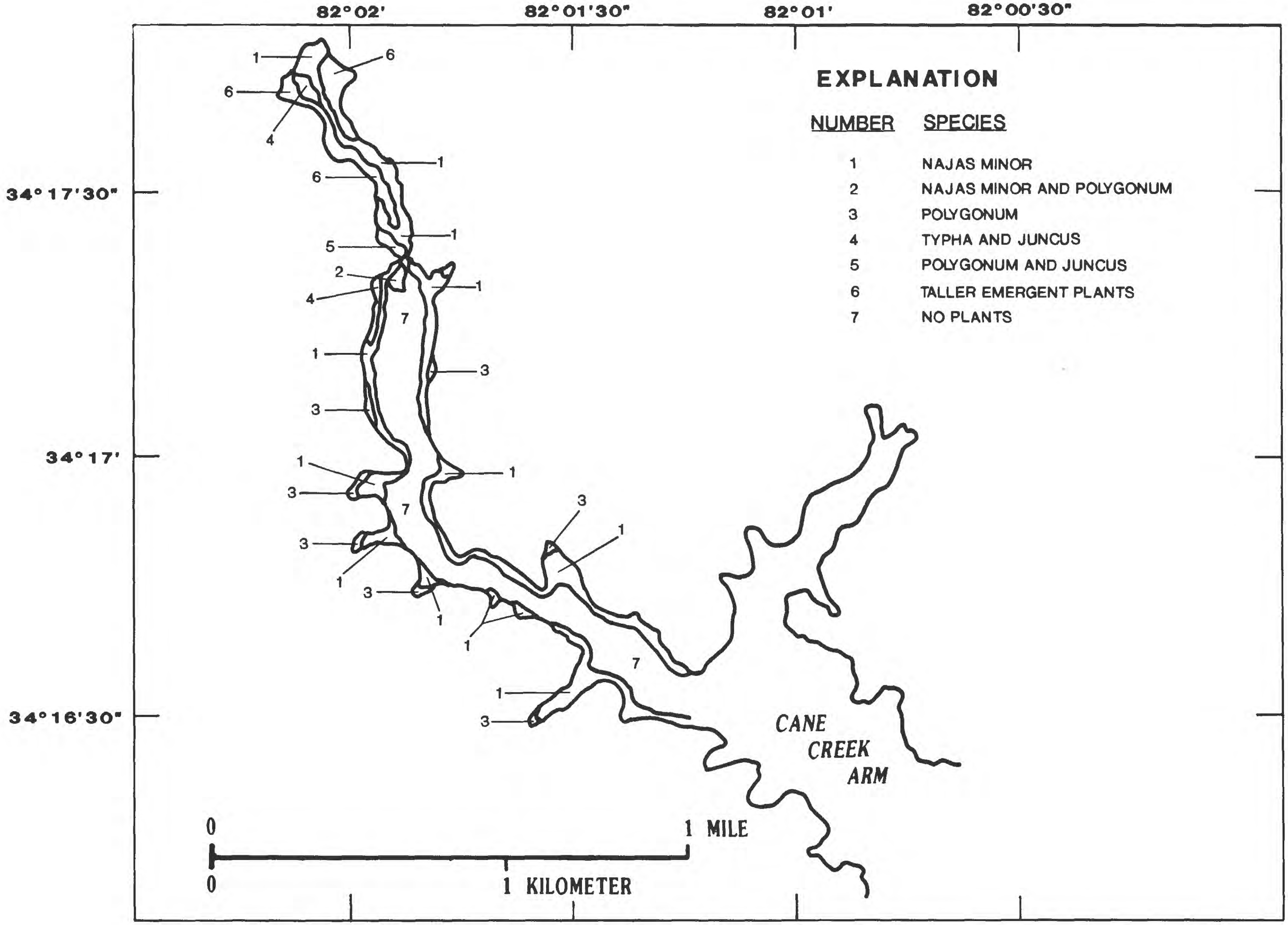

Figure 15.--Distribution of aquatic macrophytes in Lake Greenwood.

Lake Moultrie

Lake Moultrie is a large reservoir in the Cooper River basin fed by water diverted from the Santee River via Lake Marion and the Diversion Canal. Although much of the lake is shallow enough for plant growth, the sandy bottom sediments are frequently disturbed by wind-driven currents and wave action. Growth of aquatic macrophytes is limited to protected areas along the shoreline. Dominant plants included *Egeria densa*, *Ludwigia uruguayensis*, *Najas minor*, and *Nymphoides aquatica* (fig. 16, table 15).

Table 15.--Acreage of dominant aquatic macrophytes in Lake Moultrie, September 1985

Aquatic macrophyte or vegetation type	Area (acres)
Egeria densa	25
Ludwigia uruguayensis	35
Najas minor	500
Nelumbo spp.	95
Chara spp.	45
Ceratophyllum demersum	30
Nymphoides aquatica	70
Pontederia corda	10
Potomogeton diversifolius	5
Typha latifolia	15
Utricularia spp.	2

