

**U.S. National Park Service
Cooperative Park Studies Unit
Institute of Ecology
University of Georgia
Annual Report 1987**

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Feb. 1988

**U.S. National Park Service
Cooperative Studies Unit
Institute of Ecology
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I. Marine sciences and aquatic resources.

A. Project title:

The effects of sediment on coral metabolism, Virgin Islands National Park.

Funding sources:

NPS, Southeast Region - 50% of total project costs
NPS, Virgin Islands NP - 25%
University of Georgia - 25%

Principal Investigators:

James W. Porter, Zoology Department, University of Georgia, Athens, GA.
Caroline S. Rogers, NPS, Virgin Islands NP.

Background:

Human activities in the area of Virgin Islands NP may be increasing sediment loads on coral reef ecosystems. Sediment is thought to damage or kill living coral if levels are high.

Purpose:

This project was initiated in order to determine if terrestrial sediments washing onto or over a reef could have lethal or sublethal effects on reef building corals. The method for approaching this question was to measure photosynthesis and respiration of corals exposed to differing amounts (weights) of sediments and differing kinds (coarse-grain or fine-grain) of sediments and compare these oxygen metabolism results to control (no sediments) metabolic rates.

Progress:

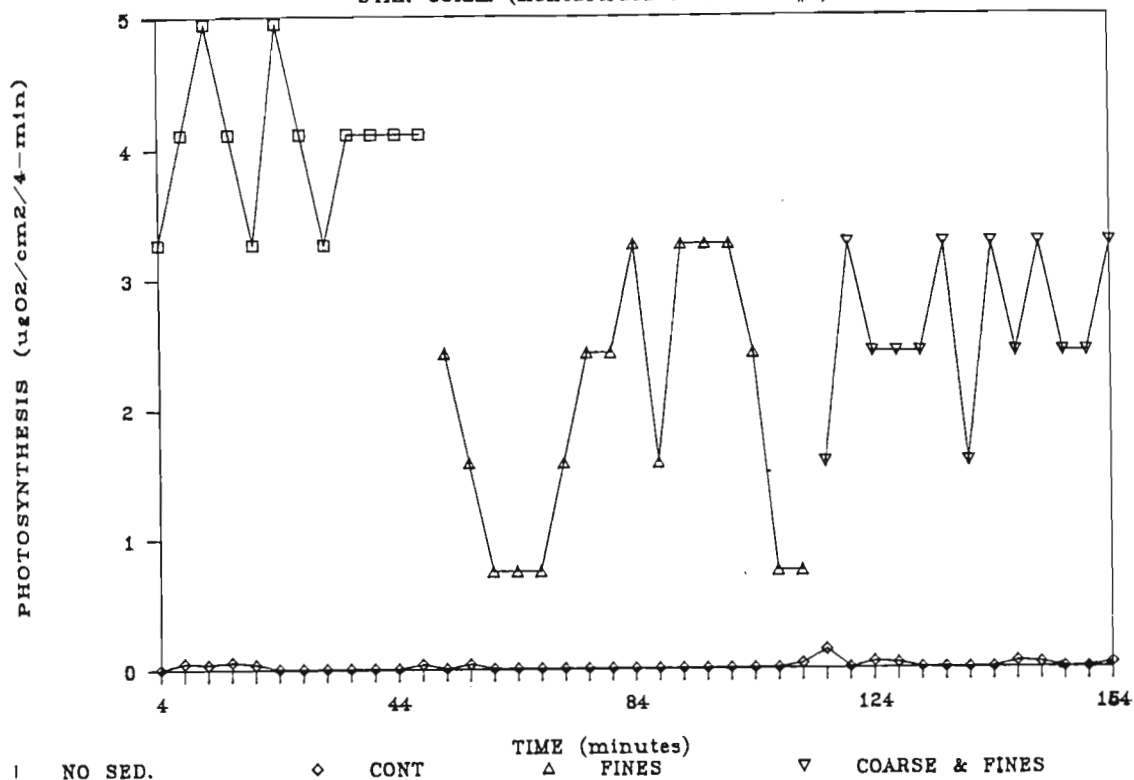
This work was conducted throughout the month of November, 1987 in the Virgin Islands NP on St. John, U.S.V.I. A representative sample of the results can be seen in Figures 1 and 2. The equipment and the research team functioned perfectly and the results are definitive for the major reef builder, the star coral, *Monastraea annularis*. Sediments increase the respiration of this species by as much as double the normal rate and lower photosynthesis by an equally large amount.

Publications:

A paper is in preparation.

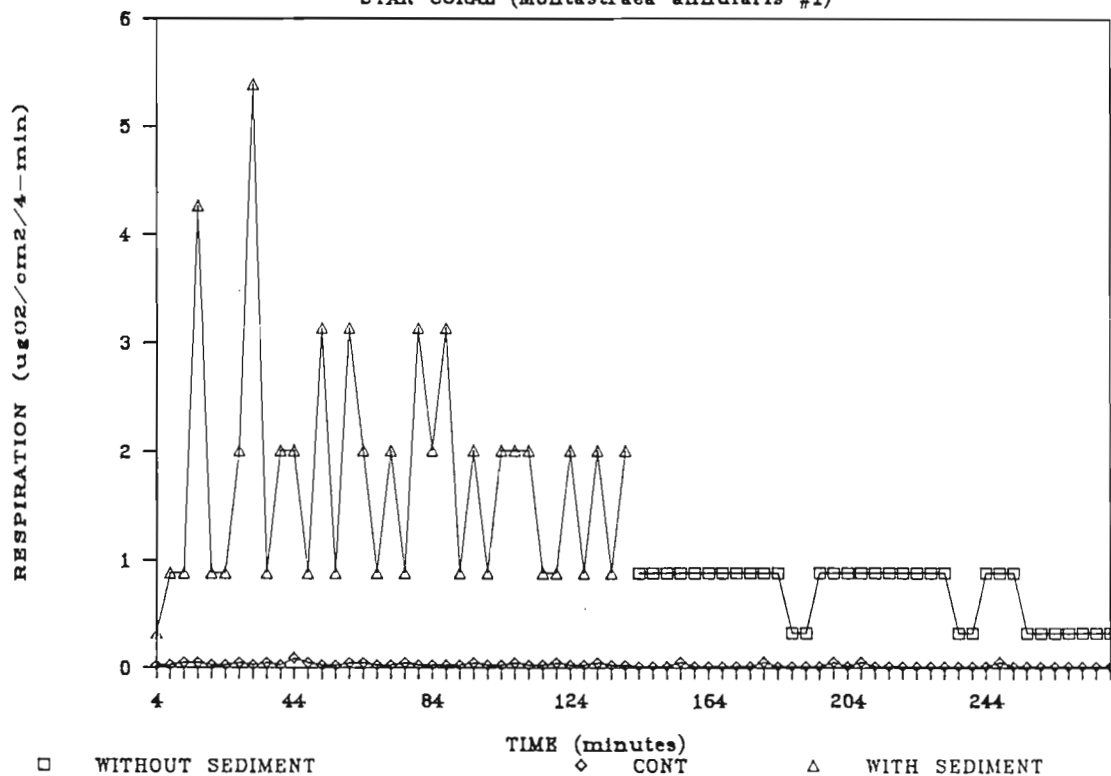
SEDIMENTATION EFFECTS ON PHOTOSYNTHESIS

STAR CORAL (*Montastraea annularis* #3)



CORAL STRESS DUE TO SEDIMENTATION

STAR CORAL (*Montastraea annularis* #1)



I. Marines sciences and aquatic resources.

B. Project Title:

Water quality monitoring, Cape Hatteras NS.

Funding Sources:

NPS, water quality funds.
University of Georgia.

Principal Investigator:

Susan P. Bratton, CPSU, University of Georgia, Athens, GA.

Other Investigator:

To be selected.

Background:

NPS lands on Bodie Island are bordered by private land which is being developed at an increasingly accelerated rate. Development has increased the number of septic tanks adjoining the park and has changed the amount and quality of run-off water moving into the park.

Purpose:

The purpose of this project is to evaluate baseline water quality at ten sites on Bodie Island and to initiate a water quality monitoring program for Cape Hatteras NS.

Progress:

Applications for on site project leader have been solicited and equipment purchases have begun. The project will begin in the field early in 1988.

II. Wildlife ecology - endangered and extirpated species.

A. Project Title:

Movements and foraging behavior of manatees in Cumberland Sound.

Funding Sources:

Department of Defense - 25%
University of Georgia - 10%
NPS, Cumberland Island NS - 10%
NPS, CPSU University of Georgia - 15%
Fernandina Port Project - 25%
U.S. Fish and Wildlife Service - 20%

Principal Investigators:

Lynn LeFebvre, U.S. Fish and Wildlife Service, Gainesville, FL.
Susan Bratton, CPSU, University of Georgia, Athens, GA.
Jim Valade, Fernandina Port Project, Fernandina, FL.

Other Investigator:

Barbara Zoodsma, CPSU, University of Georgia, Athens, GA.

Background:

Manatees, presently considered nationally endangered, have been frequently sighted in the Cumberland Sound area, but almost nothing is known about their numbers, foraging patterns or movements. Increased development for defense related projects may adversely impact manatee habitat.

Purpose:

This project determines manatee movements in Cumberland Sound and nearby waters and attempts to locate manatee foraging areas.

Progress:

Observations from 1986 indicated manatee sightings along Cumberland Island shoreline about once a week during the summer months. All major types of manatee behavior were observed including resting, foraging, cavorting, and courtship. Manatees were of both sexes and included both juveniles and adults. A cow calf pair was recorded. Manatee movements were correlated to the tides. A report on this information was compiled early in 1987.

In March 1987, radio transmitters were placed on two animals in Fernandina, FL. One of these animals went up North River, GA and was tracked until the transmitter was vandalized, probably in the Altamaha area. The second animal, a female returned to Brevard County, FL and

then returned to the Cumberland Sound area. Two additional animals, transmitted in Brevard County, visited Cumberland Sound during the summer and were tracked while in the Georgia - north Florida area.

Preliminary data indicate the manatees are utilizing *Spartina alterniflora* marsh extensively for foraging and are staying in the Cumberland Sound area for several weeks at a time. Areas utilized include the Kings Bay Naval Submarine Base, the western shore of Cumberland Island, including Beach Creek and Old House Creek, Tiger Basin, the North River and Crooked River. Previous estimates of manatee use of Cumberland Sound may have underestimated its importance for feeding during the warmer months of the year. An interim report is in preparation and will be available by the end of February, 1988.

Publications:

Zoodsma, B. and S. P. Bratton. 1987. Cumberland Island Manatee Watch 1986. NPS/CPSU, Insititute of Ecology, University of Georgia, CPSU Technical Report No. 37, 13 pp.

Presentations:

Atlanta Zoological Society, August 1987.

II. Wildlife ecology - endangered and extirpated species.

B. Project Title:

Habitat preferences of wading birds on Cumberland Island NS.

Funding Sources:

Department of Defense - 55%
NPS, Cumberland Island NS - 5%
NPS, CPSU, University of Georgia - 10%
University of Georgia - 30%

Principal Investigator:

Susan Bratton, CPSU, University of Georgia, Athens, GA.

Graduate Assistant:

Laura Wagner, School of Forest Resources, University of Georgia, Athens, GA.

Technician:

Barbara Zoodsma, CPSU, University of Georgia, Athens, GA.

