WOOD STORK RECOVERY PLAN

U.S. Fish and Wildlife Service, Southeast Region

REVISED
RECOVERY PLAN FOR THE
U.S. BREEDING POPULATION
OF THE WOOD STORK

for

U.S. Fish and Wildlife Service
Southeast Region
Atlanta, Georgia

Original Approved: September 9, 1986

Approved: Noreen K. Clough
Noreen K. Clough, Regional Director, Southeast Region,
U.S. Fish and Wildlife Service

Date: January 27, 1997

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U.S. Fish and Wildlife Service. 1996. Revised recovery plan for the U.S. breeding population of the wood stork. U.S. Fish and Wildlife Service. Atlanta, Georgia. 41 p.

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The following standard abbreviations for units of measurement are found throughout this document:

cm = centimeters	in = inches	m = meters	ft = feet
km = kilometers	mi = miles	kg = kilograms	lbs = pounds
ppm = parts per million			

ACKNOWLEDGMENTS

The Service gratefully acknowledges the countless hours of research and commitment made by the following individuals to the recovery of the wood stork. Without their help, this revision would not have been possible.

Larry Bryan
Savannah River Ecology Laboratory

Malcolm Coulter
IWRB/IUCN/BirdLife International
Specialist Group on Storks, Ibises and Spoonbills

John Fowler
Chehaw Wild Animal Park, Zoo Atlanta

Mike Harris
Georgia Department of Natural Resources

Tom Murphy
South Carolina Department of Natural Resources

John Ogden
South Florida Water Management District
(formerly, Everglades National Park)

John Robinette
U.S. Fish and Wildlife Service
Savannah Coastal Refuges

Jim Rodgers
Florida Game and Fresh Water Fish Commission

Becky Shortland
The Georgia Conservancy

EXECUTIVE SUMMARY

Current Species Status: The United States breeding population of the wood stork is listed as an endangered species and is found throughout Florida, Georgia, and coastal South Carolina. Since the 1960's, the wood stork population has shown a substantial decline in southern Florida, and substantial increases in northern Florida, Georgia, and South Carolina. Over the last 12 years, the U.S. population has ranged between 5,500 and 6,500 pairs.

Habitat Requirements and Limiting Factors: Wood storks use a variety of freshwater and estuarine wetlands for nesting, feeding, and roosting. Freshwater colony sites must remain inundated throughout the nesting cycle to protect against predation and abandonment. Foraging sites occur in shallow, open water where prey concentrations are high enough to ensure successful feeding. Limiting factors include loss of feeding habitat, water level manipulations affecting drainage, predation and/or nest tree regeneration, and human disturbance.

Recovery Objective: The objective of this revised recovery plan is to assure the long-term viability of the U.S. breeding population of the wood stork in the wild, allowing initially for reclassification to threatened status and ultimately removal from the list of threatened and endangered species.

Recovery Criteria: Reclassification from endangered to threatened could be accomplished when there are 6,000 nesting pairs and annual regional productivity is greater than 1.5 chicks per nest/year (calculated over a 3-year average). Delisting could be accomplished when there are 10,000 nesting pairs calculated over a 5-year period beginning at the time of reclassification, annual regional productivity greater than 1.5 chicks per nest/year (also calculated over a 5-year average) and a minimum of 500 successful nesting pairs in South Florida.

Actions needed: The major actions needed to accomplish the recovery objective are: (1) protect currently occupied habitat; (2) restore and enhance habitat; (3) conduct applied research; and (4) increase public awareness.

Total Estimated Cost of Recovery: $1,095,000.00

Date of Recovery: Under an ideal set of circumstances, the earliest possible date for complete recovery of this population would be 2005. However, because of the time necessary to complete some of the long term restoration tasks, full recovery may not be possible for an additional 15 or 20 years.

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PART I. INTRODUCTION

This is the revised recovery plan for the U.S. breeding population of wood storks (*Mycteria americana*). The U.S. Fish and Wildlife Service (Service) listed the United States breeding population of wood storks as endangered on February 28, 1984, pursuant to the Endangered Species Act of 1973, as amended (U.S. Fish and Wildlife Service 1984). All populations of wood storks breeding within the United States, and their offspring, are protected by the listing action. The wood stork is also listed as an endangered species pursuant to Alabama, Florida, Georgia, North Carolina, and South Carolina State laws. The Service approved this recovery plan in 1986 to identify actions necessary to recover the population. Since that time, many tasks identified in the original plan have been accomplished and more information is now available on the biology and distribution of storks throughout the Southeast. This revised recovery plan updates the original information and addresses new threats and needs.

A. DESCRIPTION

The following description is derived from Robertson (1989). The wood stork is a large, long-legged wading bird, with a head to tail length of 85-115 cm (33-45 in) and a wingspread of 150-165 cm (59-65 in). The plumage is white, except for iridescent black primary and secondary wing feathers and a short black tail. Storks fly with necks and legs extended. On adults, the rough scaly skin of the head and neck is unfeathered and blackish in color, the legs are dark, and the feet are dull pink. The bill color is also blackish. Immature storks, up to the age of about 3 years, differ from adults in that their bills are yellowish or straw colored and there are varying amounts of dusky feathering on the head and neck. During courtship and the early nesting season, adults have pale salmon coloring under the wings, fluffy undertail coverts that are longer than the tail, and toes that brighten to a vivid pink. The wood stork is also known as the wood ibis, ironhead, flinthead, and gannet.

B. DISTRIBUTION

The wood stork is one of 17 species of storks (Ciconiidae) occurring worldwide, and is the only stork regularly occurring in the United States (Figure 1). The breeding range of the species extends from the southeastern United States south through Mexico and Central America, Cuba and Hispaniola, and through South America to western Ecuador, eastern Peru, Bolivia, and northern Argentina (American Ornithologists' Union 1983).

Figure 1. Breeding range of the wood stork.

The wood stork may have formerly bred in all the coastal Southeastern States from Texas to South Carolina. Currently, wood storks breed throughout Florida, Georgia, and coastal South Carolina (Figures 2, 3 & 4). Post-breeding storks from Florida, Georgia, and South Carolina disperse occasionally as far north as North Carolina and as far west as Mississippi and Alabama. Storks sighted in Arkansas, Louisiana, Texas, and points farther west may have dispersed from colonies in Mexico. The amount of overlap and/or population interchange is unknown.

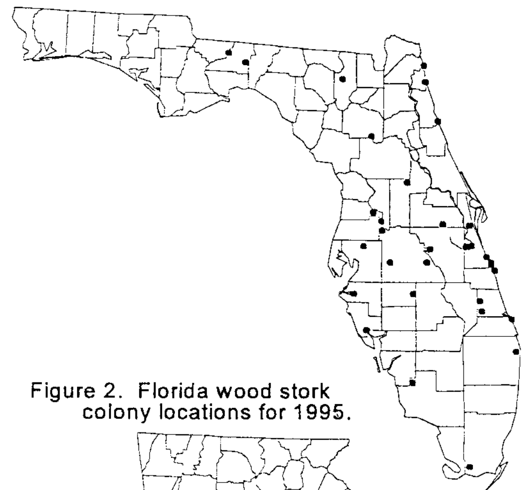

Figure 2. Florida wood stork colony locations for 1995.

It is believed that storks nesting in north Florida, Georgia, and South Carolina move south during the winter months. The large number of storks that occur during winter in the freshwater wetlands of south Florida far exceeds the number known to breed in south Florida colonies in the same months. Bancroft et al. (1992) have shown that the number of storks feeding in the three Water Conservation Areas of the central and northern Everglades varied greatly among winters, ranging from a low of 1,233 birds in a high water year to 7,874 birds in a low water year. In most of the study years, 1985-1989, the total number of storks in the Water Conservation Areas increased substantially between December and January, and dropped off sharply after March. In some years, the inland marshes of the Everglades have supported the majority (55%) of the U.S. population of wood storks.