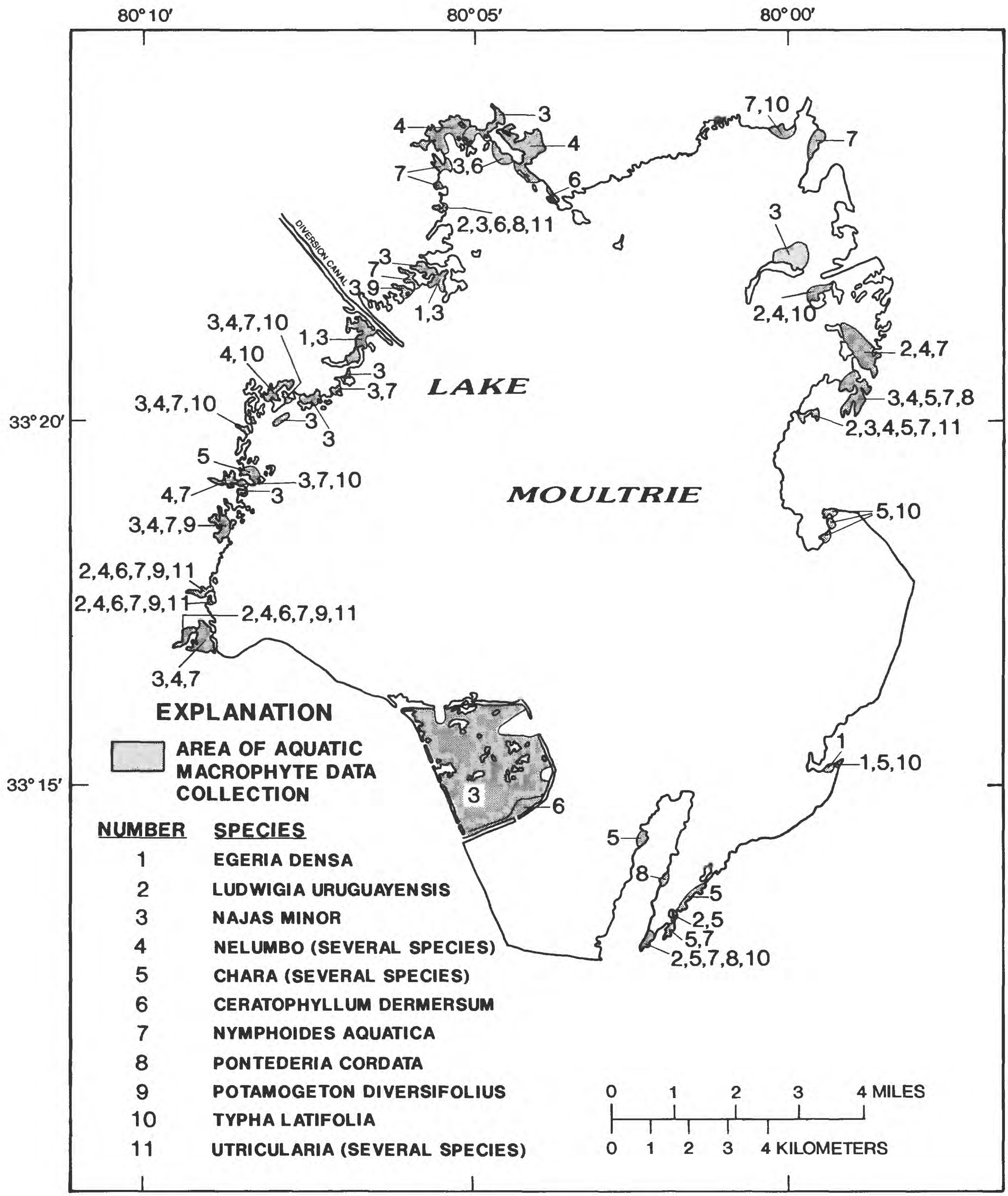

Figure 16.--Distribution of aquatic macrophytes in Lake Moultrie.

Black Creek

The study area spanned 21.5 miles between Hartsville and Darlington. The creek was between 10 and 30 feet wide in the upper portion (sections 1-5) widening to 80-120 feet wide downstream of the confluence with Horse Creek, near Darlington. Much of the creek flows through a bald cypress-tupelo forest association, but the downstream sections flow through oak-pine forest.

Aquatic plant distribution was generalized for each of 8 sections of the creek, averaging about 3 miles in length. Section boundaries were determined using landmarks such as bridges and power lines. Alternanthera philoxeroides was the only troublesome plant found in Black Creek, covering the entire width in some sections (fig. 17, table 16). The occurrence of Alternanthera corresponded closely with that of shallow water, snags (fallen trees), and man-made structures (bridges). Small creeks entering Black Creek were almost always totally covered by Alternanthera.

The bottom of the creek was sandy with no significant growth of submerged aquatic macrophytes.

North Fork Edisto River

The study reach included 19.7 miles from Orangeburg to the confluence with the South Fork. Alternanthera philoxeroides and Polygonum sp. were the dominant aquatic macrophytes (figs. 18, 19, 20; table 17). These plants generally covered less than 50 percent of the width of the stream but appear to have increased in abundance since 1979, when they were estimated to cover less than 10 percent of the width of the stream (White, 1980).

Little Pee Dee River

The study reach included 15.5 miles from U.S. Highway 378 to the confluence with the Pee Dee River (fig. 21). In the first 6 miles of this reach (section 1 in fig. 21) 30-50 percent of the river was covered with emergent vegetation, extending about 50-70 feet from either bank. The dominant species was Alterhanthera philoxeroides, with some Polygonum and a small amount of Zizaniopsis miliacea. Most of the tributary creeks entering the Little Pee Dee in this reach supported bank-to-bank growth of vegetation. In the next 7 miles (section B in fig. 21) the plant coverage decreased and primarily affected only point bars and mouths of tributary creeks. Some Nymphaea was found in this reach. The amount of plant coverage continued to decrease downstream. The 2.5 mile reach upstream of the confluence, (section C in fig. 21) was virtually free of emergent vegetation. The acreages covered in each section are listed in table 18.