Background:

The marshes and shoreline of Cumberland Island NS are excellent wading bird habitat. In recent years woodstorks, now nationally endangered have been seen in the Cumberland Sound area. Development of defense facilities may be disturbing these species and causing habitat degradation.

Purpose:

The purpose of this project was to determine where wading birds were foraging and roosting on Cumberland Island and where wood storks were most frequently seen. The study concentrated on the area around Beach Creek marsh most likely to be disturbed by Navy dredging.

Progress:

A preliminary survey of four selected study areas was begun in January 1987, and the survey was repeated March-May, June-July, August-September, and October-November. The survey collected 1994 observations of individual study sites. Of these 133 observations included wood storks, and an additional 32 wood stork sightings were collected from a "wood stork watch" effort.

A wood stork roost, used at all four seasons, was documented at South End Ponds, and a nesting area was documented on the Ferguson property, north of Stafford. Wood storks tended to be away from the roost in the morning and in the roost on the high tide. Foraging observations

documented wood storks feeding in fresh or brackish ponds or lakes, and in estuarine areas. Wood storks will forage in low *Spartina alterniflora*, but were more frequently seen along the banks of the larger tidal creeks. Foraging observations were primarily in the morning. Wood storks foraged in fresh ponds at low tide and in the estuaries at low to midtide. Flock size on Cumberland was small. Most observations, away from the roost or rookery, were of three birds or less. The wood storks are residents in the Cumberland Sound area through out the year.

The data indicate white ibis use of low *Spartina* flats at all times of day and tides, although fewer birds were present on the high tide. Other waders tend to forage on exposed creek banks at low to midtide and move into *Spartina* at high tide. Seasonal variations in wader habitat use were quantified.

A publication on wood storks is available in editing draft.

Publications:

Bratton, S.P. (in review). Wood stork use of fresh and salt water habitats on Cumberland Island NS. CPSU Technical Report (in review).

II. Wildlife ecology - endangered and extirpated species.

C. Project Title:

Seasonal locations of raccoons relative to sea turtle nesting on Canaveral NS.

Funding Sources:

NPS, Rutgers Center for Coastal Studies - 75%
University of Georgia - 25%

Principal Investigator:

Robert J. Warren, School of Forest Resources, University of Georgia, Athens, GA.

Other Investigator:

Charles R. Ford, School of Forest Resources, University of Georgia, Athens, GA.

Graduate Assistant:

Jennifer McMurtray, School of Forest Resources, University of Georgia, Athens, GA.

Background:

Raccoon sightings on the beaches of Cape Canaveral NS increase several fold each spring and summer, coincident with the arrival of nesting sea turtles. In order to minimize raccoon depredation of sea turtle nests, it was important to document whether these raccoons on the beaches were resident or transient individuals.

Purpose:

This study was undertaken to determine if raccoons on the beaches in the spring and summer subsequently depart from the island after sea turtle nesting has ended.

Progress:

Seven males and one female were fitted with radio-transmitters. They were captured during peak turtle nesting on CANA, which began 7 May 1986 and ended 30 August 1986 (loggerheads) and 9 September 1986 (green sea turtles) (R. Bryant, pers. comm.). Raccoon predation was first noted on 8 May 1986 and ended 30 August 1986. Nest hatching started on 3 July 1986 and continued into mid-October.

Monitoring of nighttime locations for all eight raccoons did not reveal any movement off of CANA after the sea turtle nesting season. The radio locations (N = 1,982) of the eight raccoons indicated a preferred and constant nighttime use of the beachfront area during the summer, the time of sea turtle nesting and subsequent hatching of young turtles, and also into the fall and winter,

long after the sea turtle egg/hatchling food resource had disappeared.

Based on telemetry data and the predominance of adult raccoons (8) to subadult raccoons (3) captured by live-trapping, depredation of sea turtle nest is done primarily by resident, adult raccoons. Depredation of sea turtle nests by raccoons continues to have a serious impact on CANA. The rate of depredation has decreased significantly during the last few years as a result of a screening program and an apparent die-off of raccoons in the Volusia County - Apollo beach area during the summer of 1985. During 1986, of 344 marked, unscreened (control) nests, 261 (75.9%) were depredated by raccoons. To achieve a further reduction in depredation of turtle nests, a removal of adult raccoons from the beachfront area is recommended.

Publications:

Ford, Charles R., (submitted). Seasonal locations of racoons relative to sea turtle nesting on Canaveral NS, Florida. *Wildl. Soc. Bull.*

II. Wildlife ecology - endangered and extirpated species.

D. Project Title:

Sea turtle nesting on Cumberland Island NS.

Funding Sources:

U.S. Fish and Wildlife Service - 30%
Private sources - 10%
University of Georgia - 20%
Investigator interest - 30%
NPS, Cumberland Island NS - 10%

Principal Investigator:

Jim Richardson, Institute of Ecology, University of Georgia, Athens, GA.

Background:

Populations of the loggerhead sea turtle (*Caretta caretta*) are presently considered nationally threatened and continue to be in decline. Cumberland Island has an important nesting beach for the Georgia population. The Georgia sea turtle cooperative project has been conducting a long term population monitoring study of nesting females on the Georgia coast.

Purpose:

The purpose of this project is to continue the long term population monitoring effort on Cumberland Island. The project is presently in its sixteenth year on Cumberland and the data set is becoming increasingly valuable. The US Fish and Wildlife Service intends to use data from the project to evaluate the effectiveness of turtle excluder devices on shrimp boats. Once these devices are in operation for the local fishing fleet.

Progress:

The project completed another summer season of recording crawls and tagging nesting females in the Cumberland study area. A final report was finished for the previous three years of the project supported by the NPS and is now under review as a technical report from the NPS/CPSU at the University of Georgia.

Publications:

Richardson, James. (under review). Sea turtle nesting on Cumberland Island NS. Institute of Ecology, CPSU Technical Report.

II. Wildlife ecology - endangered and extirpated species.

E. Project Title:

Reintroduction of bobcats to Cumberland Island NS.

Funding Sources:

Being sought, University of Georgia 100% at present.

Principal Investigators:

Robert Warren, School of Forest Resources, University of Georgia, Athens, GA.
Mike Conroy, U.S. Fish and Wildlife Service Cooperative, University of Georgia,
Athens, GA

Background:

All larger predators except humans and alligators have been extirpated on Cumberland Island NS. The native fauna once included mountain lions, black bears, bob cats, and probably red wolves. The deer herd is presently heavily over browsing the live oak forest and a number of mammal populations are high. There was recently a distemper outbreak among racoons. Increased predation pressure might help to relieve browse damage and to reduce native wildlife and non-native armadillo populations.

Purpose:

The purpose of this project is to obtain bob cats from appropriate coastal populations and reintroduce the species to Cumberland Island.

Progress:

During 1987, funding sources have been sought. The Georgia DNR has agreed to cooperate and has offered the use of mainland facilities for holding bob cats prior to release on the island. A proposal has also been prepared for the Southeastern State Game Commissioners for an evaluation of bob cat census methods. Preliminary contacts have been made with island residents and other interested parties including the Georgia Conservancy.

III. Wildlife ecology - over-grazing and non-native species.

A. Project Title:

Feeding and movement ecology of armadillos On Cumberland Island NS.

Funding Sources:

University of Georgia -80%
NPS, CPSU - 10%
NPS, CUIS - 5%
Texas Tech University - 5%

Principal Investigator:

Robert J. Warren, School of Forest Resources, University of Georgia, Athens, GA.

Other Investigator:

Danny B. Pence, Department of Pathology, Texas Tech University Health Sciences Center, Lubbock, TX.

Graduate Assistant:

Martin I. Nelson, School of Forest Resources, University of Georgia, Athens, GA.

Background:

Armadillos were first observed on Cumberland Island in 1973, and are now abundant. Armadillo home range size and movements are poorly known, and knowledge of food habits is limited. No aspect of armadillo natural history has been investigated in Georgia or on a barrier island. The ecological impacts of this exotic species are unknown. As a carrier of leprosy, armadillos pose a potential threat to human health.

Purpose:

The purposes of this study are to determine the food habits of armadillos in major habitats on Cumberland Island, and to analyze seasonal and sexual differences in diet and to determine daily and seasonal home range size and habitat use of Cumberland Island armadillos.

Progress:

A total of 150 armadillos was collected in FY 87; their viscera have been frozen for food habits and endoparasite analyses. Average weight of the 150 armadillos was 3.80 kg (3.95 kg for females and 3.70 kg for males). The overall sex ratio was 1.42 males: 1 female, which may indicate a skewed sex ratio at birth. In November 1986, a radio-transmitter was surgically implanted in an adult male armadillo on Cumberland Island to evaluate the efficacy of this technique

for researching armadillo movement ecology. This animal was monitored for 2 months, and the results of this experiment have been published. Following this initial success, transmitters were implanted in 12 additional armadillos in July 1987. During two 3-day periods in July and September 1987, home range size of the animals varies from 1.67 - 11.33 ha. Average burrow use of 11 radio-equipped armadillos during 8 days in September 1987 was one burrow/1.97 days. Palmettos were strongly preferred den sites, with 68% of the burrows located in palmetto thickets.

Publications:

Nelson, M.I., and R. J. Warren. 1987. Preliminary evaluation of intraperitoneally implantable radiotelemetry in armadillos. *Proc. Annu. Meet. Amer. Soc. Mammal.* 67:Abstract No. 154.

Presentations:

Nelson, M. I., and R. J. Warren. 1987. Preliminary evaluation of intraperitoneally implantable radiotelemetry in armadillos. (Presented at the Annual Meeting, American Society of Mammalogists, Albuquerque, New Mexico, 21-25 June 1987).

III. Wildlife ecology - over-grazing and non-native species.

B. Project Title:

Parasite and nutritional ecology of feral hogs on Cumberland Island NS.

Funding Sources:

NPS, SE Region - 50% (Sub-agreement No. 8)

NPS, CUIS - 25%

University of Georgia - 20%

Texas Tech University - 5%

Principal Investigator:

Robert J. Warren, School of Forest Resources, University of Georgia, Athens, GA.

Other Investigators:

Charles R. Ford, School of Forest Resources, University of Georgia, Athens, GA.

Danny B. Pence, Department of Pathology, Texas Tech University Health Sciences Center, Lubbock, TX.

Background:

Feral hogs occur as an exotic species on Cumberland Island, where there is concern regarding their impacts on native plant and animal communities. In 1975, because of their documented ecological impacts, the National Park Service initiated a program of live-trapping and hunting to reduce the feral hog population. Parasites and malnutrition are potential contributing mortality factors in any wild population. Therefore, data on the parasite and nutritional ecology of a population are important to thoroughly assess the impacts of any population control program.

Purpose:

The purpose of this study was to determine seasonal variations in endoparasite burdens, nutritional status, and food habits of feral hogs on Cumberland Island NS.

Progress:

Collections of adult feral hogs were completed in 1986. The collections had been conducted at about 2- to 3-month intervals from October 1984 to June 1986, and provided 20 male and 28 female swine for evaluation. The final report on the parasite analyses has been completed and published in the *Journal of Wildlife Diseases*. The nutritional status and food habits data are being finalized. The results of this project generally have indicated that feral hogs on Cumberland Island are in better health now than when the program of hog reduction began. With an improvement in animal health and nutritional condition, it is very likely that increased reproduction will occur in the population. Without appropriate control measures, the hog population may very likely increase significantly in the next few years. Thus, it is recommended that hog trapping and hunting efforts

continue or be increased.