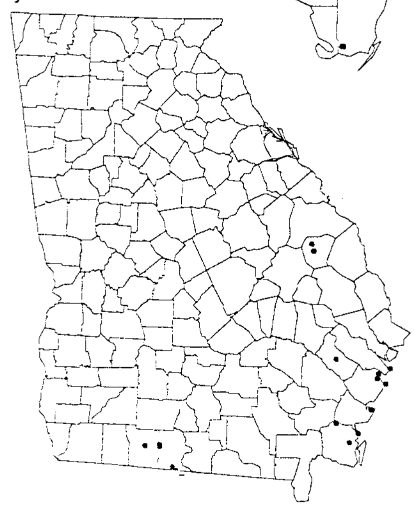

Figure 3. Georgia wood stork colony locations for 1995.

Winter abundance of wood storks in coastal Georgia is much reduced from the fall when storks are commonly seen along the coast feeding in the tidal marshes during low tide. Although some flocks may be seen during mild winters, most sightings during this season are of just a few birds. Georgia's coast does not appear to be a primary wintering area for storks (M. Harris, Georgia Department of Natural Resources (GADNR), pers. comm.).

Figure 4. South Carolina wood stork colony locations for 1995.

Wood storks have been seen in South Carolina during every month of the year. However, storks are uncommon from December through mid-March. During a sudden cold snap in 1989, several storks were recovered with their bills frozen shut and a coating of ice on their legs. These storks were alive when found but later died. Most storks seen during the winter are immature. Virtually all storks seen from March through mid-June are adults. Juvenile storks are first seen in June, but are not common until July. The lack of juveniles in the State during the nesting season has unknown consequences on the recruitment to South Carolina colonies (Tom Murphy, South Carolina Department of Natural Resources (SCDNR), pers. comm.).

C. HABITAT CHARACTERISTICS

Wood storks use a variety of freshwater and estuarine wetlands for nesting, feeding, and roosting sites. Each habitat type has distinct characteristics.

Nesting. Typically, storks select patches of medium to tall trees as nesting sites, which are located either in standing water (swamps) or on islands surrounded by relatively broad expanses of open water (Palmer 1962, Rodgers et al. 1987, Ogden 1991). At freshwater sites, nests are often constructed in cypress (*Taxodium distichum*), black gum (*Nyssa biflora*), and southern willow (*Salix carolina*). Coastal nest sites occur in red mangroves *(Rhizophora mangle)* and occasionally Brazilian pepper (*Schinus terebinthifolius*), prickly pear cactus (*Opuntia stricta*), and Australian pine (*Casuarina equisetifolia*). Coastal nest sites in Georgia occur in black gum, willow, and button bush (*Cephalanthus occidentalis*) (J. Robinette, U.S. Fish and Wildlife Service, pers. comm.). Colony sites located in standing water must remain inundated throughout the nesting cycle to protect against predation and nest abandonment.

Storks tend to use the same colony sites over many years, as long as the sites remain undisturbed, and sufficient feeding habitat remains in the surrounding wetlands. Colony turnover rates (calculated using Erwin 1977) for colonies in South Carolina are very low at 0.17 with a 89% likelihood of remaining active in consecutive years. Traditional wetland sites may be abandoned by storks once local or regional drainage schemes remove surface water from beneath the colony trees. As a result of such drainage, many nesting storks have shifted colony sites to managed or impounded wetlands. Ogden (1991) suggested that recent increases in the number of colonies in north and central Florida have been possible because of the availability of altered or artificial wetlands. The percentage of the total number of storks that nested in either altered wetlands (former natural wetlands with impounded water levels) or artificial wetlands (former upland sites with impounded water) in central and north Florida colonies increased from about 10% in 1960 to between 60-82% between 1976 and 1986.

Foraging. Storks forage in a wide variety of shallow wetlands, wherever prey concentrations reach high enough densities, in water that is shallow and open enough for the birds to be successful in their hunting efforts (Ogden et al. 1978; Browder 1984; Coulter 1987). Good feeding conditions usually occur in relatively calm water, where depths are between 5-40 cm (2-16 in), and where the water column is uncluttered by dense patches of aquatic vegetation (Coulter and Bryan 1993). In southern Florida, a dropping water level is often necessary to concentrate fish to suitable densities (Kahl 1964; Kushlan et al. 1975). In east-central Georgia, where stork prey is almost twice as large as the prey in southern Florida, the birds usually feed where prey is sparse and foraging storks do not seem to depend on evaporative concentration of prey (Coulter 1992; Coulter and Bryan 1993; Depkin et al. 1992). Typical foraging sites throughout the species' range include freshwater marshes and stock ponds, shallow, seasonally flooded roadside or agricultural ditches, narrow tidal creeks or shallow tidal pools, managed impoundments and depressions in cypress heads and swamp sloughs. Almost any shallow wetland depression where fish become concentrated, either through local reproduction or the consequences of area drying, may be used as feeding habitat.

Differences between seasons and years in rainfall and surface water patterns often cause storks to make changes between years in where and when certain habitats are used for nesting, feeding or roosting. These hydrological changes may cause storks to shift the timing or intensity of feeding at a local wetland, or cause entire regional populations of birds to make large geographical shifts between one year and the next (Bancroft et al. 1992). Because nesting storks generally use foraging sites that are located within about a 50 km (31 mi) flight range of the colony, successful colonies are those that are in regions where birds have options to feed under a variety of rainfall and surface water conditions (Ogden et al. 1978; Coulter 1987). Maintaining this wide range of feeding site options requires that many different wetlands, both large and small and with relatively long and short annual hydroperiods, be available as foraging habitat.

Roosting. Although storks tend to roost at sites that are structurally similar to nesting sites, they also use a wider variety of sites for roosting than for nesting (Coulter 1990; Bryan 1995; J. Ogden, South Florida Water Management District (SFWMD), pers. comm.). Non-breeding storks, for example, may change roosting sites in response to changing feeding locations, and in the process, will roost in patches of trees that would be unacceptable for nesting (i.e. stands of trees over dry ground). Roosts may be used for long periods of time, either seasonally or annually over many years, or may be used for only brief periods, depending on the availability of persistent foraging areas in surrounding wetlands. Roosting sites include cypress heads and swamps, pine or hardwood islands in marshes, mangrove islands, expansive willow thickets or dry marshes, or on the ground on levees.

D. LIFE HISTORY/ECOLOGY

Prey items and density

Wood storks feed almost entirely on fish between 2 and 25 cm (1-10 in) in length (Kahl 1964; Ogden et al. 1976; Coulter 1987). In a study on regurgitation samples from a stork colony in east-central Georgia, fish (primarily sunfish - (*Lepomis* spp.), bowfin (*Amia calva*), redfin pickerel (*Esox americanus*) and lake chubsuckers (*Erimyzon sucetta*)) represented 92% of all individual prey items consumed and 93% of the biomass (Depkin et al. 1992). In south Florida, Ogden et al. (1976) found that certain fish species were taken preferentially; mosquito fish (*Gambusia affinis*) were underepresented in the diet in proportion to availability, whereas, flagfish (*Jordanella floridae*), sailfin mollies (*Poecilia latipinna*), marsh killifish (*Fundulus confluentus*), yellow bullheads (*Ictalurus natalis*), and sunfish were over-represented. In 1994, regurgitation samples from a coastal colony on St. Simons Island, Georgia yielded primarily (93.75%) brackish/saltwater species. The majority of those fish were mummichogs (*F. heteroclitus*) and one juvenile mullet (*Mugil* spp.) (A.L. Bryan, Jr., Savannah River Ecology Laboratory (SREL), pers. comm.). Wood storks also occasionally consume crustaceans, amphibians, reptiles, mammals, birds, and arthropods. Fish densities at stork foraging sites varied from 15.6 individuals/m^2 in east-central Georgia to 40 individuals/m^2 in south Florida (Depkin et al. 1992; Ogden et al.1978). The natural hydrological regime in south Florida involves seasonal flooding of extensive areas of the flat, low-lying peninsula, followed by drying so that water is increasingly restricted to ponds and sloughs. Fish populations reach high numbers during the wet season, but become concentrated in increasingly restricted habitats as drying occurs. Consumers such as the wood stork are able to exploit high concentrations of fish in drying pools and sloughs.