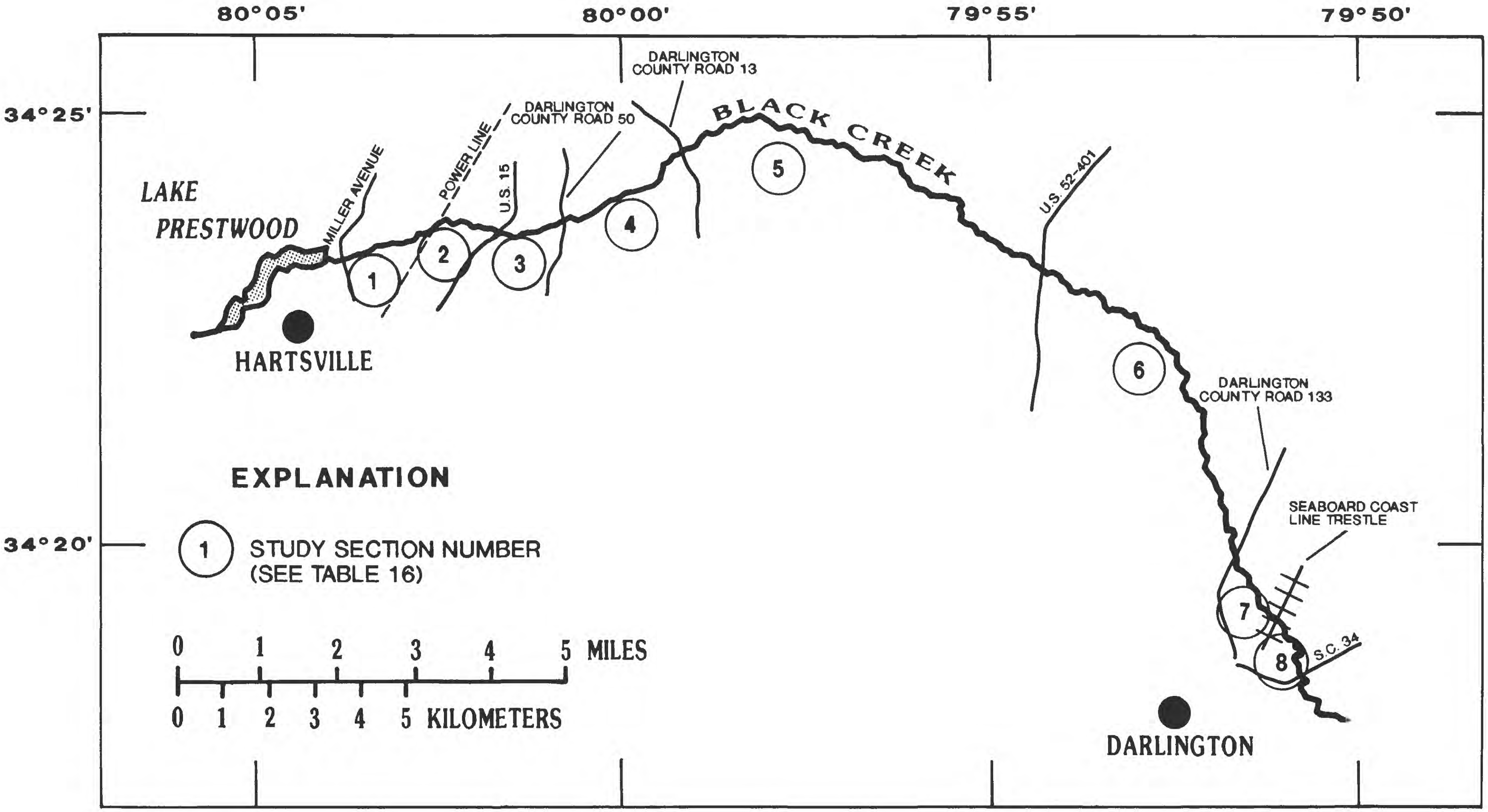

Figure 17.-- Locations of study sections for Black Creek.

Table 16.--Acreage of *Alternanthera philoxeroids* in Black Creek, August 1985

Section number and location (see fig. 17)	Length of section (miles)	Area covered by *Alternanthera philoxeroides* (acres)	Remarks
(1) Miller Ave. bridge to first power line	1.79	1.3	*Alternanthera* was distributed throughout with a total coverage of about 25 percent of the creek. Other plants found were *Polygonum* sp. and unidentified grasses on the banks and floodplain and occasional patches of *Eleocharis* sp.
(2) First power line to U.S. 15 Bypass bridge	.74	1.1	This area was dominated by cypress/tupelo swamp and there was greater light penetration than in Section 1. *Alternanthera* was distributed over about 50 percent of the area of the creek, especially around bridges and open areas around fallen trees and snags.
(3) U.S. 15 Bypass bridge to County Road 50	1.13	2.5	The creek flows through a cypress/tupelo swamp forest. *Alternanthera* coverage about 75 percent. Some parts of the creek were choked off by vegetation, especially around snags, and fallen trees.

Table 16.--Acreage of *Alternanthera philoxeroides* in Black Creek, August 1985--Continued

Section number and location (see fig. 17)	Length of section (miles)	Area covered by *Alternanthera philoxeroides* (acres)	Remarks
(4) County Road 50 bridge to County Road 13 bridge	2.13	4.4	About 70 percent coverage of *Alternanthera*. Especially dense in more open areas.
(5) County Road 13 bridge to U.S. 52-401 bridge	6.74	11.9	About 60 percent coverage of *Alternanthera*. Problematic around bridges and open areas.
(6) U.S. 52-401 bridge to County Road 133 bridge	6.6	6.5	*Alternanthera* seemed to decrease in occurrence farther downstream as the banks rose and supported oak-pine forest. There was about 10 percent *Alternanthera* coverage.
(7) County Road 133 bridge next to Seaboard Coast Line trestle	1.4	0.2	Higher and steeper banks than upstream; *Alternanthera* not problematic. It was seen at some fallen trees and around bridges (1 percent coverage).

Table 16.--Acreage of Alternanthera philoxeroids in Black Creek, August 1985--Continued

Section number and location (see fig. 17)	Length of section (miles)	Area covered by *Alternanthera philoxeroides* (acres)	Remarks
(8) Seaboard Coast Line trestle to State Highway 34	1.0	0.2	Same as section 7. 1 percent coverage by *Alternanthera*
Total	21.5	28.1	