Publications:

Pence, D. B., R. J. Warren, and C. R. Ford. 1987. The helminth communities of an insular population of feral swine. *Proc. Annu. Conf. Wildl. Dis. Assoc.* 36: 16 (Abstract).

Pence, D. B., R. J. Warren, and C. R. Ford. 1988. Visceral helminth communities of an insular population of feral swine. *J. Wildl. Dis.* 24 (1): 105-112.

Presentations:

Warren, R. J. 1987. Internal parasite analysis of feral hogs on Cumberland Island. (Invited presentation at the spring meeting, Georgia Chapter, The Wildlife Society, Round Oak, Georgia, 14 May 1987).

Pence, D. B., R. J. Warren, and C. R. Ford. 1987. The helminth communities of an insular population of feral swine. (Presented at the Annual Meeting, Wildlife Disease Association, Lincoln, Nebraska, 2-5 August 1987).

III. Wildlife ecology - over-grazing and non-native species.

C. Project Title:

Electrophoretic analysis of white-tailed deer on Cumberland Island NS.

Funding sources:

University of Georgia - 55% of total project costs (TPC)
NPS, Rutgers Center for Coastal Studies - 40% (TPC)
NPS, CUIS - 5% (TPC)

Principal investigator:

Robert J. Warren, School of Forest Resources, University of Georgia, Athens, GA.

Other investigator:

Charles R. Ford, School of Forest Resources, University of Georgia, Athens, GA.

Graduate assistants:

Randall D. Rowland, School of Forest Resources, University of Georgia, Athens, GA.
Susan K. Miller, School of Forest Resources, University of Georgia, Athens, GA.

Background for project:

Little information is available about the genetic characteristics of barrier island white-tailed deer. The genetic characteristics of other insular mammals indicate reduced genetic variability in these populations, primarily due to founder effect during colonization. Aside from genetic variability limitations in insular populations, factors such as lack of immigration and genetic drift are likely different from those of mainland populations. For this reason, a study of the genetic characteristics of insular deer is needed.

Purpose:

The major objectives of this proposed research project are:

1. To examine allelic frequency data for the Cumberland Island NS deer herd.
2. To identify the spatial extent of local population(s).
3. To determine the breeding structure of the population(s).
4. To assay population quality from genetic indices.

Progress:

A total of 196 adult white-tailed deer (*Odocoileus virginianus*) was collected from the Cumberland Island NS, which is located on Georgia's southernmost barrier island. Collections were conducted approximately every two months from March 1986 through August 1987. The

island was divided into two collection zones based on previous deer harvest management and habitat differences; approximately half of the deer were collected from each zone. Muscle and liver tissue samples were collected from each zone. Muscle and liver tissue samples were collected from each deer for electrophoretic analysis. The electrophoretic data were analyzed to determine genetic variability of the island population. The sample population was more variable genetically than expected for an isolated population - 13 of the 36 enzyme systems run were variable. Allele frequency data also yielded evidence of breeding sub-populations within the island. Sex, age, body weight, number of antler points, and reproductive status of each deer also were examined by multiple correlation analysis for relationships with the genetic data.

III. Wildlife ecology - over-grazing and non-native species.

D. Project Title:

Reproductive biology of white-tailed deer on Cumberland Island NS.

Funding Sources:

University of Georgia -55%
NPS, Rutgers center for Coastal Studies - 40%
NPS, CUIS - 5%

Principal Investigator:

Robert J. Warren, School of Forest Resources, University of Georgia, Athens, GA.

Other Investigator:

Charles R. Ford, School of Forest Resources, University of Georgia, Athens, GA.

Graduate Assistants:

Susan K. Miller, School of Forest Resources, University of Georgia, Athens, GA.
Randall D. Rowland, School of Forest Resources, University of Georgia, Athens, GA.

Background:

Cumberland Island supports a high white-tailed deer population which is contributing to the destruction of vegetation on the island. A program of recreational hunting is currently the only means of controlling the size of the herd. However, few data have been collected to determine its effectiveness, and more reproductive information is needed to aid in management decisions.

Purpose:

The purpose of this project is to determine the annual, seasonal, and spatial variations in male and female breeding cycles for the white-tailed deer population on Cumberland Island NS.

Progress:

Reproductive tracts from 104 female deer collected between March 1986 and September 1986 were analyzed. Ovarian weights, number of corpora lutea, and number and size of follicles were determined. Fecundity of does and fetal sex ratios were determined. Fetuses were aged by two methods: forehead-rump length (FRL) and developmental characteristics (DC). Discrepancies in fetal ages and estimated conception dates were found between the methods. Estimated conception dates ranged from 16 September to 2 January for the FRL method, compared to 25 September to 3 January for the DC method. The estimated peak in conception occurred in late-October using the FRL method, compared to late-September for the DC method.

Publications:

Miller, S.K., R.J. Warren, C.R. Ford, R.D. Rowland. 1988. Reproductive biology of the white-tailed deer on Cumberland Island, Georgia. Proc. Annu. Conf. Southeastern Deer Study Group 11: 24. (Abstract)

Presentations:

Miller, S.K., R.J. Warren, C.R. Ford, R.D. Rowland. 1988. Reproductive biology of the white-tailed deer on Cumberland Island, Georgia. Annual Meeting, Southeastern Deer Study Group, Paducah, Kentucky 21-24 Feb., 1988.

III. Wildlife ecology - over-grazing and non-native species.

E. Project Title:

Diseases and nutritional ecology of white-tailed deer on Cumberland Island NS.

Funding Sources:

University of Georgia - 55%
NPS, Rutgers Center for Coastal Studies - 40%
NPS, CUIS - 5%

Principal Investigator:

Robert J. Warren, School of Forest Resources, University of Georgia, Athens, GA.

Other Investigator:

Charles R. Ford, School of Forest Resources, University of Georgia, Athens, GA.

Graduate Assistants:

Susan K. Miller, School of Forest Resources, University of Georgia, Athens, GA.
Randall D. Rowland, School of Forest Resources, University of Georgia, Athens, GA.

Background:

Cumberland Island supports a dense white-tailed deer population that is contributing to the destruction of vegetation on the island. The disease occurrence, nutritional status, and food habits of a deer population are of particular importance in the formulation of management programs designed to limit a deer herd to its habitat's carrying capacity.

Purpose:

The purpose of this project is to determine the annual, seasonal, and spatial variations in the disease and nutritional ecology of white-tailed deer on Cumberland Island NS.

Progress:

Collections of white-tailed deer have been conducted in a systematic manner as proposed. During FY 87, an average of 23 deer were collected about every two months, for a total of 158 individuals. The number collected was equally divided between northern and southern zones of Cumberland Island, and between males and females. Records and samples obtained from each deer included specific location, weight, age, kidney fat, humerus marrow fat, fecal pellets, rumen contents, abomasum, and blood samples. Samples have been and continue to be processed to provide data on disease, parasite, and nutritional characteristics of the deer population. Preliminary serological analyses of blood samples revealed an incidence of epizootic hemorrhagic disease

(EHD) antibody titers in 5.4% (5 of 92) of the deer examined. This incidence rate is not abnormally high in comparison to other southeastern United States deer herds.

III. Wildlife ecology - over-grazing and non-native species.

F. Project Title:

Population and ecological characteristics of white-tailed deer on Catoctin Mountain Park.

Funding Sources:

NPS, National Capitol Region - 40%
NPS, Catoctin Mountain Park - 30%
University of Georgia - 30%

Principal Investigator:

Robert J. Warren, School of Forest Resources, University of Georgia, Athens, GA.

Other Investigator:

Charles R. Ford, School of Forest Resources, University of Georgia, Athens, GA.

Background:

Over-browsing by white-tailed deer is a serious problem in many parks in the eastern U.S. Catoctin does not permit hunting and presently has serious problems with vegetation damage initiated by its large deer herd.

Purpose:

This project will determine baseline population and ecological characteristics of the Catoctin deer herd in preparation for possible herd reduction.

Progress:

Preliminary contact with the park staff has been established and equipment radio collars have been obtained. The first deer to receive transmitters have been captured and collared. This project is just beginning, and will go into full implementation in the field in 1988.

III. Wildlife ecology - over-grazing and non-native species.

G. Project Title:

Habitat preferences of white-tailed deer and feral horses on Cumberland Island NS.

Funding Sources:

University of Georgia -70%
NPS, CPSU - 20%
NPS, CUIS - 10%

Principal Investigator:

Robert J. Warren, School of Forest Resources, University of Georgia, Athens, GA.

Graduate and Undergraduate Assistants:

Cynthia Hall, School of Forest Resources, University of Georgia, Athens, GA.
Robin B. Goodloe, School of Forest Resources, University of Georgia, Athens, GA.
L. Annette O'Kelley, School of Forest Resources, University of Georgia, Athens, GA.
Sam Stokes, Jr., School of Forest Resources, University of Georgia, Athens, GA.

Background:

White-tailed deer and feral horses, the most common large mammals on Cumberland Island, have tremendous impact on native plant communities due to their grazing and browsing activities. Detailed information on habitat preference and use by these species is needed to provide a basis for management regimes to minimize adverse impacts on native habitats.

Purpose:

The study was initiated to determine habitat preference and use by white-tailed deer and feral horses on Cumberland Island, and to evaluate habitat use overlap by these species throughout the year.

Progress:

Five adult white-tailed deer on Cumberland Island were captured May-June 1987, fitted with radio transmitters and released on site. Locational data for these animals, as well as four feral horses radio-collared December 1986-January 1987, were obtained at three-hour intervals during 96-hour sampling periods conducted in July, August, and September 1987. Habitat overlap between white-tailed deer and feral horses on Cumberland Island was 56%, 30% , and 62% in July, August, and September, respectively. Pastures and lawns, oak-pine forests and oak-palmetto forests were the most heavily used habitat types. These results cannot be used to determine if competition occurs between the two herbivores, but habitat impacts can be predicted. Research during FY 88 will continue evaluation of annual habitat use and overlap by white-tailed deer and feral horses on Cumberland Island on a monthly basis through June 1988.

III. Wildlife ecology - over-grazing and non-native species.

H. Project Title:

Genetic management of barrier island horses.

Funding Sources:

University of Georgia - 60%
NPS, Rutgers Center for Coastal Studies - 35%
NPS, CUIS - 5%

Principal Investigators:

Robert J. Warren, School of Forest Resources, University of Georgia, Athens, GA.
Susan P. Bratton, Institute of Ecology, University of Georgia, Athens, GA.

Other Investigator:

E. Gus Cothran, School of Veterinary Medicine, University of Kentucky, Lexington, KY.

Graduate Assistant:

Robin B. Goodloe, School of Forest Resources, University of Georgia, Athens, GA.

Background:

Grazing by feral horse populations on several U.S. east coast barrier islands causes significant impacts on dune and marsh ecosystems. Most unmanaged island populations appear to be increasing, but information on genetic variability among and between the different barrier island horse herds is needed before any major, long-term sterilization program can be initiated.

Purpose:

The study was initiated to evaluate genetic variability among and between feral horse herds on Cumberland Island, GA; Shackleford Banks, NC; Hatteras Island, NC; and Assateague Island, VA.

Progress:

Blood Samples were collected from 22 horses on Cumberland Island, 4 horses on Shackleford Banks, 16 horses on or from Hatteras Island, and 75 horses on Assateague Island. All electrophoretic analysis of blood samples collected to date has been completed and statistical analyses of genetic data are underway. A final report on the genetic variability of these barrier island horses should be completed in FY 88.