Feeding behavior

The specialized feeding behavior of the wood stork involves tactilocation, also called grope feeding. A feeding stork wades through the water with the beak immersed and partially open (7-8 cm (2.5-3.5 in)). Upon contact with a prey item the mandibles are forcibly snapped shut, the head is raised, and the food swallowed (Kahl 1964). Occasionally, storks will stir the water with their feet in an attempt to startle hiding prey (Rand 1956; Kahl 1964; Kushlan 1979). Tactilocation allows storks to feed at night or utilize water that is turbid or densely vegetated. However, for this type of feeding to be effective, prey must be concentrated in relatively high densities (see discussion under prey items and density).

Wood storks are able to use distant feeding sites without major expenditures of energy because of their soaring abilities, which allow them to rise to high altitudes on thermals, then coast many miles without flapping. A recent study suggested that soaring flight by storks can be accomplished at one-tenth the energetic cost of flapping flight (Bryan et al. 1995). Long distances traveled, however, shorten the time available for feeding and the number of return trips to feed nestlings (Kahl 1964). During the breeding season, feeding areas located in close proximity to a colony site may play an important role in chick survival, and provide enhanced opportunities for newly fledged birds (weak fliers) to learn effective feeding skills.

Storks from the Corkscrew Swamp colony in Collier County, Florida, sequentially forage in a variety of drying sites, feeding within approximately a 96-km (60-mi) radius around the colony (Browder 1984). However, Coulter (1986) reported that greater than 80 percent of the feeding sites for the Jenkins County, Georgia wood stork colony were within 20 km (12 mi) of the colony and that 55 percent of the feeding sites were within 10 km (6 mi). Storks in south Florida traditionally travel in large groups from the colony to feed. In contrast, storks in Georgia often travel alone or in small groups to forage (Coulter 1992). In coastal areas, the tidal cycle strongly influences use of saltwater habitats by wood storks. The relatively great tidal amplitudes characteristic of coastal marshes in northeast Florida, Georgia, and South Carolina serve to concentrate prey similarly to the seasonal drawdowns found in freshwater systems. In a study conducted at the Priest Landing roost site in Chatham County, Georgia, departure times of storks from the site strongly suggested the storks were foraging in estuarine systems at low tide equally both day and night (Bryan 1995).

Breeding

Wood storks are seasonally monogamous, probably forming a new pair bond every season. There is documented first breeding for 3- and 4-year-old birds, but the average age of first breeding is unknown. It is believed that once storks reach sexual maturity they nest on a yearly basis (J. Ogden, SFWMD, pers. comm.). Mating occurs after a period of highly ritualized courtship displays at the nest site.

Nest initiation varies geographically. In Florida, wood storks lay eggs as early as October and as late as June (Rodgers 1990). In general, earlier nesting occurs in the southern portion of the State (<27°N). Storks in Georgia and South Carolina initiate nesting on a seasonal basis regardless of environmental conditions. Wood storks in Georgia and South Carolina lay eggs from March to late May, with fledging occurring in July and August. Storks nesting in Everglades National Park (ENP) and in the Big Cypress, under pre-drainage conditions, formed colonies between November and January (December in most years) regardless of annual rainfall and water level conditions (Ogden 1994). In response to deteriorating habitat conditions in south Florida, wood storks in these two regions have delayed the initiation of nesting to February or March in most years since the 1970's. This shift in the timing of nesting explains the increased frequencies of nest failures and colony abandonment in these regions over the last 20 years. Colonies that start after January in south Florida risk having young in the nests when May-June rains flood marshes and disperse fish.

Nests are constructed as high as 30.5 m (100 ft) in cypress trees but as low as 1m (3 ft) in mangrove colonies. Nests are constructed of sticks, vines, leaves, and Spanish moss, and lined with leaves or cypress foliage. Wood storks have also successfully nested in man-made artificial structures (Robinette et al. 1992).

Females lay a single clutch of eggs per breeding season. A second clutch is sometimes laid if nest failure occurs early in the season (M. Coulter, IWRB/IUCN/BirdLife International, pers. comm.). Two to five (usually three) eggs are laid. Average clutch size may increase during years of favorable water levels and food resources. Incubation requires about 30 days, and begins after the first one or two eggs are laid; the eggs therefore hatch at different times and young nestlings in a single nest vary in size. Younger, smaller chicks are often the first to die during times of food stress. About 9 weeks are required for fledging, but the young return to the nest for an additional 3 to 4 weeks to be fed. Parents feed young by regurgitating whole fish into the bottom of the nest at a rate of 3 to 10 or more feedings per day. Feedings tend to be more frequent when young are small. Ogden reports that only 1 - 2 feedings per day, per nest, have been recorded in south Florida colonies, when adults were forced to fly great distances to locate prey. Kahl (1964) calculated that an average wood stork family requires 201 kg (443 lbs) of fish during a breeding season, and that a colony of 6,000 nests therefore requires 1,206,000 kg (2.6 million lbs) of fish during the breeding season.

Productivity

Actual colony production measurements are difficult to determine because of the prolonged fledging period, during which time the young return daily to the colony to be fed. It appears that colonies experience considerable variation in production among years and locations, apparently in response to differences in food availability. Table 1 represents data from several south and central Florida colonies demonstrating the variation (J. Ogden, SFWMD and J. Rodgers, Florida Game and Fresh Water Fish Commission (FGFC), pers. comm.).

Table 1. Average number of nestlings per successful nest (N/SN).

AREA	YEAR	Colony name	AGE	N/SN
Central Florida	1976	Mulberry	4-6 wk	2.0
Central Florida	1977	Brewster	7-9 wk	1.8
Central Florida	1977	Pelican Island	4-6 wk	1.8
Central Florida	1977	El Clair	7-9 wk	1.9
Central Florida	1977	Pelican Island	7-9 wk	2.0
Central Florida	1977	Moore Creek	7-9 wk	2.0
Central Florida	1977	El Clair	4-6 wk	2.2
Central Florida	1977	Moore Creek	7-9 wk	2.3
Central Florida	1977	Moore Creek	4-6 wk	2.6
Central Florida	1979	El Clair	4-6 wk	1.9
South Florida	1975	Lane River	6wk	2.5
South Florida	1977	Lane River	6wk	1.7
South Florida	1979	Madeira	6wk	2.5
South Florida	1988	Cuthbert	7-9 wk	1.0
South Florida	1989	Cuthbert	7-9 wk	1.6
South Florida*	1990	Cuthbert	7-9 wk	1.7

(*Heavy rains subsequently resulted in the starvation of all nestlings in Cuthbert in 1990 and all 250 nestlings in nearby Paurotis Pond in 1995. Colony failures such as these have plagued south Florida colonies since the 1970s.)

Maintaining adequate water levels to protect nests from predation is a critical factor affecting production within Georgia colonies (M. Harris, GADNR, pers. comm.). Sufficient fall/winter rainfall can provide enough water within colonies to last through the nesting season. If this is followed by general drying conditions in late spring through mid-summer, most colonies will produce young to flight stage (A.L. Bryan, SREL, pers. comm.). Conditions similar to those described above, persisted in 1991 and 1992 in coastal Georgia. Average production (birds produced per successful nest) during the 1991-1992 nesting season from a coastal colony in McIntosh County (Harris Neck) was 2.40 and 2.44 respectively.