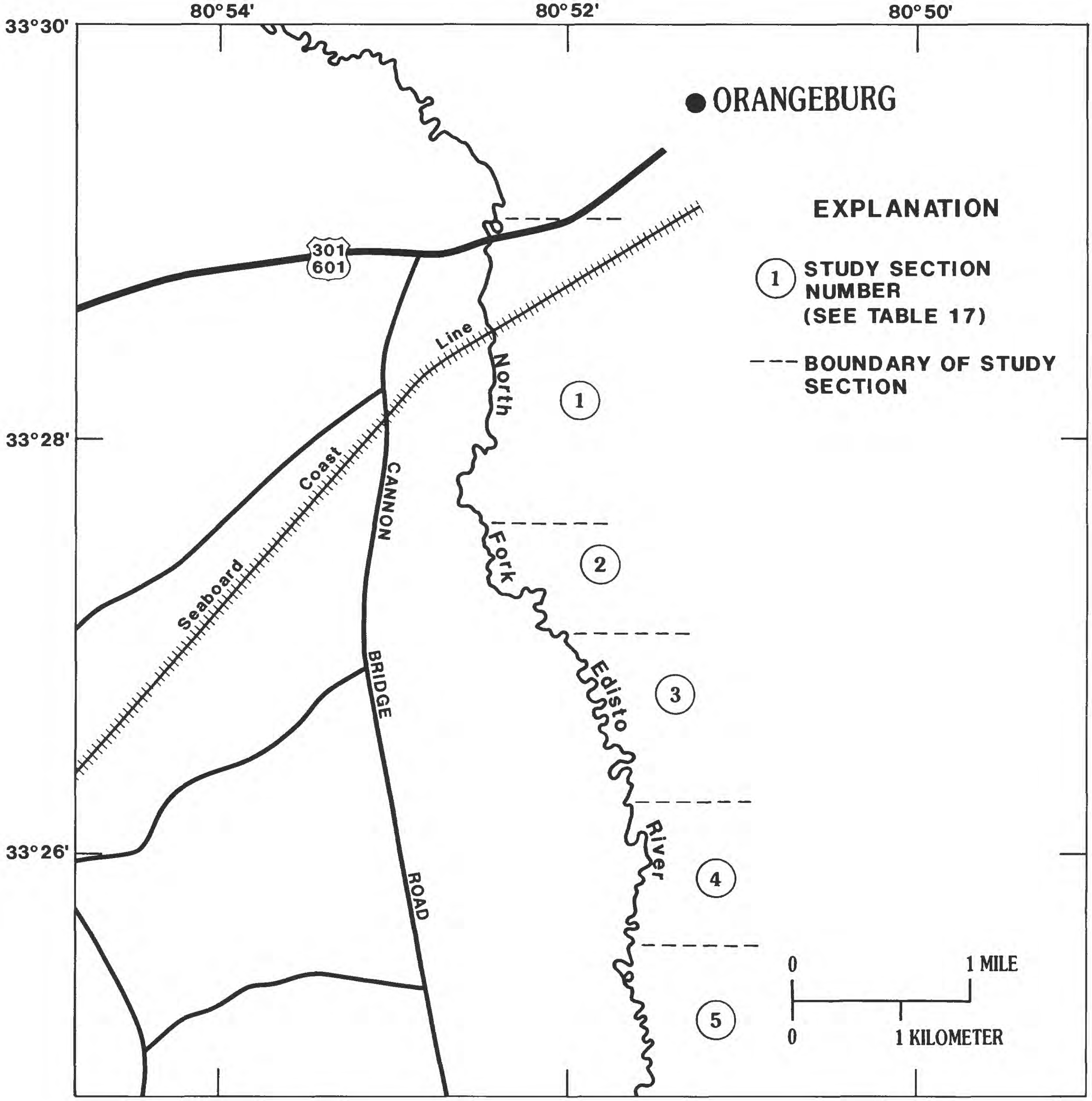

Figure 18.-- Locations of study sections 1-5 for North Fork Edisto River.