III. Wildlife ecology - over-grazing and non-native species.

I. Project Title:

Immunosterilization of barrier island horses.

Funding Sources:

University of Georgia - 85%
NPS, CPSU -- 10%
NPS, CUIS - 5%

Principal Investigator:

Robert J. Warren, School of Forest Resources, University of Georgia, Athens, GA.

Other Investigator:

Daniel C. Sharp, Department of Animal Science, University of Florida, Gainesville, FL.

Graduate Assistant:

Robin B. Goodloe, School of Forest Resources, University of Georgia, Athens, GA.

Background:

Excessive grazing by feral horses on US east coast barrier islands limits distribution of dune-stabilizing vegetation and causes changes in dune structure that affect a variety of marine and wetland species. Grazing also reduces populations of smooth cordgrass, the dominant species of the salt marsh, and affects marsh successional patterns, productivity, and density of some invertebrate species.

Purpose:

The study was initiated to evaluate one of the more promising methods of non-lethal horse population control - sterilization of breeding adults. Emphasis was placed on testing compounds that could be delivered remotely in a single treatment and that posed few health hazards to the animal or the operator.

Progress:

Twenty-nine adult female horses on Cumberland Island and five adult pony mares at the University of Florida were treated between December 1986 and February 1987 with biodegradable bullets that contained GnRH-KLH conjugate. This compound is less effective than adjuvanted materials in stimulating antibody production against endogenous GnRH, but it is not known to cause lesion formation at the injection site and can be freeze-dried for more efficient delivery. Blood samples were collected from 16 feral mares immobilized prior to treatment, and 10 mares

were fitted with radio transmitters to facilitate identification and monitoring of herd movement.

Three feral mares are known to have died within 1.5 months of treatment, but only one death was attributed to the sampling protocol. The mare became mired in marsh sediment after she was darted and probably suffocated when pulmonary vessels ruptured during the stress of sample collection and removal from the marsh. A fourth treated animal was not located during the 1987 field season.

The other 25 treated mares and 31 control mares on Cumberland Island appeared healthy when 1987 studies began, although some mares that were nursing 1986 foals were thin. Treatment did not appear to affect herd stability. The majority (82.1%) of the adult mares in both treatment and control groups remained with the same stallion throughout the 1987 breeding season. Three dominant stallions lost all adult harem females during the March-August breeding season, and four new herds were formed when bachelor males or previously subordinate herd stallions acquired adult females.

Immobilization and treatment of pregnant mares with GnRH-KLH conjugate had little impact on continuance of pregnancy. Seventeen of 25 treated mares (68%) on Cumberland Island delivered live foals in 1987. However, in February, one treated mare aborted a near-term fetus that appeared to have died of bacterial pneumonia. Fifteen foals (48%) were produced by 31 control mares in 1987, and 27 foals (48%) were produced by breeding adults in 1986, before treatment began.

Four 1986 foals are known to have died within a few months of birth. In 1987, eight foals died within several weeks of birth, including six born to treated mares. The greater foal mortality observed in 1987 probably is related to sampling chronology, conducted only in April, May, and August, and it is likely that some foal deaths that occurred during June and July were not documented. Five foals that died in 1987, including four produced by treated mares, were born after May 31, a period during which over half of all newborns died. Only 13.0% of the animals born on or before May 31 died.

Preliminary results, therefore, indicate that treatment with GnRH-KLH conjugate has little impact on horse health, herd stability, or fetus survival. The effect of the compound on reproduction of feral mares on Cumberland Island cannot be determined until the 1988 breeding season; however, the corralled horses at the University of Florida that were treated with GnRH-KLH conjugate failed to produce significant levels of GnRH antibody, and 80% produced at least one conceptus during the 1987 breeding season. These results indicate that GnRH-KLH conjugate is not an adequate sterilizing agent for horses.

Emphasis during FY 88 and FY 89 will focus on evaluating other GnRH compounds that have greater antibody-stimulating properties but that are less easily administered or pose greater health hazards to the animal or operator.

Publications:

Goodloe, R. B., R. J. Warren, and D. C. Sharp. (in prep) Immunosterilization of feral and captive horses.

Presentations:

Immunosterilization and genetic management of barrier island horses. Fourteenth Annual Natural Areas Conference, Peoria, IL. October 1987.

Immunosterilization of feral and captive horses. Contraception in Wildlife symposium. Philadelphia, PA. November 1987.

IV. Wildlife ecology - management of native species.

A. Project Title:

The response of small mammals to prescribed fire on Cape Hatteras NS.

Funding Sources:

NPS, Rutgers Center for Coastal Studies - 40%
University of Georgia - 30%
NPS, Cape Hatteras NS - 30%

Principal Investigator.

Susan Bratton, CPSU, University of Georgia, Athens, GA.

Technician:

James Boone, CPSU, University of Georgia, Athens, GA.

Background:

Shrub invasion is blocking vistas and displacing marsh species on Cape Hatteras NS. Methods are being tested to inhibit shrubs.

Purpose:

The purpose of this study was to assess the impact of prescribed burns on small mammals at Cape Hatteras NS. in each of the major habitat types found on the seashore.

Progress:

Small mammals were censused in four habitat types at Cape Hatteras NS between February and September 1987. In each habitat type, two areas were censused on three occasions; one of the two areas in each habitat type was burned after the first census. Small mammal populations of all habitats were found to be very low and highly variable in species number and composition. Fires in the marsh are probably of no consequence to these populations because there are so few animals in any one area, and because the patchiness of the fires leaves many refugees. The data suggest, however, that there may be a slight positive effect resulting in slightly higher populations in burned areas. It is highly unlikely that fires, except perhaps large fires during droughts, would have a serious negative impact on these animals.

Publications:

Boone, James. (under review). The response of small mammals to prescribed fire in a North Carolina salt marsh. CPSU Technical Report.

IV. Wildlife ecology - management of native species.

B. Project Title:

Waterfowl use of ponds on Cape Hatteras NS.

Funding Sources:

NPS, Cape Hatteras NS
University of Georgia
Investigator interest

Principal Investigator:

James Boone, CPSU, University of Georgia, Athens, GA.

Background:

Vegetation changes and marsh succession on Bodie Island may be effecting use of ponds by wading birds, shore birds and waterfowl.

Purpose:

The purpose of this project was to evaluate avian use of the Bodie Island ponds by season and water level.

Progress:

Birds were censused from March through August 1987. Ducks were most common early in the season and their use of the ponds did not vary with water level. Shorebirds and wading ponds used the ponds more frequently when the water was low. A maximum of 45 black ducklings were seen in 7 broods. Results indicate manipulation of water levels through an existing water control structure on the lighthouse pond may enhance use of the area.

Publications:

Boone, James. (under review). Birds of the Bodie Island Lighthouse Pond and the Roadside Ponds and Marshes. CPSU Technical Report.

IV. Wildlife ecology - management of native species.

C. Project Title:

Mycoplasma gallisepticum in wild turkeys on Cumberland Island NS.

Funding Sources:

The Turkey Foundation - 35%
University of Georgia - 60%
NPS, Cumberland Island NS - 5%

Principal Investigators.

Willaim R. Davidson, School of Forest Resources, University of Georgia, Athens, GA.
Victor Nettles, Southeastern Cooperative Wildlife Disease Study, College of Veterinary Medicine, University of Georgia, Athens, GA.
Stanley Kleven, Poultry Disease Research Center, College of Veterinary Medicine, University of Georgia, Athens, GA.

Graduate Assistant:

Page Luttrell, School of Forest Resources, University of Georgia, Athens, GA.

Background:

Wild turkeys on Cumberland Island are known to have been infected with *Mycoplasma gallisepticum*, a disease also found in commercial poultry flocks, and of concern both to managers of commercial poultry and of wild turkey populations on the mainland.

Purpose:

The purpose of the project is to determine if *Mycoplasma gallisepticum* is still found in the Cumberland Island wild turkey population and to determine how widely it occurs in the population.

Progress:

In 1987 the project leaders met with the park superintendent and island residents and made arrangements for field sampling. Field work will begin in January 1988.

V. Historic landscape documentation and management.

A. Project Title:

Vegetation changes on Bodie Island, Cape Hatteras NS.

Funding Sources:

University of Georgia - 60%
NPS, Southeast Region - 35% (project now closed)
NPS, Cape Hatteras NS - 5%

Principal Investigator:

Ian Firth, School of Environmental Design, University of Georgia, Athens, GA.

Background:

Shrub invasion on Bodie Island has greatly increased since the 1930's. Shrubs are now blocking vistas and encroaching on grasslands. The 1984 General Management plan for the Cape Hatteras NS called for further investigation of the application of fire to counter the invasion of woody shrubs in the wetlands of Bodie Island.

Purpose:

The purpose of this study was (1): to analyze the changing distribution of shrubs and trees on Bodie Island, (2) to catalog anthropogenic disturbances, and (3) to examine the connections between vegetation change and the disturbance history of the island.

Progress:

All field work has been completed and a publication was prepared and submitted in 1987. Results indicate shrub invasion has slowed along the roads and marsh edges, but that shrubs now occupy a much larger area of the island than they did historically.

Publications:

Firth, Ian. 1987. Vegetation changes on Bodie Island, Cape Hatteras NS. Research/Resources Manage. Rep., NPS Southeast Region. SER- 85, 33 pp. plus maps and figs.

V. Historic landscape documentation and management.

B. Project Title

The historic landscape of Dungeness, Cumberland Island NS.

Funding Sources:

Investigator interest - 60%
NPS, CPSU, University of Georgia - 20%
University of Georgia - 20%

Principal Investigator:

Ian Firth, School of Environmental Design, University of Georgia, Athens, GA.

Graduate Assistant:

Lauren Zeichner, School of Environmental Design, University of Georgia, Athens, GA.

Background:

Historic plantings and biotic landscape features at Dungeness are slowly changing under park management.

Purpose:

The purpose was to document and map the historic landscape of Dungeness by archival research, field survey and interviews.

Progress:

The mapping of the site has been completed and a final descriptive report with maps was released in 1987. An MLA thesis discussing potential management of the site is expected in spring of 1988.

Publications:

Zeichner, Lauren. 1986. The Historic Landscape of Dungeness, Cumberland Island NS, Georgia. NPS/CPSU, Institute of Ecology, University of Georgia, CPSU Technical Report No. 35, 126 pp. plus maps.

V. Historic landscape documentation and management.

C. Project Title:

The historic landscape of Plum Orchard, Cumberland Island NS.

Funding Sources:

Investigator Interest - 60%
University of Georgia - 35%
NPS, Cumberland Island NS - 5%

Principal Investigator:

William Mann, School of Environmental Design, University of Georgia, Athens, GA.

Graduate Assistant:

Henry Parker, School of Environmental Design, University of Georgia, Athens, GA.

Background:

The landscape of the Plum Orchard Historic District was originally surveyed by Jay Avriett in 1983.

Purpose:

The purpose of the project is to evaluate the use of repeated photography for monitoring long term change at an historic site and to evaluate the use of photography for making management recommendations.

Progress:

The investigators have assembled relevant photography and conducted field visits of the site. An MLA thesis is expected by late 1988.

V. Historic landscape documentation and management.

D. Project Title:

Recent landscape change at Ocmulgee NM.