When drought conditions persist during chick rearing, production from inland and coastal colonies may increase due to prey concentration in non-tidal feeding areas, provided colonies are not subject to predation (M. Harris, GADNR, pers. comm.). During drought conditions in the spring and summer of 1993, the Harris Neck colony produced a mean of 2.94 birds per nest. Three additional coastal colonies in McIntosh, Camden and Glynn counties each produced over 2.85 birds and two inland colonies in Jenkins county produced 2.53 and 2.08 birds per successful nest.

Artificial feeding ponds have been used successfully to provide supplemental high quality forage for wood storks and other wading birds (Coulter et al. 1987; Robinette and Davis 1992). Their potential impact on nesting success, production, and survival of newly fledged young is unknown. Preliminary results from a study conducted in 1995, on coastal colonies in Georgia, indicate artificial feeding ponds, located in close proximity to a colony site, may have significant positive impacts on production (L. Bryan, SREL and J. Robinette, USFWS, pers. comm.). Drawdowns during breeding season, and early post-breeding season, (March - September) can cause anoxic conditions and summer kill. Annual fall stocking will ensure that a consistent high quality forage base is provided on an annual basis, and that prey density is optimum for foraging storks.

It appears that above normal rainfall can severely impact production in inland colonies that depend solely on non-tidal fresh water food sources (A.L. Bryan, SREL, pers. comm.). Inland colonies in Jenkins County, Georgia (Big Dukes Pond and Chew Mill Pond) averaged 0.94 and 0.69 birds per active nest respectively in 1994 when heavy rain kept water levels relatively high in traditional feeding areas. Along Georgia's coastal plain, weather conditions varied among coastal colony sites during the 1994 season, but in general, water levels in most non-tidal fresh water feeding areas were higher than normal. One colony received above normal rainfall, and lost chicks during high winds, but still maintained production above 2.0 birds in nests that remained following the storm (Harris Neck 2.21 chicks per nest). Others suffered loss of chicks to predation when falling water levels allowed raccoons to enter the colony (Black Hammock 1.67 chicks per nest and Brailey Swamp 1.64 chicks per nest). The colony on St. Simons Island received above normal rainfall but did not suffer chick loss from predation or high winds (2.47 chicks per nest). The availability of fresh and brackish tidal marshes, combined with high tidal amplitude, may provide a more consistent food supply for coastal colonies in Georgia. Current data indicate coastal colonies may be less affected by above normal water levels than inland colonies.

Productivity in South Carolina colonies is similar to that found in Georgia and north Florida. In the period from 1981 to 1995, South Carolina colonies averaged 2.25 chicks/nest with an annual range of 1.75 to 2.75 (T. Murphy, SCDNR, pers. comm.).

Life span, Survivorship and Mortality

Little information is available on annual adult survivorship or survival of fledglings once they leave the colony. The oldest known age bird in the wild was 11 years 8 months (Hancock et al. 1992, p. 284). The oldest recorded specimen in captivity was a bird that was held at the National Zoological Park for 27 years and 6 days (May 28, 1923 to June 3, 1950) (Brouwer et al. 1992), although Hancock et al. note a 30+ year old bird (1992, p. 284).

Little is known about mortality among storks except in nesting colonies. In most colonies, the greatest mortality in nests occurs due to egg loss during incubation, and among nestlings during the first 2 weeks following hatching (J. Rodgers, FGFC, In press). As a result of delayed nesting in colonies in the southern Everglades, many nestling storks have died of starvation once summer rains dispersed fish concentrations on foraging grounds (Ogden 1994). Coulter and Bryan (1995a) examined factors that affected reproductive success of storks in east-central Georgia. Five factors accounted for the loss of nests: raccoon predation, stress induced by cold weather, intraspecific aggression, storm damage, and other unknown factors. Raccoon predation occurred when the swamp under nesting trees dried up. Alligators appeared to be an effective deterrent to raccoon predation. When sufficient water was under the nest trees, alligators were present. When water levels receded, the alligators left and raccoon predation became a problem.

Population status

Historically, wood storks were reported to have nested in all coastal states between Texas and South Carolina (Bent 1926; Cone and Hall 1970; Dusi and Dusi 1968; Howell 1932; Oberholser 1938; Oberholser and Kincaid 1974; Wayne 1910). There is no evidence, however, that colonies located outside of Florida ever, at any time prior to about 1970, formed on a regular basis or contained large numbers of storks. The largest individual colonies were in southern Florida, and contained from 5,000 to 10,000 nesting pairs in some years during the period from about 1900 through 1968 (6,000 pairs at Corkscrew Swamp in 1961 and 1966).

The estimated total population of nesting storks throughout the southeastern United States declined from 15,000 to 20,000 pairs during the 1930s, to 10,000+ pairs in 1960 to 1961, to a low of between 4,500 and 5,700 pairs in most years from 1977 to 1980 (Ogden et al. 1987). The lowest annual total, 2,500 pairs in 1978, probably reflected the combined influences of a low regional population and poor conditions for nesting in that year - many storks may not have attempted to breed. Surveys for all known colonies in South Carolina, Georgia, and Florida since 1983 have revealed a population ranging from 5,500 to 6,500 pairs. Over 6,000 pairs were estimated in 1983, 1984, 1993, and 1995.

Since the 1960s, the wood stork population has shown a substantial decline in southern Florida, and a substantial increase in northern Florida, Georgia, and South Carolina (Ogden et al. 1987). The number of pairs nesting in the traditional colony sites located in the Everglades and

Big Cypress regions of southern Florida declined from 8,500 pairs in 1961 to fewer than 500 pairs (from 1987 through 1995). During the same years, the number nesting in Georgia increased from 4 pairs in 1965 to 1,501 pairs in 1995, and the number nesting in South Carolina increased from 11 pairs in 1981 to 829 pairs in 1995. Appendix A shows recent survey information for storks in the Southeast.

Rodgers et al. (1995) pointed out shortcomings in the aerial surveys used to generate population estimates for storks in Florida, Georgia, and South Carolina. Rodger's study compared ground surveys of wood stork colonies with aerial surveys of the same colonies. The variability of the aerial estimates were very large. For example, an approximate 95% confidence interval for the 1993 Statewide (Florida) nesting population was 3,807 to 12,653 nests. The greatest variability occurred in large colonies with a high proportion of other white-plumage nesting birds.

The Service acknowledges the limitations involved in relying on aerial surveys for developing population estimates. However, storks are a long-lived species that demonstrate considerable variation in population numbers in response to changing hydrological conditions. Over the long-term, aerial surveys are the most cost-effective method for estimating population trends. Ground surveys, while providing greater individual colony accuracy, are more time consuming and expensive on a region-wide basis. Rodgers recommended the following actions to minimize variability in aerial surveys; incorporating ground counts at selected colonies, training observers in presurvey flights, and replicating counts for each colony. Surveys in Georgia and South Carolina, where colonies are not as numerous, often include ground counts. When possible, surveys in Florida will also include ground counts to reduce some of the variability..

E. REASONS FOR LISTING

When the Service listed the wood stork as an endangered species in 1984, several factors were listed as contributing to the decline of the population.

1. Loss of feeding habitat. The generally accepted explanation for the decline of the wood stork as a U.S. breeding species is the reduction in the food base (primarily small fish) necessary to support breeding colonies. This reduction is attributed to loss of wetland habitat as well as to changes in hydroperiods (Ogden and Nesbitt 1979; Ogden and Patty 1981). Wetland drainage and hydroperiod alteration are believed to have lowered the productivity and availability of fish for the wood stork, as well as for other wading bird species utilizing interior wetlands in Florida (Ogden and Nesbitt 1979; Ogden 1983).