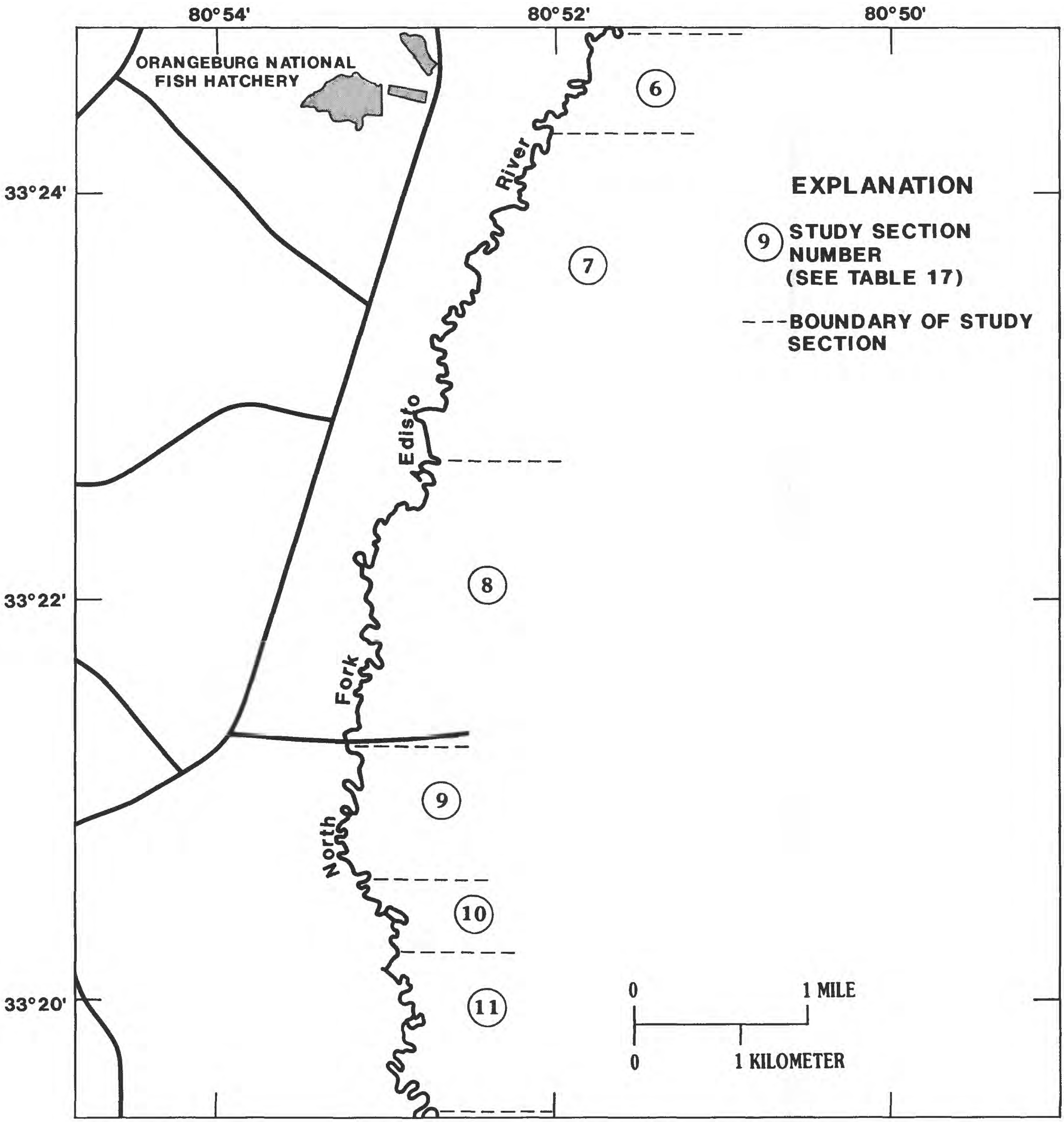

Figure 19.-- Locations of study sections 6-11 for North Fork Edisto River.

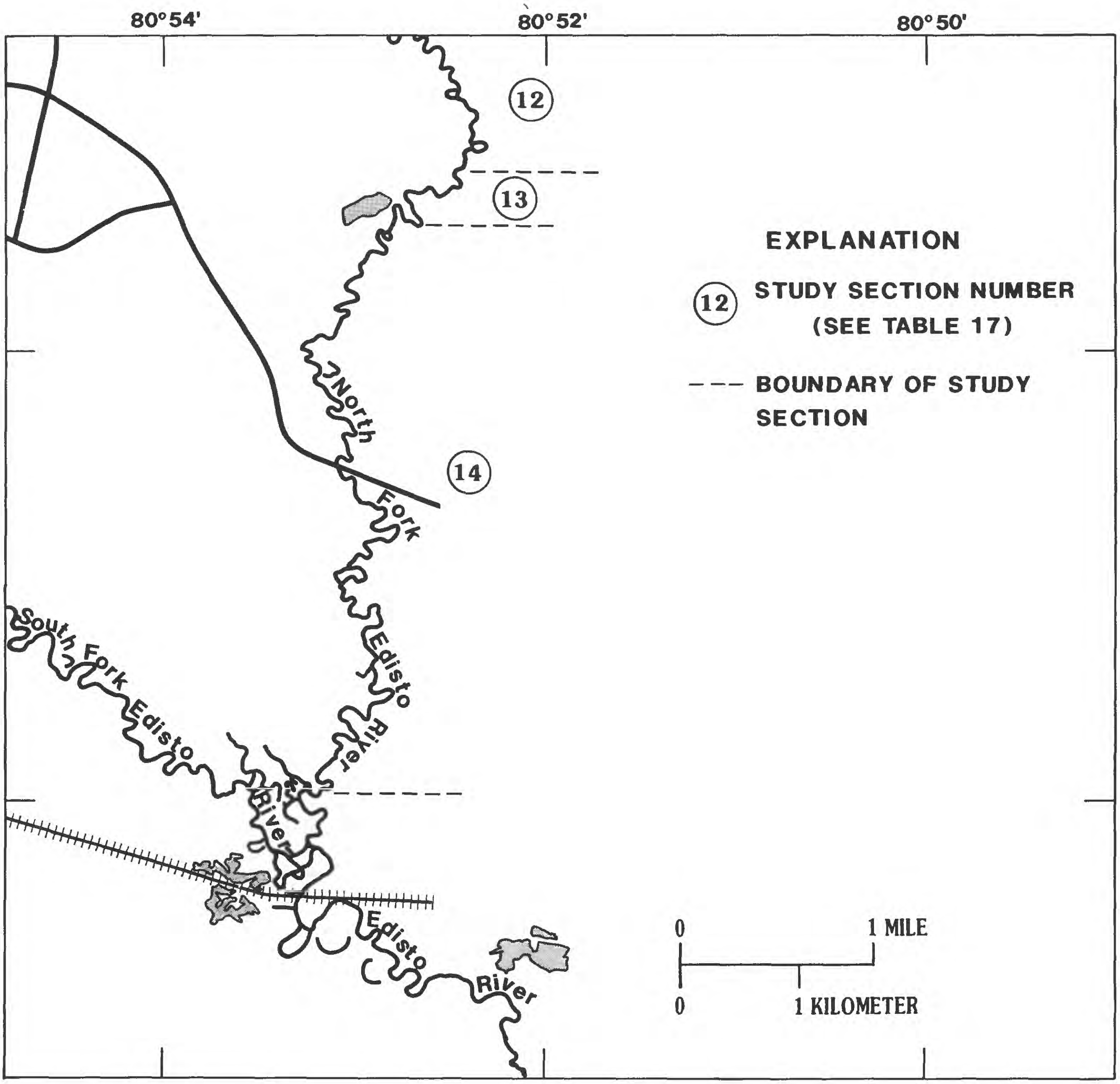

Figure 20.-- Locations of study sections 12-14 for North Fork Edisto River.

Table 17.--Acreage of Alternanthera and Polygonum sp. in North Fork Edisto River, August, 1985

Section (see fig. 18)	Length (miles)	Area covered by indicated plants (acres)		Remarks
		Alternanthera philoxeroides	Polygonum sp.	
1	1.7	<2	<2	Small amount of Pontederia cordata
2	1.0	0.9	2.5	Plants cover 45 percent of stream in some places. Some Typha, Pontederia cordata.
3	1.4	.4	2.4	Plants cover about 15-25 percent of stream.
4	1.0	.1	1.2	Plants cover about 10-30 percent of stream.
5	1.0	.1	0.4	Plants cover up to 50 percent of stream. Oxbow upstream completely filled with Polygonum.
6	0.8	.8	2.0	Plants cover about 30 percent of stream.
7	2.5	1.0	1.1	Most plant growth on point bars
8	2.2	2.4	3.9	Plant growth extends across stream in places.
9	1.0	1.0	3.9	Plant growth mostly on point bars.