Funding Sources:

Investigator interest - 70%
University of Georgia - 20%
NPS, CPSU - 10%

Principal Investigators:

Ian Firth, School of Environmental Design, University of Georgia, Athens, GA.
Susan Bratton, NPS, CPSU, University of Georgia, Athens, GA.

Graduate Assistant:

Peggy Froeshauer, School of Environmental Design, University of Georgia, Athens, GA.

Background:

The landscape at Ocmulgee has changed greatly since the period of Indian agriculture. The park may consider attempting to restore some historic features and landscape boundaries.

Purpose:

To document landscape changes at Ocmulgee within the recent historic period and to investigate the impacts of European settlers on the landscape.

Progress:

Archival investigations and field survey were completed in 1987. A student project report and possibly a technical publication will be produced in 1988.

V. Historic landscape documentation and management.

E. Project Title:

Disturbance and change in Buxton Woods, Cape Hatteras NS.

Funding Sources:

NPS, CPSU - 70%
University of Georgia - 20%
NPS, Cape Hatteras NS - 10%

Principal Investigators:

Susan Bratton, NPS, CPSU, University of Georgia, Athens, GA.
Kathryn Davison, CPSU, University of Georgia, Athens, GA.

Background:

Staff at Cape Hatteras had observed pine succession in Buxton Woods accompanied by high fuel loadings. Development along the park boundary is increasing the risk of an ignition.

Purpose:

The purpose of the project was to document changes in Buxton Woods since European settlement and to determine the probable fire history. The project included constructing a contemporary map of the vegetation in the woods and evaluating fuel loadings.

Progress:

Field work on the project was completed in 1985 and resulted in a technical report on the history of the site. During 1986 and 1987 further publications were prepared and maps were professionally drafted. The results indicate the species composition of Buxton Woods has changed greatly since Colonial times with loblolly pine replacing oaks. This change is due not just to logging but also to intensive livestock grazing and anthropogenic burning. Since the cessation of grazing in 1937, fuel loadings have increased. Management for hardwoods is desirable because this was the pre-settlement condition of the woods and hardwood cover is less likely to forward fire spread.

Publications:

Bratton, S.P. and K. Davison. 1987. Disturbance and succession in Buxton Woods. *Castanea* 52(3):166-179

Bratton, S.P. and K. Davison. (in press) Landscape history and its implications for fire management in a maritime forest. In *Vegetation Change and Historic Landscape Management*. Proceedings of the 1986 Conference on Science in the National Parks, 15 pp.

Davison, K. and S.P. Bratton. 1987. The vegetation and fuels of Buxton Woods, Cape Hatteras NS, North Carolina. CPSU Technical Report No. 40, 45 pp.

V. Landscape history documentation and management.

E. Project Title:

Symposium volume for national parks science meeting.

Funding Sources:

NPS, CPSU - 80%
University of Georgia - 20%

Principal Investigator:

Susan Bratton, NPS, CPSU, University of Georgia, Athens, GA.

Background:

Historic landscape research is presently increasing in the national parks.

Purpose:

The purpose of the project was to prepare an edited volume of papers which presented examples of some of the commonest types of historic landscape work and reviewed the present state of the art in the parks.

Progress:

During 1987 papers were solicited, assembled, reviewed and edited and prepared for publication. The volume was submitted to Dr. Ray Herrmann at the CPSU at Colorado State University.

Publications:

All in *Vegetation Change and Historic Landscape Management*, Proceedings of the 1986 Conference on Science in the National Parks. (in press)

Bratton, S.P. Vegetation change and historic landscape management: An introduction. 3 pp.

Bratton, S.P. The management of historic ecosystems and landscapes in National Parks. 41 pp.

Davison, K. and S.P. Bratton. The impacts of European settlement on the vegetation and fire regimes of Canaveral NS, Florida. 30 pp.

Firth, I. The management of biotic cultural resources. 33 pp.

VI. Vegetation management.

A. Project Title:

Control of *Phragmites communis* on Cape Hatteras NS.

Funding Sources:

NPS, Rutgers Center for Coastal Studies - 50%
University of Georgia - 30%
NPS, Cape Hatteras NS - 20%

Principal Investigator:

Susan Bratton, NPS, CPSU, University of Georgia, Athens, GA.

Other Investigators:

Jim Boone, School of Forest Resources and Institute of Ecology, University of Georgia, Athens, GA.
Elaine Furbish, CPSU, University of Georgia, Athens, GA.
Kent Turner, Resource Management Specialist, Cape Hatteras NS, NC.

Background:

Cape Hatteras is presently experimenting with the use of prescribed fire. *Phragmites communis*, an invasive species, is very fire tolerant and may be encouraged by burning.

Purpose:

The purpose of this study was to evaluate the cost and effectiveness of non-herbicide control methods on *Phragmites communis* and to evaluate recovery after burning.

Progress:

Methods of controlling of *Phragmites communis* by manual cutting, burning, and covering with sheets of clear plastic were evaluated. None of these methods, used on a single occasion, were effective in killing the plant. There was a significant reduction in stem density in three of four plots that were cut or burned, and then covered with plastic ($p < 0.01$; mean reduction = 49%). There were significant statistical reductions in stem heights. Cut and burned stems were an average of 21% shorter than they had been before treatment, and stems covered with plastic were 65% shorter. There were mechanical problems associated with plastic. These problems included moving large sheets of plastic into the marsh, holding it in place in high winds, and its rapid degradation in sunlight. Covering with plastic may be a useful for killing *Phragmites* without herbicides if treatment application methods are modified.

Publications:

Furbish, E. and K. Turner. 1987. Control of *Phragmites communis*. Results of burning, cutting, and covering with plastic in a North Carolina salt marsh. CPSU Technical Report No.42, 15 pp.

VI. Vegetation management.

B. Project Title:

The use of fire to retard shrub invasion on Cape Hatteras NS.

Funding Sources:

NPS, Rutgers Center for Coastal Studies - 40%
University of Georgia - 30%
NPS, Cape Hatteras NS - 30%

Principal Investigator:

Susan Bratton, NPS, CPSU, University of Georgia, Athens, GA.

Other Investigators:

Kent Turner, Resources Management Specialist, Cape Hatteras NS, NC.
Elaine Furbish, CPSU, University of Georgia, Athens, GA.

Graduate Assistant:

Haines Currie, Department of Botany, University of Georgia, Athens, GA.

Technicians:

James Boone, CPSU, University of Georgia, Athens, GA.
Barbara Zoodsma, CPSU, University of Georgia, Athens, GA.

Background:

Shrubs have invaded many areas of Cape Hatteras NS including roadsides, marsh edges, and inter-dune grasslands. Management of shrub thickets by cutting is very expensive, so alternative methods are needed.

Purpose:

The purpose of the project is test burning, cutting and salting as methods of shrub control and to determine if any of these methods have adverse impacts on adjoining plant communities such as inter-dune meadows.

Progress:

The project is presently on schedule except for the reburning of a shrub thicket area. This delay is the result of restrictions on burning in spring 1986, due to drought conditions in North

Carolina. The reburn of a burned area is scheduled for spring 1989 and a second area may also be reburned in fall 1989. To date six experimental burns have been completed, four of which were successful.

Salting and cutting on roadsides

A preliminary test of the effects of cutting and salting has been completed for three size classes of roadside side shrub thickets dominated by *Myrica* spp. In order to test the potential of sea salt for shrub control along roads, 1 x 10 m plots were established in tall (> 1.5 m), medium (≤ 1.5 m, >.5 m), and low ($\leq .5$ m) shrub areas along the roads. The dominant species on these sites was *Myrica cerifera*, although other woody plants such as *Prunus* spp. and *Rhus radicans* were also present. For each height class there were eight treatments: control, no disturbance; cutting only; salt at 10, 20 and 30 ppt; and cutting with salt at 10, 20 and 30 ppt. For the tall height class salt was spread 2 m outside the plot to increase the chances of killing shrub roots. Ten ppt salt, if simultaneously released into soil water, was estimated to be 235 gm/m² of surface application. Treatments were applied in mid-May, 1986.

In late August, 1986, the tall class showed close to 100% survivorship of *Myrica*, regardless of treatment. Sprout height for the tall plots averaged 76 cm. The medium and low height classes also had almost 100% survivorship where cutting or salting alone were used. The combination of cutting and salting, however, reduced survivorship to 47% for the medium class. Sprout height for medium cut and salted plots varied from 28 to 38 cm. For low plots, the combination of cutting and salting gave an average survivorship of 23% with an average sprout height of 15 cm. Salting alone did retard sprout growth in low *Myrica* but did not kill stems.

The results, to date, indicate the effects of the treatments increase as the shrub height decreases and that combination treatments greatly reduced survivorship and sprout growth. Tests of sea salt application in dune, *Phragmites communis*, and *Juncus roemerianus*/ *Iva frutescens* communities indicated no visible response to salt at the 10, 20 or 30 ppt levels. The plots treated in 1986 were remeasured in for sprout density and height in 1987. A technical report has been completed in editing draft and should be published in 1988.

Burning, cutting and salting of four plant communities

Four series of plots have been established for monitoring spring burning in each of four vegetation types including: dune grassland, shrub thicket, *Spartina patens* marsh, and *Juncus* - *Iva* marsh. Each plots series includes the following treatments:

- 2 plots as controls
- 2 plots burned
- 2 plots burned and cut
- 2 plots burned and salted
- 2 plots burned, cut and salted
- 2 plots cut
- 2 plots salted
- 2 plots cut and salted

Each of these plots was 10 x 20 m in size. Herbs and shrubs were sampled for cover in ten 1 x 1 m plots taken on the center line. In marsh and dunes communities, clip plots were collected prior to burning and in August 1987. The shrub plots were also sampled for woody stems, classified by species, height and percent of the crown alive. Soil samples were collected pre-burn and after salting was completed.

During the first year of this study, two technicians were employed to a) sample the plots and b) to help the park prepare for prescribed burning by writing prescriptions, checking equipment, conducting fire training, etc. The first spring (1986) some test burns were conducted but these

were not successful. The first shrub burn was too "cool", and a first attempt at burning *Spartina patens* aborted when the fire spread much more quickly than expected.

During 1987, the pre-burn sampling was completed and successful burns were conducted. The shrub and marsh plots were burned on March 24, 1987, the *Juncus-Iva* plots were burned on March 24 and 29 (these plots did not burn completely), and the dune plots were burned on April 2, 1987. The shrub thicket burn went very well, gathering intensity as it spread through the marsh and burned through the crowns of the shrubs.

A post burn sample for cover and shrub sprouting was conducted in late May and early June 1987. The rest of the treatments were applied to the plots. This included cutting, done first, and then salting. These treatments took over a month to apply.

The plots were sampled again for cover and standing crop in late August. Soil samples were taken at this time. The data have not yet been analyzed, but field observations indicate the following:

- 1) The fire was very effective in removing shrubs. There was 100% above ground kill in 6 of 8 burned plots and only a few live shrubs remaining in the other two.
- 2) The shrubs in the burned plots were resprouting vigorously by late May.
- 3) Herbs and grasses regenerated quickly after fire in all four community types.
- 4) *Juncus-Iva* is difficult to burn. Fuels tend to be patchy.
- 5) The salt killed forbs in the shrub thickets and in the dune grasslands but had little effect on the two types of marsh.
- 6) Salt killed part of the poison ivy in the shrub plots.

These preliminary results indicate fire is potentially an inexpensive and effective method for suppressing shrubs.