2. Water level manipulations. The development of intensive water management in southern Florida has apparently affected wood stork reproductive success in two ways. The primary and most obvious effect is the decrease in areas subject to natural flooding followed by gradual drying; such a regime is essential to wood storks. If suitable concentrations of prey fish are not available, nest abandonment may occur. Kushlan et al. (1975) found that a water level increase as little as 3 cm (1.2 in) in the first 2 months of nesting was correlated with nest desertion in the ENP colonies, and that subsequent re-nesting efforts were usually unsuccessful. They also found that, while successful wood stork nesting was associated with wet years prior to 1962, nesting

became relatively more successful in dry years after that date. This coincided with the restriction of water deliveries through a smaller flow section across the Tamiami Trail, causing higher water levels in some portions of ENP per given rainfall, and at the same time, overdrainage of other areas of the Park.

The history of water management in Florida has been summarized by Blake (1980). Early water management efforts were intended to drain wetlands for agriculture. The drainage schemes sought to alter the natural hydrological regime, which consisted of extensive seasonal (mainly summer-fall) flooding, followed by gradual declines in water levels as the drier seasons (fall, winter, and spring) commenced. The larger watersheds of primary concern to the wood stork in Florida are the Kissimmee - Okeechobee - Everglades system and the St. Johns River Basin. A wide variety of other, mostly smaller, watersheds are important to the wood stork over its breeding range. The initial modifications involved digging headwater canals to drain off water quickly to the ocean. Increased human use of flood-prone areas caused additional demands for further structural flood control measures. Subsequently, the construction of additional canals, levees, gates, water storage areas, and the use of backpumping, brought the hydrological regimes largely under human control. These structural modifications affected vast areas in both south and central Florida, and also made the ENP largely dependent on release of water from the Water Conservation Areas. In 1970, ENP was guaranteed an annual allotment, but in drought years this can be inadequate for optimum wetland health and productivity. Just as important, unseasonably large releases of water can cause wood stork nesting failures. A newer, Experimental Water Delivery program for the Park, initiated in 1985, has not yet resulted in the recovery of sufficiently natural hydrological patterns to have improved habitat conditions for storks in the Everglades basin.

It should be pointed out that the long reproductive lifespan of the wood stork allows it to tolerate reproductive failure in some years, and naturally occurring events (prolonged drought or unseasonal heavy rainfall) have undoubtedly always affected the breeding success of this species, causing some breeding failures. Modified hydrological regimes, however, have caused nesting failures to become chronic, rather than occasional, in the important south Florida wood stork colonies.

3. <u>Predation and/or lack of nest tree regeneration.</u> Drainage of cypress stands will prevent wood storks from nesting, and lowered water levels after nest initiation facilitates raccoon predation. Raccoons may also enter colonies more easily when mats of aquatic vegetation form under cypress swamp colonies (J. Rodgers, Jr., FGFC, pers. comm.). On the other hand, colonies that are perpetually flooded will have no cypress regeneration. In recent years, some wood stork colonies have formed on islands in clay settling ponds formed as a result of phosphate mining operations. These colonies tend to be temporary, because vegetational succession results in the death of the pioneering willows used for nesting and shrubs and dense vines ultimately predominate (Clewell 1981). In some such settling impoundments, all vegetation dies after a few years (J. Ogden, SFWMD, pers. comm.).

4. Human disturbance. Human disturbance may cause adults to leave nests, exposing the eggs and downy nestlings to predators, sun, and rain. However, it appears that wood storks may be less sensitive to low levels of human disturbance than other wading birds. Rodgers and Smith (1995) examined 8 colonies of mixed-species wading birds (including wood storks) for responses to various human disturbances. They calculated recommended setback distances for each species depending on their sensitivity to disturbance. Of the 15 species examined, wood storks exhibited the smallest mean flush distance in response to a walking approach (18.4 $\pm$ 5.5 m) and an equally small (<20 m) flush distance in response to a motor boat approach. Rodgers and Smith recommended minimum setback distances for wood storks at 65 meters for any type of walking activity and 63 meters for any type of boating activity.

5. Pesticides and other chemical pollutants. Pesticide contamination has not generally been considered to adversely affect wood stork reproduction (Ohlendorf *et al.* 1978), but a 1984 study (Fleming *et al.*) suggests that reproduction in north and central Florida colonies may have been adversely affected by DDE. This compound, a DDT metabolite, was found in higher concentrations in eggs from nests in which not all eggs hatched. The levels of heavy metals and selenium were examined in the feathers of young wood storks nesting in northeastern Florida (Dee Dot, Duval County) and compared to nesting wood storks on the west coast of Costa Rica (Burger et al. 1993). Concentrations of mercury, cadmium, and lead were significantly higher in the chicks from Florida compared to those from Costa Rica. Additionally, feather and liver tissue samples from a road-killed wood stork in Florida were examined for mercury content (Facemire and Chlebowski 1991). Liver and feathers contained an average of 10.1 and 9.9 mg mercury/kg wet weight, respectively. This level is below the level of acute toxicity (16.5 ppm wet weight), but is well within the range of residues (5.0 to 40.0 ppm) known to have impaired reproduction in several species of birds (Eisler 1987).

6. Current concerns. Recent programs designed to begin the ecosystem restoration process for Everglades National Park, including the Minimum Water Deliveries Program of the 1970's, and the Experimental Water Deliveries Program beginning in the mid-1980's, have shown no evidence that they have benefited storks. Peak numbers of nesting storks in ENP were 1,500 to 2,000 pairs during the 1960's, 1,000 to 1,200 pairs during the 1970's, 500 to 1,000 pairs during the 1980's and fewer than 250 pairs since 1989. Urban and agricultural expansion in southwestern Florida continue to adversely impact the Corkscrew Swamp and other Big Cypress Basin colonies, resulting in a continuing decline in total nesting effort by storks in that region as well.

F. ONGOING CONSERVATION EFFORTS

Management Guidelines. In 1990, the Service developed a set of management guidelines for wood stork nesting, feeding, and roosting habitats (Appendix B). The Guidelines recommend buffer zones that may be necessary to reduce human disturbance for storks using nesting and roosting habitats. These efforts have substantially contributed to the protection of stork habitat, particularly where new developments have been proposed in areas where it could be demonstrated that storks were using specific sites. The buffer zones recommended in the management guidelines are greater than those recommended by Rodgers and Smith (1995) in their analysis. At the time the guidelines were developed, very little empirical data were available on the response of wood storks to human activities. Rodgers and Smith analyzed only three types of human activities: walking, canoeing, and a small motorboat with two persons. They did not evaluate responses to other activities such as construction or aircraft. The current guidelines recommend buffer zones to protect colonies from many kinds of activities including human disturbance. J. Rodgers (FGFC, pers. comm.) plans to develop recommended minimum setback distances for loafing and foraging sites in the near future. Upon completion of his report, the management guidelines should be reevaluated to consider the recommendations of Rodgers and Smith.

Guidelines for Forestry Practices. In 1994, the Florida Game and Fresh Water Fish Commission developed draft guidelines to assist professionals conducting forestry practices (when Federal cost-share program funds are used) on lands where wood storks occur. The guidelines are designed to prevent incidental take and provide management options to enhance the species and habitat when consistent with the landowners objectives. When approved, these guidelines will have the concurrence of the U.S. Forest Service and the U.S. Fish and Wildlife Service.

Foraging Habitat Management. Over the last several years, South Carolina and Georgia have been successful in managing man-made diked impoundments for use by wood storks. These impoundments can be made available to storks under a variety of circumstances because of the ability to artificially manipulate water levels and concentrate fish in canals and natural pools.