Table 17.--Acreage of Alternanthera and Ploygonum sp. in North Fork Edisto River, August 1985--Continued

Section (see fig. 18)	Length (miles)	Area covered by indicated plants (acres)		Remarks
		Alternanthera philoxeroides	Polygonum sp.	
10	0.4	0.2	2.1	Oxbow filled in with plants. Some Peltandra virginica.
11	.8	.6	5.4	Plant growth mostly on point bars. Oxbow filled with plants.
12	1.2	.3	2.4	Island surrounded by Polygonum.
13	.7	.1	0.8	Plants on point bars only.
14	4.0	<1	<1	Channel is wider and deeper than upstream; plants sparse and restricted to point bars.
Total	19.7	7.9	28.1	

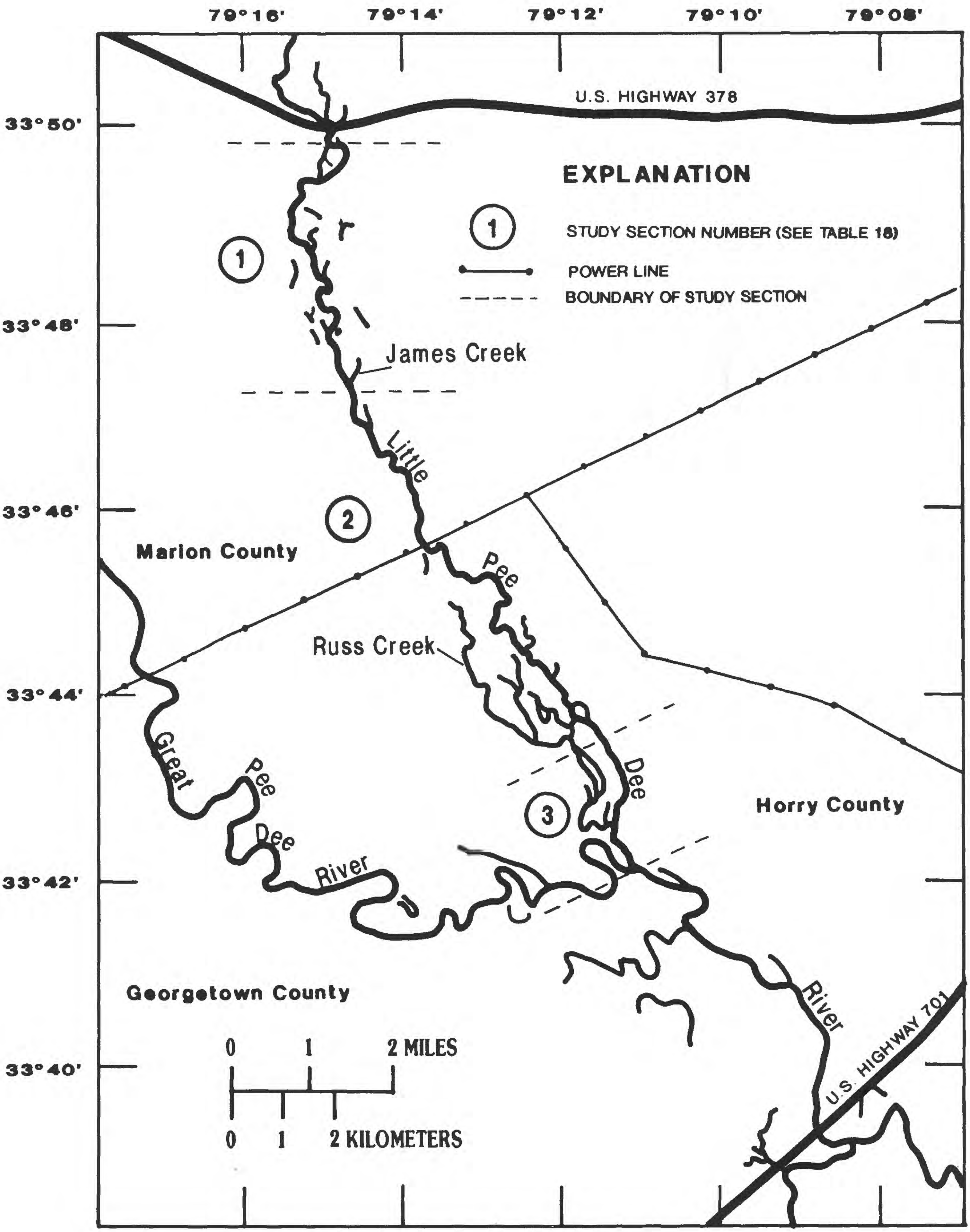

Figure 21.-- Location of study sections for Little Pee Dee River.

Table 18.--Acreage of dominant aquatic macrophytes in Little Pee Dee River, August 1985

Section (see fig. 19)	Length (miles)	Area covered by *Alternanthera philoxeroides* and *Polygonum* sp. (acres)
1	6	36
2	7	29
3	2.5	2
Total	15.5	67

Waccamaw, Black, and Pee Dee Rivers

In the low country between Myrtle Beach and Georgetown the Waccamaw, Black, and Pee Dee Rivers join amid a complex network of interconnecting creeks to form the headwaters of Winyah Bay (fig. 22). The marshes along the reaches that are influenced by the tide but still contain freshwater were developed for rice culture during colonial times, creating additional channels. The mapping effort concentrated on the distribution of *Egeria densa* in the connecting creeks between Sandy Island and the mouth of the Black River because of the effect of this species on boat traffic. The area covered by *Egeria densa* and notes on the occurrence of some other plants in these creeks during 1985 are summarized in table 19. For comparison purposes, acreages of *Egeria densa* growth determined during the Fall of 1979 (White, 1980) are also included. The total acreage of *Egeria densa* in these channels in 1985 was 52 percent of that reported in 1979. The locations of the creeks mapped in this area are shown in figure 22.