Fall burning

In August 1987, additional shrub and marsh plots were established in preparation for burning in October or November 1987. Two of the shrub plots were designated for pre-burn cutting. A series of marsh plots was placed in locations with high densities of *Kosteletskyia*, in order to evaluate the effects of burning on an important wildflower species. One plot was burned in November and a first post burn sample was completed in December 1987.

Publications:

Furbish, C.E., S.P. Bratton and K. Turner (in press). Control of invading shrubs by sea salt. *Restoration and Management Notes* 51(2) #131, pp. 94-95.

Furbish, C.E., S.P. Bratton and K. Turner (in press). Removal of *Phragmites communis* using clear plastic mulch. *Restoration and Management Notes* 51(2) #132, p. 95.

Presentations:

Information from this project has been used at two National Park Service training sessions on vegetation management and will be used again at training sessions scheduled in November and May.

VI. Vegetation management.

C. Project Title

Forest dynamics and a successional model for Cumberland Island NS.

Funding Sources:

NPS, Rutgers Coastal - 40%
University of Georgia - 40%
NPS, CPSU - 15%
NPS, Cumberland Island NS - 5%

The project began April 1, 1986 and is expected to terminate June 30, 1988.

Principal Investigator:

Susan P. Bratton, NPS, CPSU, University of Georgia, Athens, GA.

Graduate Assistants:

Lee Graham, Institute of Ecology, University of Georgia, Athens, GA.
Christi Lambert, Department of Geography, University of Georgia, Athens, GA.

Background:

Live oak forest on Cumberland Island has been disturbed by grazing, fire and dune encroachment.

Purpose:

The purpose of the study is to document historic vegetation changes on Cumberland Island, and to evaluate the effects of different fire regimes and of grazing impacts on forest stand structure.

Progress:

The project is presently ahead of schedule in developing a forest stand and grazing model, on schedule in collection of plot data and behind schedule in collection of historic wetland information, due to delayed hiring of a suitable student, followed by illness of the student.

Forest plot survey

About seventy 20 x 40 m forest plots have been placed in oak dominated stands on Cumberland Island. Data have been entered into Lotus on an IBM-PC microcomputer, and preliminary ordinations (using DECORANA) and plot summaries have been constructed. All plots include samples of canopy individuals by species and diameter at breast height, ten 2 x 2 m shrub plots with species cover and stem counts by basal size class, and ten 1 x 1 m herb plots sampled for cover. Permission has been obtained to sample some control plots without a history of

intensive grazing on control areas outside the park.

Deer grazing model

Lee Graham, a doctoral student, has completed the necessary literature review on white-tailed deer and horse grazing, as well as analysing available forest stand data. She is developing a grazing model but is presently waiting for deer food habits and seasonal habitat preference data, which is being gathered by deer projects not covered by this proposal. The model should be ready late in 1988.

Wetlands history

Christi Lambert, an M.S. student, has gathered historic maps and air photos of the north end of the island and has begun analysing changes in the vegetation in the wetlands around Lake Whitney. She has begun a vegetation map of the area and has tested transect sampling methods for detecting changes in wetland species composition.

Forest history

Maps and photos have also been gathered showing former field locations and the positions of plantations. Preliminary field survey indicates the understory species composition definitely varies with the past sequences of plowing and grazing. Analysis of stand data indicate few oaks below 10 cm in size. Oaks have been increment cored to develop age regressions, so past understory disruption can be more accurately dated.

Presentations:

Information from the forest history section of this study has been used in field exercises for a National Park Service training course on historic landscape management. Plot survey techniques have been used in a vegetation management training course (April 1986) and will be used again in courses taught in 1988.

VI. Vegetation management.

D. Project Title:

The vegetation of Bodie Island, Cape Hatteras NS.

Funding Sources:

NPS, CPSU - 50%
University of Georgia - 30%
NPS, Cape Hatteras NS - 20%

Principal Investigator:

Susan Bratton, NPS, CPSU, University of Georgia, Athens, GA.

Technician:

Kathryn Davison, CPSU, University of Georgia, Athens, GA.

Background:

The vegetation of the Outer Banks of North Carolina is very dynamic, subject to change via storms, fires and other types of disturbances.

Purpose:

The purpose of this project was to describe and map the vegetation of Bodie Island, Cape Hatteras NS and to establish a permanent transect monitoring system from the Atlantic to Pamlico Sound.

Progress:

Five permanently marked vegetation transects were established from the Atlantic shore to Pamlico Sound, on Bodie Island, the northern most island of Cape Hatteras NS, North Carolina. Fourteen vegetation communities were mapped and described, twelve of which were sampled along the transects. Although herbaceous communities predominated, woody types were well established and woody plant invasion was noted in areas protected by artificial dunes and along the road. The vegetative communities were found similar to those described by Devine and McCaffery on their map of Ocracoke Island, with the exception of vegetation associated with the large inland sandhills. *Spartina patens* and *Juncus roemerianus* dominated the marshes, although several other types of vegetation were encountered. *Myrica cerifera*, *Prunus serotina* and *Rhus radicans* dominated the wooded areas. Herbaceous species, most frequently grasses and sedges specific to the community type, dominated the sandhills. Wooded communities around the base of the sand hills were also distinct, being dominated by *Persea borbonia* and other woody species not found in *Myrica* dominated shrub thickets. A vascular species checklist was completed and published and specimens contributed to the park herbarium.

Publications:

Davison, K., S.P. Bratton, L. Graham. 1987. Vascular plant species checklist for Bodie Island, Cape Hatteras NS, North Carolina. NPS-CPSU Technical Report No. 33. 30 pp.

Davison, K. and S.P. Bratton. (in revision) Vegetation patterns on Bodie Island, Cape Hatteras NS, North Carolina. Institute of Ecology, University of Georgia, CPSU Technical Report , 34 pp.

VI. Vegetation management.

E. Project Title:

Oak survivorship after fire on Cumberland Island NS.

Funding Sources:

NPS, CPSU - 100%

Principal Investigator:

Susan P. Bratton, NPS, CPSU, University of Georgia, Athens, GA.

Technicians:

Barbara Zoodsma, CPSU, University of Georgia, Athens, GA.
Tom Engelsma, CPSU, University of Georgia, Athens, GA.

Background:

Recent natural fires on Cumberland Island have killed live oaks and other hardwoods adjoining scrub and marsh areas.

Purpose:

The purpose of this project was to monitor survivorship of hardwoods and pine scorched by lightning ignited fires in 1986.

Progress:

Trees were tagged after fires in 1986. Scorch height, and percentage of live canopy were evaluated. These trees were relocated in summer 1987, and their condition was reevaluated. The trees will be relocated again in 1988 to determine survivorship after two growing seasons. Data will be analysed late in 1988 or early in 1989.

VI. Vegetation management.

F. Project Title:

Recovery of vegetation in horse and deer exclosures on Cumberland Island NS.

Funding Sources:

NPS, CPSU - 60%
NPS, Cumberland Island NS - 20%
University of Georgia - 20%

Principal Investigator:

Susan P. Bratton, NPS, CPSU, University of Georgia, Athens, GA.

Technicians:

Elaine Furbish, CPSU, University of Georgia, Athens, GA.
Barbara Zoodsma, CPSU, University of Georgia, Athens, GA.

Background:

Horse and deer grazing are thought to be greatly reducing forest reproduction on Cumberland Island. Horse impacts in the marsh have been evaluated but horse and deer impacts in the inner dune have not.

Purpose:

The purpose of the project is to evaluate deer and horse impacts on live oak - pine forest and on the inter-dune grassland.

Progress:

"Horse only" and "deer, horse, and hog" exclosures were established in two forest and two inter-dune locations in 1984. In addition, 16 horse only exclosures were placed in several inter-dune locations. These exclosures have been sampled annually, including spring (for the forest) and summer (for the inter-dune) 1987. In addition 5 beach transects for long term grazing monitoring were established in 1987.

Preliminary results indicate a strong recovery of oak sprouts in the forest exclosures which keep out white-tailed deer. The horse only exclosures to not show recovery of hardwood regeneration. Response of the exclosures in the inter-dune have been low, probably due to continued summer drought. Exclosures will be resampled in 1988 and a report prepared.

VI. Vegetation Management.

G. Project Title:

Plant poaching effects on woodland herbs.

Funding Sources:

Investigator interest - 80%
NPS, CPSU - 20%

Principal Investigator:

Susan P. Bratton, NPS, CPSU, University of Georgia, Athens, GA.

Background:

Plant poaching is thought to be disturbing populations of rare plants and showy flowering species in a number of park areas in the southeast.

Purpose:

The purpose of the project is to investigate the effects of "poaching pressure" on two flowering woodland herbs.

Progress:

Plots were established at Coweeta Hydrologic Laboratory in 1985. These sites have been experimentally poached for three spring seasons. In 1987, plots were poached and remeasured for presence of flowering plants, size of plants and plant location. A final experimental season is planned for 1988. A report should be prepared in 1988 or 1989.

Publications:

Bratton, S.P. 1987. Impacts of experimental poaching on pink lady slipper, *Cypripedium acaule*, and on common wood violet, *Vila papilionacea*. ASB Bulletin 34(2): 264.

Presentations:

Bratton, S.P. Impacts of experimental poaching on pink lady slipper, *Cypripedium acaule*, and on common wood violet, *Vila papilionacea*. ASB 48th Annual Meeting, April 1987, Athens, GA.

VII. Visitation patterns and visitor impacts.

A. Project Title:

Visitor impacts and rare plant protection at Craggy Gardens, Blue Ridge Parkway.

Funding Sources:

The University of Georgia - 60%
NPS, CPSU, University of Georgia - 30%
NPS, Blue Ridge Parkway - 10%

Principal Investigators:

Susan Bratton, NPS, CPSU, University of Georgia, Athens, GA.
Ian Firth, School of Environmental Design, University of Georgia, Athens, GA.

Graduate Assistant:

Bart Johnson, School of Environmental Design, University of Georgia, Athens, GA.

Background:

Craggy Gardens has the greatest number of rare and endangered plant species of any site on the Blue Ridge Parkway. Visitor trampling and plant succession both threaten these species and the integrity of the plant community.

Purpose:

The purpose of this project is to evaluate the causes for disturbance of the rare plant community and to determine a management strategy to reduce damage and to restore disturbed habitats.

Progress:

A report on the rare plants was completed and published in 1986.

The project attempted, during July 1987, to deter hikers by blocking fourteen sections of unofficial trail with heavy brush. Height, width, depth and visual permeability of the brush were recorded, and a rating was given for overall appearance as a physical and visual barrier. Materials included branches, collected dead or cut from live plants, and mountain ash, *Sorbus americana*, layered by cutting a limb halfway through and bending it across the trail to form a living hedge. If several stems are "layered" on top of each other, the path appears to dead-end in living vegetation.

Of the less substantial brushings, six were rated R3 (problematic but passable). They averaged 110 cm in height, 170 cm in depth and had an average permeability of 40%, measured by

percent sky visible. The most substantial brushings, rated R5 (looks impenetrable), averaged 160 cm in height, 290 cm in depth and had an average permeability of 11%. Within a month, six of the fourteen brushings were completely dismantled and three others rendered ineffective. Three of the less formidable R3 brushings were dismantled in the first two weeks, rebuilt, and destroyed again. Two others were destroyed within four weeks. Within two months, nine of the 14 brushings were completely broken down and four others were rendered ineffective. Only one was undiminished. At this latter brushing and at one other, hikers detoured over rocks which harbored vulnerable rare plants, spreading damage to areas which were not previously trampled. Visitor monitoring on four weekend days during summer 1987 counted 444 people on Craggy Pinnacles. On one of the three networks of brushed trails, 20 people broke through the brush barriers.