There are in excess of 70,000 acres of diked marshes in South Carolina. These impounded marsh areas are managed primarily to attract waterfowl. Management generally involves manipulation of salinity and water level through the use of water control structures and tidal flow. Impoundments may be used by storks any time water levels are shallow enough to accommodate foraging storks (<40 cm (16 in)). High density stork use most commonly occurs during periods when water levels are dropped and fish are concentrated. This procedure immitates the natural drought cycle but is artificially accelerated using water control structures and may be timed within season for maximum utility. Storks find impoundments within days of a drawdown and concentrations of >300 storks in a single impoundment are regularly recorded. Impoundment drawdowns provide continuous foraging opportunities unlike the adjacent tidal marsh which is useful only during the periods around low tide. Drawdowns of impoundments for stork use can often be accomplished within the framework of waterfowl water manipulations. Impoundment drawdowns should be conducted on different units over time to provide high quality foraging habitat over a longer period of time. Consideration should be given to conducting drawdowns during periods when other habitats are not as available, such as periods following heavy rains. The need for food is at its highest during the time when chicks are in the nest. However, in most years there appears to be adequate foraging habitat to support high levels of production. A critical need for predictable high quality habitat may well be during the period immediately after the young fledge. The presence of foraging habitat with high prey densities may reduce the high rate of mortality of recently fledged chicks.

An example of a managed impoundment for storks occurs at the Kathwood Lake facility near Jackson, South Carolina. In response to an Endangered Species Act Section 7 consultation between the Service and the U.S. Department of Energy's (DOE) Savannah River Site, the DOE modified the bottom of the drained Kathwood Lake into four impoundments to be specifically managed as wood stork foraging habitat (Coulter et al. 1987). These impoundments are periodically stocked with known stork prey species (fish) and are managed for fish reproduction in the fall, winter and spring (Coulter and Bryan 1995b). The impoundments are lowered to appropriate depths for stork foraging in the late summer months (July - September) when storks frequent south-central South Carolina. Wood storks have utilized these impoundments every year since they were constructed (1986) with the primary beneficiaries being immature (≤ 3 yrs. old) storks who were consistently present in higher numbers than adult storks on these managed impoundments (Bryan and Coulter 1995). The successful utilization of these impoundments, and future attempts to create or manage foraging habitat, was the result of active management to either produce or stock high densities of prey species and then making the prey available for the storks during a period of peak food demand, such as when parents are feeding nestlings or fledgling storks are dispersing from their colonies.

In 1994, the Service's Charleston Ecological Services field office provided technical assistance and funding to two private landowners for construction of a wood stork foraging area on their property. This Partners for Wildlife project occurred on abandoned farmland thirty miles west of Charleston, South Carolina. The drained and degraded site, currently managed for game species, was once used as a farm pond. The site received occasional stork use. With assistance from numerous cooperators, a low dike was constructed to surround the seven-acre area encompassing the farm pond, a drainage ditch and a field containing hydric soils. Since its construction, the site has been a major foraging site for a nearby (one-quarter mile away) wood stork colony. The site is seasonally ponded from rainfall. It contains emergent vegetation with areas of moist soil, islands, and a water depth ranging from a few inches to three feet. The storks are believed to be feeding on minnows, tadpoles, and crayfish. The site is also used by waterfowl, wading birds, shorebirds and alligators (L. Duncan, USFWS, pers. comm.).

Nesting habitat management. Wood storks have successfully fledged young from artificial nesting structures on Harris Neck National Wildlife Refuge in coastal Georgia since 1993. Production from structures has been similar to that from natural sites. Structures are made from four by four posts, steel re-bar, coated screen, and artificial "silk" foliage. Artificial structures can be used in existing or pre-existing colony sites where natural nesting habitat is lacking and/or degraded (Robinette 1992).

Everglades restoration. An understanding of the relationships between storks and water conditions in the Everglades has provided a basis for restoration planning for the region. The ENP staff has used a 64-year, continuous record of stork nesting in the Everglades basin (1932-1995) for this purpose. Regional plans now being developed for the ecological restoration of the Everglades basin should eventually result in much improved habitat conditions for storks in south Florida. It is currently assumed, as a part of the restoration planning, that the recovery of increased volumes of freshwater flow into the mainland estuaries downstream from the Everglades marshes will increase primary and secondary production in these regions. These broad, mainland estuaries are thought to have been the primary foraging sites for storks during the early dry season months, at the time of the year when nesting colonies were formed in the pre-drainage system. Loss of early dry season foraging habitat apparently is the reason why storks have delayed the initiation of nesting by 2-3 months each winter, resulting in the increased mortality rates among nestlings and newly fledged birds.

Tri-state surveys. Regional, aerial surveys of nesting colonies conducted during 1957 through 1961, and again in the mid-1970s, were essential for locating important habitats, and understanding threats to the southeastern population of storks. These surveys were the first to measure the status of the regional population of storks, and have been used to measure responses by nesting storks to water management practices in the Everglades region. Over the last 5 years (1991-1995), the Service coordinated a systematic multi-state aerial survey of stork nesting colonies. The results are presented in Appendix A. [Limitations of these aerial surveys, identified by Rodgers et al. (1995) are discussed in the population status section on page 10.] After a 5-year hiatus where financial efforts will be directed towards research, a new series of surveys will begin again in the year 2001.

Genetics Study. In 1990, Stangel et al. employed starch gel electrophoretic techniques to examine genetic variation in Florida wood stork populations. This study did not indicate significant allozyme differences within or between populations. In 1994, a genetics study incorporating DNA microsatellites of breeding storks in Florida and Georgia was initiated to further investigate the geographic and genetic origins of wood stork colonies in the these states. By assessing the degree of genetic interrelatedness among wood stork colonies, vital information can be obtained concerning population movements, allowing managers to determine whether the increase in numbers of storks breeding in the northern portion of their range is the result of high productivity in those colonies, increased immigration from Florida colonies, or both.

Roosting Habitat Study. A survey of a portion of the coastal zone of Georgia and South Carolina in the fall of 1994 for wood stork roosts documented 110 roost sites (Bryan 1994). The majority (59.1%) of these roosts were located along upland/salt marsh interfaces and were presumed to be temporary "day roosts" used by storks near foraging sites. Only 13 (11.8%) roost sites were classified as either "important" or "moderately important" based on the average number of storks present ($\geq$ 25 storks and 20 to 25 storks, respectively) during repeated surveys. The majority of these roosts were located in man-made or natural, enclosed wetland openings, similar to the habitat storks use as colony sites.

Additional roost sites were discovered in the southern coastal zone of Georgia in the fall of 1995 (A.L. Bryan, Jr., SREL, unpublished data). Similar trends for habitat types (wetland openings) of "moderately important" and "important" roosts were observed. Re-visiting a sample of roosts from the 1994 surveys indicated that most, but not all, of the repeatedly used roosts remained important in the second year of surveys.

In a separate study, Bryan (1995) documented that storks frequently departed from a coastal roost nocturnally. The attendance patterns of storks in this roost were linked to the tide cycle, with storks leaving the roost 2 to 3 hours prior to low tide, presumably to take advantage of fish being concentrated in tidal creeks and pools by the dropping tide.

In 1995, the Service's Charleston Ecological Services field office consulted with the Corps of Engineers on a proposed golf course and residential development near Hilton Head Island, Beaufort County, South Carolina. The Service determined that the proposed project adversely affected several foraging sites and small roosts located within the project boundaries. The applicant agreed to include, as part of the project plans, measures to minimize adverse impacts to the storks. These measures included: (1) maintaining forested buffers along onsite lakes, ponds, and the proposed development; (2) managing an onsite pond to benefit foraging storks; (3) placing interpretive signs on the golf course explaining the history of the wading bird roost and providing biological information on the wood stork and its use of the area; (4) implementing a six-year monitoring plan to determine the impacts of the development and associated human activities. (Both day and night observation periods are included in the study design.) Construction of the golf course nearest to the stork areas was completed in spring 1996. Storks continued to use the roosts and foraging areas during the 1996 season. The monitoring continues.