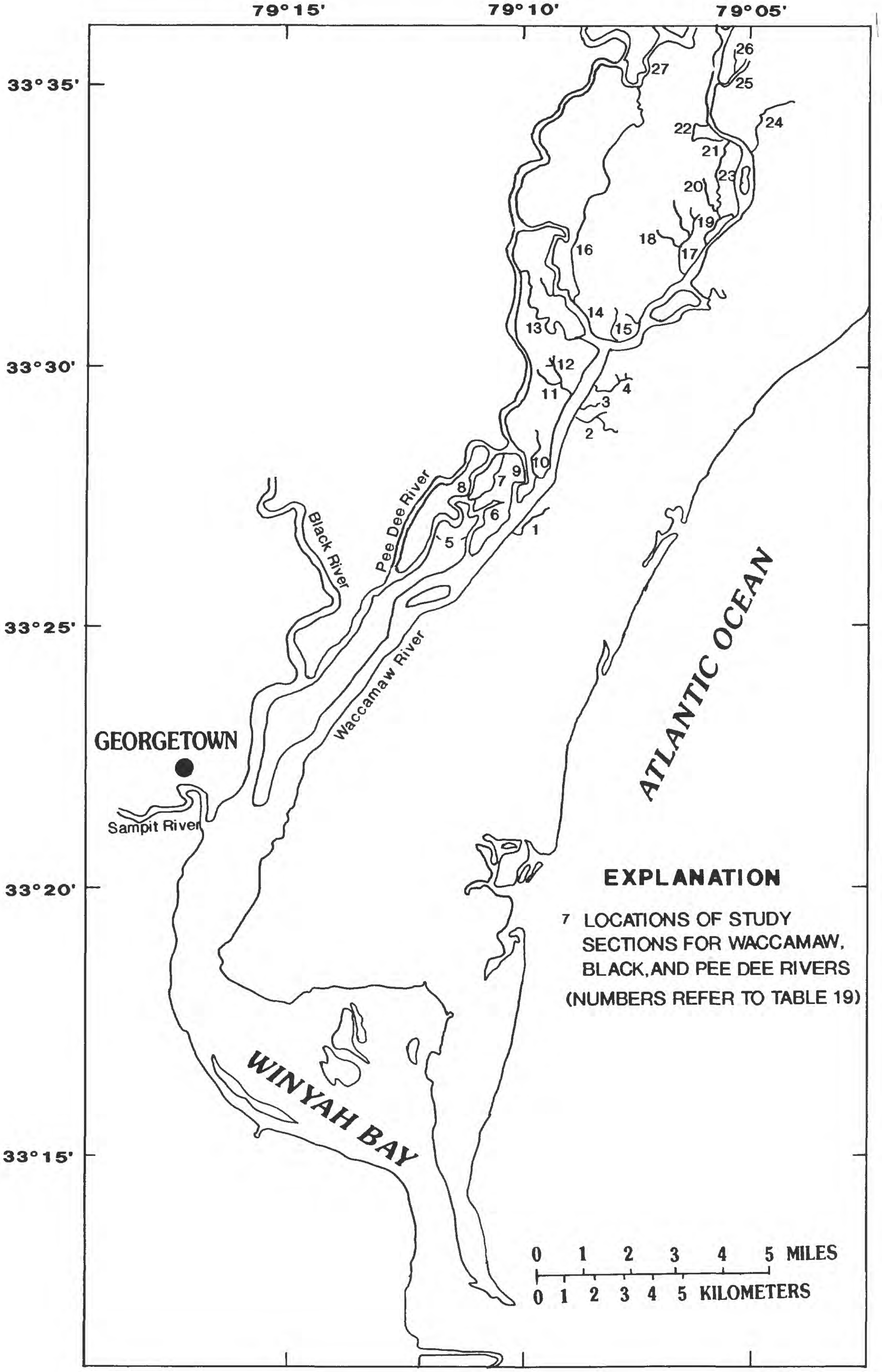

Figure 22.-- Location of study sections for Waccamaw, Black, and Pee Dee Rivers.

Table 19.--*Acreage of Egeria densa in the Waccamaw, Black, and Pee Dee Rivers, Fall of 1979 and June 1985*

Section (see fig. 20)	Creek	Area covered by *Egeria densa* (acres) 1979	1985	Remarks (1985)
1.	Caledonia Creek	2	3	Along banks
2.	Waverly Creek	7	5	In dredged residential channels
3.	Small creek between Waverly and Oatland Creeks	3	3	Also *Ceratophyllum demersum*
4.	Oatland Creek	14	11	Along banks
5.	Jericho Creek	19	4	Along banks, especially on shallow side
6.	Small Creek off Jericho Creek between Waccamaw River and Little Carr Creek	7	3	Dense along banks
7.	Little Carr Creek	4	3	Along banks, lower end
8.	Carr Creek	5	3	Lower end
9.	Schooner Creek	0	0.5	Near Pee Dee River. Also some *Nuphar Luteum*
10.	Butler Creek	4	7	Along banks. Also *Nuphar luteum*
11.	Squirrel Creek	7	0.4	Along banks
12.	Bullins Creek	23	8	Along banks
13.	Guendolose Creek	16	6	
14.	Thoroughfare Creek	0	3	

Table 19.--Acreage of *Egeria densa* in the Waccamaw, Black, and Pee Dee Rivers, Fall of 1979 and June 1985--Continued

Section	Creek	Area covered by *Egeria densa* (acres) 1979	1985	Remarks (1985)
15.	Creek off Waccamaw River just North of Thoroughfare Creek	3	1	Some *Myriophyllum aquaticum*
16.	Cooter Creek	30	2	North end closed off
17.	Sandhole Creek	7	6	Along banks. Also *Pontederia cordata*, *Myriophyllum aquaticum*, *Leersia*
18.	Ruinsville Creek	6	7	Along banks
19.	Crane Creek	3	5	Along banks
20.	Black Creek	1	3	Along banks. Also *Myriophyllum aquatium* and *Zizaniopsis miliacea*
21.	White Creek	0	0.5	Some *Aneilema Keisak*
22.	Vaux Creek	3	0	Some *Myriophyllum aquaticum*
23.	Cow House Creek	0	0	
24.	Collins Creek	2	0	Some *Nuphar luteum*, *Eleocharis equisetoides*, *Zizaniopsis miliacea*
25.	Prince Creek	11	2	Along banks

Table 19.--Acreage of *Egeria densa* in the Waccamaw, Black, and Pee Dee Rivers, Fall of 1979 and June 1985--Continued