Observations of visitor movements at Craggy Pinnacles indicate that although brushing may be useful to close unofficial trails, other measures are necessary to reduce incentives for bushwhacking. These may include interpretation of fragile, high-elevation habitats, signing, closure of a main route through a particularly vulnerable area, and improved design of two overlooks (including construction of stone barriers), where much of the bushwhacking originates. A note and a management report have been completed on this project segment.

The project also monitored visitor use for six days during summer and fall of 1987. Results for the summer describe the activities of 444 people who visited the site over four weekend days. Observations recorded included the routes to the Pinnacles used by different groups, the time spent at different overlooks, activities such as berry picking and photography and use of rock outcrops, which comprise the most important rare plant habitat, as viewing and sitting areas. Tabulation of fall data and preparation of a report on these data will be completed in 1988.

Publications:

Johnson, B., S. P. Bratton, and I. Firth (submitted). The Feasibility of Using Brushing to Deter Use of Unofficial Trails (North Carolina). Restoration and Management Notes.

Johnson, B., S. P. Bratton, and I. Firth. (in press, 1988). The Feasibility of Using Brushing to Deter Visitor Use of Unofficial Trails. CPSU Technical Report No. 43, 32 pp.

VII. Visitation patterns and visitor impacts.

B. Project Title:

Visitor use and perceptions of Cumberland Island NS.

Funding Sources:

University of Georgia - 30%
NPS, CPSU - 30%
Investigator interest - 35%
NPS, Cumberland Island NS - 5%

Principal Investigators:

James Absher, Dept. of Recreation and Leisure Studies, University of Georgia, Athens, GA.
Susan Bratton, NPS, CPSU, University of Georgia, Athens, GA.

Background:

Cumberland Island NS has been involved in a series of administrative conflicts over use of vehicles in the Wilderness Area and appropriate visitation levels for the park.

Purpose:

The purpose of this study was to select random visitors from Cumberland Island NS and to evaluate their travel patterns, their favored activities, and their knowledge and opinions about island conditions and management. The project also evaluated campsite locations suitable for attracting visitors away from the Main Road and into the interior wilderness trail system.

Progress:

During eight sampling blocks, at six week intervals, a total of 822 questionnaires were sent to visitors 16 years of age and older. Of these, 685 were returned, and 671 were useable for data analysis. Of the visitors surveyed, 62.7% were day users. Overnight use was about evenly split between developed camping at Sea Camp and backcountry camping at Stafford and in the wilderness. A minority of the visitors (7.5%) were from the local area. Many more (17.2%) came from urbanized areas around Savannah, GA or Jacksonville, FL, (41-100 miles) and 35.6% came from Atlanta, GA, Chattanooga, TN or Miami, FL (280-500 miles). About 14.9% came from 500 miles or more away. Thirty-seven percent of the visitors sampled had been to Cumberland Island at least once before.

Day users traveled primarily to Sea Camp and the south beach. Twenty-nine percent of campers staying at Sea Camp, 69.3% of the campers at Stafford, and 95.3% of the wilderness campers traveled to Plum Orchard. Less than one percent of the Seacampers, 18.9% of the Stafford campers and 29.9% of the wilderness campers traveled to Lake Whitney. The most popular activities were walking on the beach, visiting ruins and historic sites, day hiking, and looking for animals. Through the year, bird watching was as popular as sunbathing or swimming. Interpretation of natural and cultural resources is thus very important to island visitors.

The most important sources of loss of enjoyment for island visitors were motorized vehicles on the roads, vehicles on the beach, and industrial odors. These factors were somewhat of a concern (or more) for 25% or more of the visitors sampled. The least troubling factor was visitor behavior on the beaches, which was somewhat of a concern (or more) for about 5% of the visitors. Wilderness users were much more concerned about vehicles and low flying aircraft than were day users or Seacampers. The present level of visitor use does not seem to result in frequent disruptive visitor behavior or conflicts between visitor groups.

Nearly all respondents (93.9%) indicated they had seen some wildlife they considered to be significant. The most reported animals were horses, followed by turkeys, deer and armadillos. Of animals looked for and not seen the most frequently reported were deer, followed by horses, armadillos, sea turtles and turkeys.

A series of potential locations for new primitive campsites were investigated on Cumberland Island NS, Georgia. Of the possible sites, three were subjected to field evaluation for vegetation, soil density, water levels, fauna, wilderness character, and archaeologic and historic resources. Of the three sites, a location on Roller Coaster Trail south of South Cut Road best met the criteria for establishing a new campsite. This site could potentially be named Sweetwater. The potential camping areas at Terrapin Point are too close to known and possible archeological sites and will also tend to divert traffic along the Main Road. The potential site at Long Point is suitable, but somewhat smaller than the Sweetwater location, and presents some problems with drainage. The Long Point site would probably also require some minor rerouting of trails and a road closure.

Freshwater is a potential problem at all the locations, and establishment of pumps is probably necessary to prevent trampling damage and fouling of water sources in freshwater wetlands. Opening of the Sweetwater site, and possibly the Long Point site would help to divert backpackers from the Main Road, thus reducing backpacker encounter with vehicles.

Publications:

Absher, J. and S.P. Bratton. (in press, 1987) Social carrying capacity at Cumberland Island NS: Preceptions of three types of over-night users. For symposium volume from 1986 National Park Service meeting in Fort Collins, Co, 12 pp.

Absher, J. and S.P. Bratton. 1987. Cumberland Island visitor use study. NPS-CPSU Technical Report No. 36, 28 pp.

Bratton, S.P. and N.P.S. 1987. Vegetation Management Class. Possible locations for primitive campsites, Cumberland Island NS. NPS-CPSU Technical Report No. 38, 29 pp.

VIII. Coastal geology and geographic information systems.

A. Project Title:

Geographic information system for Cumberland Island NS.

Funding Sources:

Department of Defense - 60%
University of Georgia - 30%
NPS, CPSU - 10%

Principal Investigator:

John Pickering, Department of Entomology, University of Georgia, Athens, GA.

Other Investigator:

Lee Graham, Insitute of Ecology, University of Georgia, Athens, GA.

Background:

A geographic information system is needed to organize both geological and biological data from Cumberland Island, specifically for evaluating the impacts of Navy dredging.

Purpose:

The purpose of this project is to mount appropriate computer software at a central location and to develop computerized base maps from Cumberland Island.

Progress:

During 1987, SAGIS, a geographic information system developed by the US National Park Service was mounted and test maps were digitized. Base maps for Cumberland Island have been loaded onto the system and a digitizing system tested. Vegetation maps for Cape Hatteras and Cape Lookout have also been loaded on SAGIS and used in preliminary tests of modeling barrier island processes. The system will be ready for demonstration in spring 1988.

Plans for 1988 include addition of new color work stations, loading of U.S. Army Corps of Engineers geological data, and addition of GRAS software, as well as digitizing of biological data from Cumberland Island.

VIII. Coastal geology and geographic information systems.

B. Project Title:

Benchmark transects and aerial photography for Cumberland Island NS.

Funding Sources:

Department of Defense
University of Georgia

State of Project:

This project was temporarily delayed during 1987 due to negotiations with the Army Corps of Engineers over the future progress of the geological work for Cumberland Island, the St. Marys Entrance channel. The project was revised in December 1987 to better complement Corps activities. Bids on aerial photography have been obtained and the first overflights will take place in March 1988.

IX. Interpretation.

A. Project Title:

Management brochures for Cumberland Island NS.

Funding Sources:

NPS, CPSU - 60%
Investigator interest - 40%

Principal Investigator:

Susan Bratton, NPS, CPSU, University of Georgia, Athens, GA.

Writers and Illustrators:

Lynn Robberson, CPSU, University of Georgia, Athens, GA.
Barbara Zoodsma, CPSU, University of Georgia, Athens, GA.
Marlene Finley, Cumberland Island NS, St. Marys, GA.

Background:

Several scientific and resources management projects on Cumberland will potentially be controversial with the public.

Purpose:

The purpose of the project is create a brochure series which will explain the resources management concerns of NPS to the public.

Progress:

Illustrations and texts have been obtained for three brochures.

Publications:

Bratton, S.P. and M. Finley. (in press) Horses of Cumberland Island. US Dept. of Interior, National Park Service, Cumberland Island NS, brochure for park visitors, 8 panels.

Bratton, S.P. (in review). Deer of Cumberland Island. US Dept. of Interior, National Park Service, Cumberland Island NS, brochure for park visitors, 8 panels.

Bratton, S.P. (in review). Manatees of Cumberland Island. US Dept. of Interior, National Park Service, Cumberland Island NS, brochure for park visitors, 8 panels.

IX. Interpretation.

B. Project Title:

Interpretation program on Bodie Island, Cape Hatteras NS.

Funding Sources:

Investigator interest - 70%
University of Georgia - 20%
NPS, CPSU - 5%
NPS, Cape Hatteras NS - 5%

Principal Investigator:

Christie Johnson (under the supervision of Ian Firth), School of Environmental Design,
University of Georgia, Athens, GA.

Background:

Cape Hatteras has been subjected to large scale landscape change over the last fifty years.

Purpose:

The purpose of this project is to develop an interpretive program along the major state park road, NC 12 and at the visitors' center at Bodie Island lighthouse. The program will try to encourage an awareness of the dynamic nature of the landscape and provide the public with a basis for understanding management policies.

Progress:

Initial field visits have been undertaken. This project should result in an MLA thesis in sometime in 1989.

X. Planning and park policy.

A. Project Title:

National natural landmarks program.

Funding Sources:

NPS, CPSU - 100%

Principal Investigator:

Susan P. Bratton, NPS, CPSU, University of Georgia, Athens, GA.

Graduate Assistant:

Wendy Fulks, Department of Zoology, University of Georgia, Athens, GA.

Background:

The Department of Interior requested each NPS region to review 10 potential National Natural Landmarks during 1987.

Progress:

The Cooperative Unit prepared seven reports including Panther Creek, GA; Craggy Gardens, NC; Troopville Woods, GA; Alcovy River Swamp, GA; Boggs Rock, SC; Grand Bay Natural Area, GA; Monticello Bottomland, GA; and Flint River Gorge, GA. Of these, only Flint River needs additional work.

Each nomination includes maps and photographs of the natural, a description of the most important natural features, and an evaluation of human impacts to the site. Suggestions for future protection of key natural values are included.

X. Planning and park policy.

B. Project Title:

Cumberland Island dredging proposal.

Project Leaders:

Susan P. Bratton, NPS, CPSU, University of Georgia, Athens, GA.
Robert Dolan, Environmental Sciences, University of Virginia, Charlottesville, VA.

Participants:

Several University of Georgia staff including Ed Chin, Marine Sciences; Larry Pomeroy, Ecology; Frank Golley, Ecology; Dick Wiegert, Ecology; and Chuck Hopkinson, Sapelo Marine Lab.

Progress:

Negotiations with the U.S. Navy were completed in 1987 and one million dollars was appropriated for the first full year of the study. The Georgia Cooperative Unit continued to provide biological consultation throughout.