Educational efforts. A Wetlands-Wood Stork Summit was held on October 13-14, 1994, in Georgia. The Georgia Conservancy and Zoo Atlanta convened this summit to initiate a coordinated region-wide effort in wetlands education focusing on the wood stork. The initiative is comprised of both an education and a research component. A grant proposal was submitted in early 1995 requesting support for this effort.

G. STRATEGY FOR RECOVERY

The fact that wood storks nesting in the southeastern U.S. represent a single, highly mobile population strongly favors the development of a regionally integrated recovery strategy. Storks operate over relatively large spatial scales when foraging, meaning that the timing and location of colonies, and the number of birds initiating nesting, are much more likely to be a reflection of regional rather than local ecological conditions. The long-term survival and recovery of this population requires that the mosaic of nesting, foraging, and roosting habitats necessary to support storks throughout their range during varing climatological and seasonal conditions must be identified and protected. Mere preservation of wetland acreage does not necessarily preserve the processes necessary for the production of a strong prey base for wading birds. Wetlands must be managed to maintain or recover the dynamic wetland processes that create and make available the abundance of food required by nesting birds. Continuous habitat assessment and protection, and population monitoring, will best assure that recovery objectives are met.

A prerequisite for the complete recovery of wood storks in the Southeast will be the restoration of the defining ecological characteristics of the Everglades and Big Cypress systems. These wetlands must, once again, provide at the right locations and times, the food resources that are necessary to support traditional stork wintering and nesting patterns.

PART II. RECOVERY

A. RECOVERY OBJECTIVE

The objective of this revised recovery plan is to assure the long-term viability of the U.S. breeding population of the wood stork in the wild, thereby allowing removal of this population from the Federal List of Endangered and Threatened Wildlife (50 CFR 17.11 and 17.12). In the original recovery plan, the Service set recovery criteria for delisting at 10,000 pairs provided that the population was self-sustaining and adequate feeding and nesting areas over the species' historic range were secured. This number was based on the estimated number of breeding wood storks in 1960, when good rates of reproduction were occurring at major Florida colonies (Ogden and Patty 1981). The recovery criteria for reclassification to a threatened species was 6,000 breeding pairs provided that the increase was sufficiently well understood so that the population level could be maintained or increased. The basis for this number was the estimate of breeding pairs in 1975 (Ogden and Patty 1981). The original plan acknowledged that past and ongoing destruction and alteration of wetlands may preclude reaching this objective.

Knowledge of wood stork biology and distribution has increased significantly since the original recovery plan. Part I of this plan incorporates this new information into a strategy for recovery encompassing the entire regional distribution of storks.

After a thorough evaluation of current information, the original recovery criteria remain as reasonable estimates of what is necessary to maintain this population of wood storks into the future. However, numbers of nesting pairs are not a complete indication of the stability of a population. Productivity levels exceeding a minimum standard are necessary to ensure continued viability. Additionally, for complete security of the wood stork population, some improvement in productivity and population trends must occur in the Everglades and Big Cypress systems. Habitat in Georgia and South Carolina has not changed substantially in recent years to explain the increase in nesting pairs occurring in these areas. Rather, these increases may have resulted from declines in the South Florida colonies - the health of which continue to decline. Without some restoration of the Everglades and Big Cypress systems, the wood stork cannot ever be considered fully recovered. Available habitat in north Florida, Georgia, and South Carolina cannot be expected to support the entire population of wood storks. Further, it should not be assumed that habitat in the northern range will continue to be protected as well in the future as it is at present. As a result of these conclusions, the revised recovery criteria are as follows:

DOWNLISTING TO THREATENED STATUS: An average of 6,000 nesting pairs and annual regional productivity greater than 1.5 chicks per nest per year, calculated over 3 years.

DELISTING: An average of 10,000 nesting pairs (50% of historical population) calculated over 5 years beginning at time of reclassification, annual regional productivity greater than 1.5 chicks per nest per year (also calculated over a 5-year average). As a subset of the 10,000 pairs, a minimum of 2,500 successful nesting pairs must occur in the Everglades and Big Cypress systems.

B. NARRATIVE OUTLINE

This narrative outline provides a detailed explanation of the recovery tasks and actions believed necessary to recover this species.

1. Protect currently occupied habitat. At a minimum, for continued survival of the U.S. population, currently occupied nesting, roosting and foraging habitat must be protected from further loss or degradation. Watersheds supporting natural nesting habitat should remain unaltered, or be restored to function as a natural system if previously altered.

1.1. Locate important habitat. Identifying important nesting and roosting sites for protection is relatively easy as storks tend to use the same sites year after year. Important foraging sites, however, are more difficult to identify. Individual feeding sites vary from day to day and season to season depending on hydrologic changes and availability of food.

1.1.1. Locate nesting habitat. The health and productivity of colonies must be known to evaluate the status and recovery of the wood stork. Continue periodic aerial surveys to determine the status of nesting storks. Distribute survey information to public and private organizations and interested individuals.

1.1.2. Locate roosting and foraging habitat. Identifying important foraging and roosting habitat is critical to the recovery of the wood stork. The pattern of wetland use by wood storks is poorly known. Recent studies along the Georgia and South Carolina coast have provided valuable information on roosting and foraging behavior (Bryan 1995); additional work of this sort is needed.

1.2. Prioritize habitat. Using data gathered from task 1.1., develop a prioritization scheme to focus protection efforts on colonies and feeding sites with the greatest degree of threat. Efforts should be made to identify important foraging and roost sites associated with high priority colonies.

1.3. Work with private landowners to protect habitat. Conservation agencies need to recognize the significant contributions that private landowners have made to the protection of wood storks.

1.3.1. Inform landowners of the presence of storks nesting on their property. Property owners having priority foraging and roost sites (as defined in task 1.2.) should also be informed. Encourage compliance with existing regulatory mechanisms (see task 1.6.).

1.3.2. Provide assistance and support to landowners in managing their property for the benefit of wood storks. Assistance can be in the form of written material explaining best management practices, site visits, local recognition, tax and/or monetary incentives, etc. For example, in 1994, the Service's Partners for Wildlife program funded a wetland restoration project on private land in South Carolina. The project involved providing a cost share to the landowner to restore hydrology to the previously drained wetland. The project resulted in a shallow water feeding site of several acres and is used by many wood storks.

1.3.3. Develop management plans for private lands. Conservation agencies should assist landowners in developing specific management plans for each colony site. These management plans should adequately protect colony sites yet be flexible enough to respond to the changing needs of the landowner. The success or failure of management prescriptions for nesting, roosting and foraging areas should be clearly documented and reported.

1.4. Acquire land. Federal and State conservation agencies and private conservation organizations should continue efforts to acquire wood stork habitat as it becomes available. Low turnover rates of established stork nesting colonies (see p. 5) result in a high probability of continued use of colony sites. Site acquisition may be a viable management option. Initial land acquisition efforts should be carefully targeted to sites having the greatest potential for maintaining storks over time. Large, stable colonies that are in immediate threat from disturbance should be of highest priority. Priority should also be given to larger colonies with a history of annual use, sites most in need of management, colony sites where alternate habitat is not available, and sites where water levels can be manipulated with water control structures to provide optimal conditions independent of rainfall patterns.

1.5. Protect sites from disturbance. Nesting habitat should be protected from disturbance and human alteration. The Service developed Habitat Management Guidelines for Wood Storks (Appendix B) in an effort to reduce disturbance to colony sites. These management guidelines discuss various types of activities known to disturb nesting wood storks. Additionally, certain types of habitat management activities can adversely impact colony sites. Cypress logging is a potential threat to some colonies. Human disturbance causes adult wood storks to leave nests, exposing eggs to predation and weather elements. Posting or other appropriate protection may provide some benefit.