Section	Creek	Area covered by *Egeria densa* (acres) 1979	1985	Remarks (1985)
26.	Fisherman Creek	--	0.2	Upper end of creek. Also *Ludwigia uruguayensis*, *Myriophyllum aquaticum*, *Ceratophyllum demersum*, *aneilema keisak*
27.	Little Bull Creek	--	0	Some *Pontederia cordata*, *Zizaniopsis miliacea* along banks
Total		167	86.6	

Large Stands of Aquatic Macrophytes in the Study Areas

The significance of the various stands of aquatic macrophytes surveyed during this study depends on the species involved, the areal extent, the potential for future expansion, and the degree to which they hinder boat traffic and contibute to other problems. Some large stands listed in this report, such as Spartina cynosuriodes (big cordgrass) and Typha latifolia (cat tail) in the Cooper River study area, are relatively stable populations of native plants in typical habitats removed from boat traffic. Some smaller stands, however, such as Najas minor in Lake Murray, may represent the early stage of larger future stands of exotic species in areas frequented by boats. Listed in table 20 are 16 stands in 8 study areas that contain more than 100 acres of aquatic macrophytes frequently subject to control.

Table 20.--Stands greater than 100 acres, in the areas studied, of aquatic macrophytes frequently subject to control

Scientific name	Common name	Location	Area (acres)
Ceratophyllum demersum	Coon-tail	Cooper River	267
Egeria densa *	Brazilian elodea	Cooper River	2,460
		Back River Reservoir	303
		Stevens Creek Reservoir	720
Eichhornia spp. *	Water hyacinth	Cooper River	118
Ludwigia uruguayensis	Water primrose	Cooper River	248
		Back River Reservoir	365
Myriophyllum spp. *	Parrot-feather	Savannah River	149
		Stevens Creek Reservoir	130
		Lake Prestwood	134
Najas minor *	Slender naiad	Lake William C. Bowen	212
		Lake Moultrie	500
Polygonum densiflorum	Smartweed	Cooper River	2,045
		Back River Reservoir	561
		Goose Creek Reservoir	234
Pontederia cordata	Pickerelweed	Back River Reservoir	561

Note: * indicates exotic species

SUMMARY

South Carolina, like other Southeastern states, is experiencing problems caused by excessive growth of submerged and emergent herbaceous aquatic macrophytes in lakes and streams. The primary problem posed by these plants is interference with boat travel. Water quality problems, in the form of decreased concentrations of dissolved oxygen, also occur.

One factor contributing to the growth of aquatic macrophytes in South Carolina is a decreased rate of sediment transport in streams draining the Piedmont. The clearer water promotes light penetration, and hence macrophyte growth.

Six troublesome exotic species of aquatic plants have been introduced into South Carolina from other continents. These species have spread rapidly in some areas. Among these plants are Brazilian elodea (*Egeria densa*), Hydrilla (*Hydrilla verticillata*), Alligator-weed (*Alternanthera philoxeroides*), and Water hyacinth (*Eichhornia* spp.)

The distribution of the most abundant aquatic macrophytes was mapped in 15 lakes and streams in South Carolina in 1985 using combination of remote sensing techniques and field surveys.

Remote sensing, using color infrared aerial photography, was useful in mapping the distribution of aquatic macrophytes in the larger study areas. Emergent species could be differentiated based on spectral patterns. Most submerged plants could be mapped, but could not be differentiated as to species.

The field surveys were conducted by boat, using landmarks for positioning. They provided accurate identification of species and were relatively quick on small study areas less than about 3,000 acres in size. On larger study areas positioning by landmarks can be a problem, and the remote sensing was helpful.

In the 15 lakes and streams mapped, the most extensive stands of aquatic macrophytes that are frequently subject to control efforts were found in and near old rice fields along the Cooper River upstream of Charleston, in Back River Reservoir, in Stevens Creek Reservoir, and in Lake Moultrie.

REFERENCES

Godfrey, R.K., and Wooten, G.W., 1979, Aquatic and wetland plants of the southeastern United States: University of Georgia Press, Athens.

Harvey, R.M., Patterson, G.G., and Pickett, J.R., 1988, An automated positioning system for determining aquatic plant distributions: Journal of Aquatic Plant Management, Vol. 26, January 1988, p. 38-43.

Harvey, R.M., Pickett, J.R., Bates, R., 1987, Environmental factors controlling the growth and distribution of submersed aquatic macrophytes in two South Carolina Reservoirs: in "Lake and Reservoir Management", Proceedings of the 6th Annual Conference of the North American Lake Management Society, Portland, Oregon, Vol. 3, US EPA, Washington, DC., p. 243-255.

Jensen, R., and Davis, B.A., 1986, Remote sensing of aquatic macrophyte distribution in upper Lake Marion. Proceedings of annual meeting of American Congress on Surveying and Mapping and the American Society for Photogrammetry and Remote Sensing, Falls Church, Virginia, p. 181-189.

Lagman, L.H., Nelson, F.P., and Richardson, G.E., 1980, Water quality and aquatic vegetation in the Back River Reservoir, Berkeley County, South Carolina: South Carolina Water Resources Commission Report No. 130, 62 p.

Patterson, G.G., and Cooney, T.W., 1986, Sediment transport and deposition in Lakes Marion and Moultrie. Proceedings of Third International Symposium on River Sedimentation, Jackson, Mississippi, March-April 1986, p. 1336-1345.

South Carolina Aquatic Plant Management Council, 1984, South Carolina aquatic plant management plan, 1984: South Carolina Water Resources Commission, 65 p.

Welch, R., Fung, S.S., and Remillard, M.M., 1985, Aquatic macrophyte distribution in Lake Marion, South Carolina: 1983-1984. Laboratory for Remote Sensing and Mapping Science, Department of Geography, University of Georgia, Athens, Georgia.

Welch, R., and Remillard, M.M., 1986, Aquatic macrophyte distribution in Lake Marion, South Carolina, June and September 1985: Laboratory for Remote Sensing and Mapping Science, Department of Geography, University of Georgia, Athens, Georgia, 15 p.

White, Miller, 1980, Vegetation survey of Fisheries District V: South Carolina Wildlife and Marine Resources Department, Bonneau Wildlife Center, 9 p.