Dr. Steven Cofer-Shabica has transferred to the Georgia Cooperative from Biscayne National Park and will assume responsibility for managing the National Park Service portion of the monitoring of dredging impacts. The NPS CPSU will coordinate data for all phases of the project and will oversee all biological and terrestrial hydrologic projects.

X. Planning and park policy.

C. Project Title:

All coastal research proposal.

Principal Investigators:

Susan P. Bratton, NPS, CPSU, University of Georgia, Athens, GA.

Paul Buckley, NPS, CPSU, Rutgers University, New Brunswick, NJ.

Purpose:

To develop a proposal for funding of research and monitoring on top priority resources management problems in coastal and marine parks of the eastern US.

Progress:

Four drafts of an all southeast-southwest proposal were prepared in 1987. The most recent draft will be combined with a north Atlantic - middle Atlantic proposal early in 1988.

1987 publications from projects finished prior to 1987

- Miller, R. I., Bratton, S. P. and P. S. White. A regional strategy for preserve design and placement based on an analysis of rare and endangered species distribution patterns. *Biol. Conserv.* 39:255-268. 1987.
- Turner, M. and S. P. Bratton. Fire, grazing, and the landscape heterogeneity of a Georgia barrier island. pp. 87-101. *Landscape Heterogeneity and Disturbance*. Ecological Studies. Vol. 64. Springer Verlag. New York. 1987.
- Bratton, S.P. Control of tung at Cumberland Island (Georgia). *Restoration and Management Notes*. 5(1): 30-3, (Note #14). 1987.
- Bratton, S.P. Vegetation management course considered by Park Service. *Restoration and Management Notes*. 5(1):48, (Note #72). 1987.
- Bratton, S.P., and S. Bennett. 1987. Vascular Plant Checklist, Fort Frederica National Monument, St. Simons Island, Georgia. *NPS-CPSU Technical Report* No. 39. 24 pp.
- Turner, S. and S. P. Bratton. 1987. The recent fire history of Cumberland Island, Georgia. *Castanea* 52(4): 300-303.
- Turner, M. 1987. Effects of grazing by feral horses, clipping, trampling and burning on a Georgia salt marsh. *Estuaries* 10: 54-60.
- Bratton, S.P. 1987. Vegetation management: Deciding what we want and how to get there. pp. 10-12 in *A Summary of the Conference on Vegetation Management of Landscapes for Beauty and Diversity, March 2, 1987*. Brandywine Conservancy, Delaware.

Publications by Coop Unit staff not supported by NPS funds

- Bratton, S.P. A fierce green fire dying: Land ethics and wild nature. *AuSable Forum*. August 5-8, AuSable Institute of Michigan. 39 pp. 1987.
- Bratton, S.P. The original desert solitaire: Early Christian monasticism and wilderness values. *Forests, Habitats and Resources: A Conference in World Environmental History, Forest History Society, April 1987, Duke University, Durham, NC.* p. 6. 1987.

Project schedules through 1990

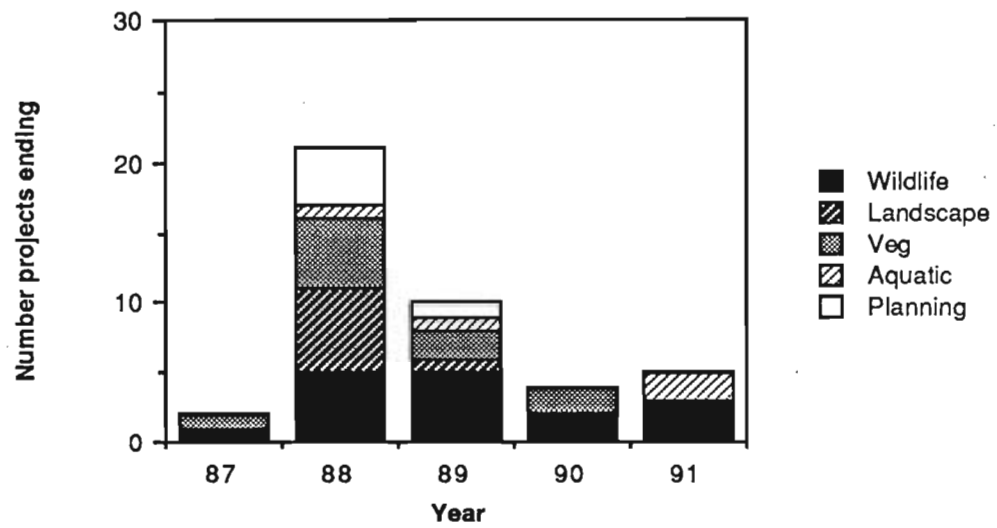
The Cooperative Unit has a continual turn over of projects. Of projects in process during 1987, a large number will be finished by the end of 1988. Six wildlife, six landscape history, six vegetation and four planning/interpretive projects are expected to be completed (except for journal publication) within the next year. Only one history and one interpretive project are expected to extend into 1989.

During 1989 an additional 11 projects should be completed, six of them in the wildlife area. Wildlife projects expected to continue past 1989 include sea turtle monitoring for Cumberland Island, the bobcat reintroduction for Cumberland Island, and efforts with immuno-sterilization of cervids and equids. Only two vegetation projects should continue past 1989 - the Cape Hatteras prescribed fire program and the grazing exclosures on Cumberland Island. All current landscape history and planning/interpretive projects should be finished before the end of 1989.

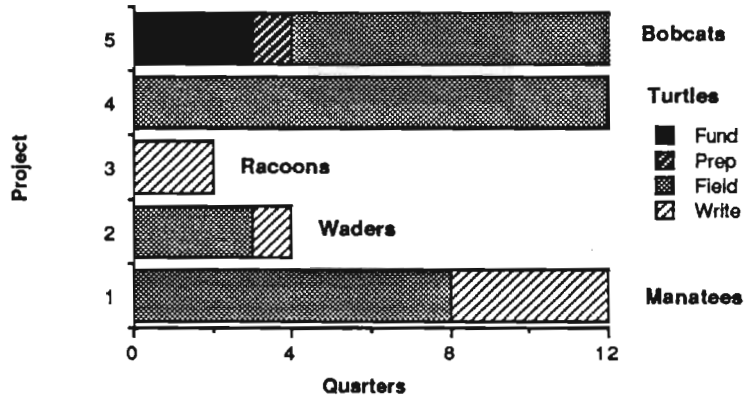
One of the aquatic/geologic projects - coral reef sedimentation - will finish by the end of 1988, but all others are just beginning and more will potentially be added in 1988, including Cumberland Island hydrology and marsh sedimentation. Only the current coral reef project is likely to produce a report before the end of 1988.

In summary, wildlife projects have a relatively even flow with several terminating in the next two years. Two new major projects currently in funding or planning phase. All but one landscape history project will terminate in 1988, which fits well with the initiation of a new cooperative agreement between NPS Cultural resources and the School of Environmental Design. Most planning and interpretive projects will end by the end of 1988. A number of vegetation projects will end in 1988, although three of the larger ones are expected to continue for one or two more years. Most of the aquatic and geologic projects are just starting, and will continue for two years or more.

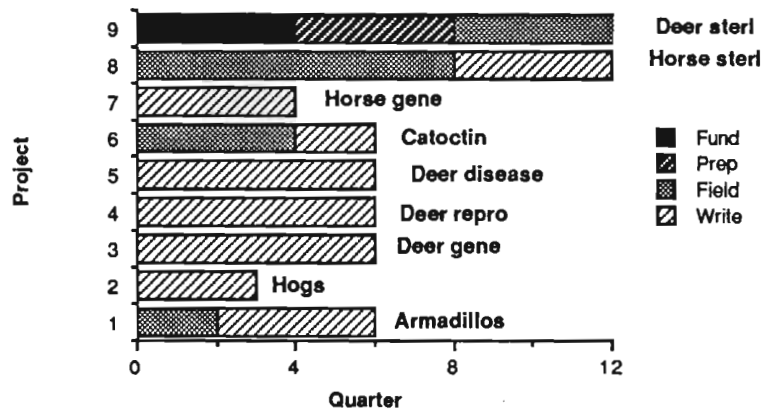
Probable ending dates for current projects



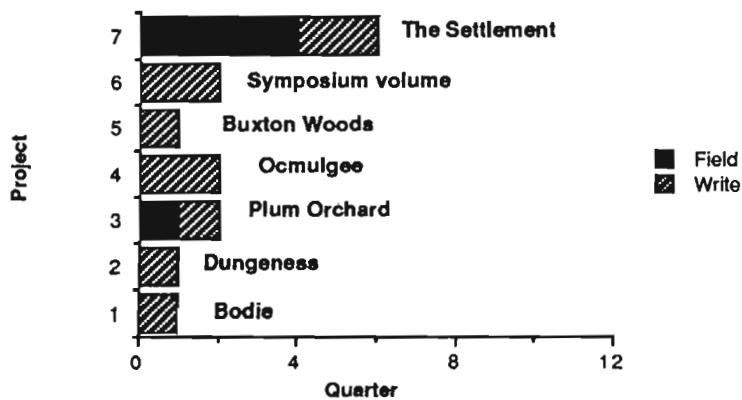
Wildlife endangered species



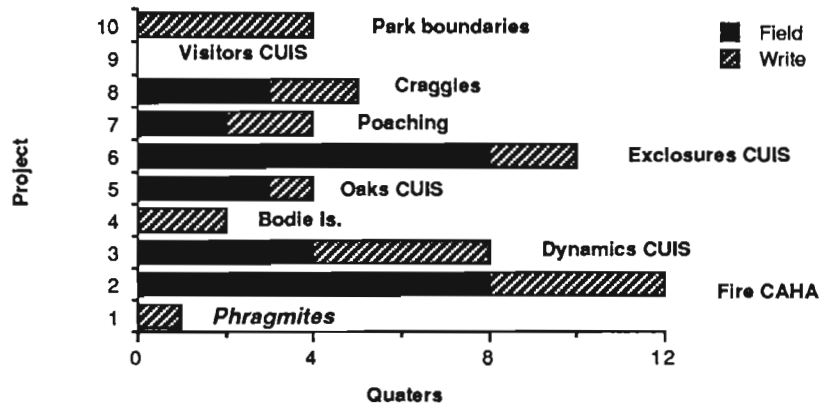
Wildlife -grazing and non-natives



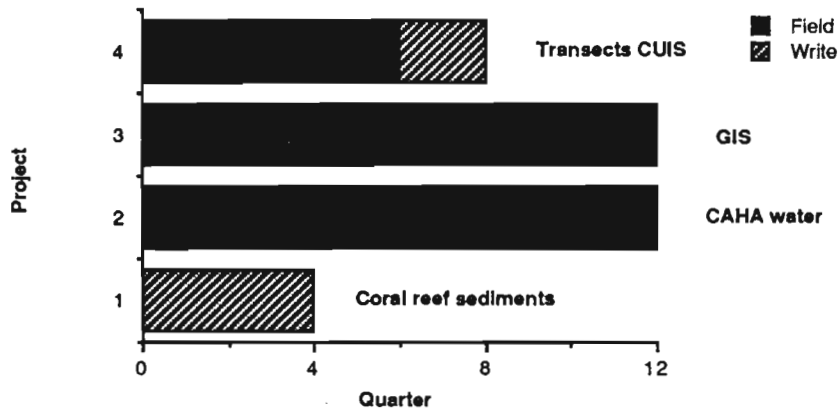
Landscape history



Vegetation and visitation projects



Aquatic and geologic projects



Planning and Interpretation