1.6. Use existing regulatory mechanisms to protect habitat.

1.6.1 Review Federal actions for impacts to wood storks. Wetlands are altered for mining, agriculture, and residential purposes. Permitting authority over such activities is held by agencies in the State of Florida (Department of Environmental Protection, Water Management Districts) and the Federal government (U.S. Army Corps of Engineers, Environmental Protection Agency). Analogous State agencies, and the same Federal agencies, exercise equivalent jurisdiction in Georgia and South Carolina. Important feeding areas should be included as a category of waters for which the Service receives Corps of Engineers predischarge notification pursuant to Section 404 of the Clean Water Act. Section 7 of the Endangered Species Act requires that all Federal agencies ensure that their actions are not likely to jeopardize the continued existence of any listed species or destroy or modify their critical habitat. Federal agencies conducting actions that may affect the continued existence of wood storks must consult with the Service.

1.6.2. Encourage conservation of wood stork habitat in Habitat Conservation Plans. Section 10(a)(1)(B) of the Endangered Species Act provides for incidental take permits that have the potential to contribute to the conservation of listed species. If appropriate, applicants should be encouraged to consider conservation of wood stork habitat when preparing Habitat Conservation Plans.

2. Restore and enhance habitat. A prerequisite for recovery of the wood stork in the southeastern U.S. is the restoration and enhancement of suitable habitat throughout the mosaic of habitat types used by this species.

2.1. Restore the Everglades and Big Cypress system. Recover viable nesting subpopulations in traditional Everglades and Big Cypress colony locations. The water delivery formula and schedules developed by the Experimental Water Deliveries Program, the structural modifications to canals and levees proposed for ecosystem restoration of Everglades National Park, and the regional Everglades restoration planning process (C&SF Review) conducted by the Corps of Engineers, should address the recovery of the ecological processes that made it possible for the pre-drainage Everglades Basin to support such large numbers of storks and other wading birds. These ecological processes were made possible by the large spatial scale of the pre-drainage Everglades, the strong between-year variation in surface water patterns, and the strong flows of surface water into the estuaries.

2.1.1. Analyze and report on existing record of stork colony patterns in the Everglades basin, including the effects of the initial restoration programs on the ecological recovery of ENP. Reports currently being generated by the staff at the South Florida Natural Resources Center, ENP should be completed. These reports present all stork colony data from the Everglades basin, and assess the impacts of past and current restoration programs on wood stork and wading bird colony patterns in the Park. They will form the basis for evaluating restoration efforts to date and improving future restoration programs.

2.1.2. Develop models of wood stork colony dynamics in south Florida wetlands. These models are needed as planning tools for improved ecosystem restoration programs. Potentially the most important of the ecological models for the Everglades is a wood stork population dynamics model, that is a part of the "Across-Trophic-Level System Simulation" (ATLSS) set of models being developed by the South Florida/Caribbean Field Station of the Biological Resources Division (U.S. Geological Survey).

2.1.3. Provide feedback for adaptive restoration planning. Monitor stork colony patterns during implementation and testing of future efforts to improve hydrological conditions. Use information on the location, timing, size, and success of stork colonies in the Everglades and Big Cypress systems to evaluate ecological responses to the restoration programs, as a basis for designing future iterations in the restoration process.

2.1.4. Organize systematic censuses of stork foraging habitat in the Big Cypress region, comparable to existing censuses in the Everglades basin. The fact that declines in nesting effort and delays in timing of colony formation have shown similar trends in the Big Cypress and have been well documented in the Everglades suggests that the Big Cypress colonies are dealing with similar kinds of habitat deterioration on the foraging grounds. The location and relative importance of stork foraging grounds in the Big Cypress are much less known, and should be determined as a basis for developing protection strategies in this region. It is also suspected that small stork nesting colonies go undectected in the Big Cypress, because of the lack of systematic colony censuses over most of the Big Cypress National Preserve.

2.2. Enhance nesting and roosting sites throughout the range.

Ideal nesting habitat consists of large nesting trees growing on islands surrounded by water. Enhancement of nesting habitat should focus on construction of islands, combined with tree planting, to provide for deep water protection, while preventing nest tree damage due to inundation during the growing season.

2.2.1. Improve colony success/productivity by impounding suitable sites. While above normal rainfall and high water levels negatively impact the foraging success of wood storks, high water levels in colony sites can improve productivity for the following reasons:

a. Prolonged flooding increases the likelihood of storks using the site for continuous nesting.

b. High water levels decrease predation by terrestrial predators.

c. Prolonged flooding reduces understory vegetation that may contribute to "hot" wildfires and damage to nesting trees.

Not all colony sites respond well to continued inundation and care must be taken to select sites that will benefit from this management action. Over time, prolonged flooding can reduce or eliminate tree recruitment for future years, reduce the growth rate of flood tolerant species and kill flood intolerant trees located within the colony. Some sites may need to be periodically drained to preserve nest trees.

2.2.1.1. Determine the structural and vegetative characteristics of impounded sites. Impounded sites currently used by nesting storks, should be examined for their structural and vegetative characteristics as a basis for understanding the feasibility of enhancing and creating additional colony sites.

2.2.1.2. Conduct long-term monitoring of impounded colony sites. Health of nesting structures (trees, etc.) should be monitored and supplemental planting of desired species conducted if natural regeneration is no longer an option. Conduct long-term monitoring of impounded sites to compare nesting histories among these sites and natural colony sites to determine importance of site types in maintaining subregional populations of storks.

2.2.2. Replace lost nesting trees. In the event that nesting trees have been lost and/or regeneration has been hindered, new trees (cypress, black gum, etc.) should be planted to eventually replace the lost nesting structures.

2.2.3. Use artificial nesting structures to attract storks to suitable habitat. Artificial structures can be used to bridge the gap until newly planted trees reach a suitable size for nesting. Artificial structures have been used to successfully raise young in south Georgia (Robinette 1992).

2.3. Enhance foraging habitat by modifying hydrologic regimes in existing artificial impoundments to maximize use by wood storks. In tidal impoundments where water levels can be controlled, there is the potential to enhance use by wood storks. Estuarine fishes are recruited during flooding of the impoundment and maintained over the entire acreage while at flood stage. These fish can then be concentrated into the perimeter canals at high density when water levels are lowered to dry the marsh bed. By staggering the timing of drawdown of different impoundments within a management unit, stork use may be extended for several months. Impoundment management efforts should include, at least, the following:

a. Maintenance of high quality water using a flow-through system, aeration tower, etc.

b. Stocking of preferred prey species (sunfish, bullhead catfish, etc.). State and Federal fish hatcheries are a potential source of fish for stocking efforts.

c. Providing preferred prey size (5-20 cm (2-8 in)) through high density stocking and/or post spawing drawdown.

d. To prolong feeding opportunities, use a slow drawdown to desired water depth, approximately 25 cm (10 in).

2.3.1. Encourage management of existing impoundments on public and private lands. Most of the management required to enhance use of artificial impoundments by storks is within the framework of normal waterfowl management practices for brackish and saline marsh impoundments. Use the combined expertise of wildlife and fisheries biologists to provide optimum habitat. State and Federal agencies should work with private landowners in an effort to incorporate wood stork feeding habitat into current management practices. Coordinated efforts should also be used to seize opportunities to provide enhanced feeding areas through the mitigation process.

2.3.2. Determine optimal drawdown time. The optimal time for drawdown of potential feeding areas is unknown. With limited acreage devoted to providing feeding areas for wood storks, land managers would like to provide additional feeding opportunities when they could have the greatest benefit to the recovery of this species. In some years the best time for drawdown may be apparent due to degradation of natural feeding areas by flooding or other natural or man-made events. Additional study is needed to determine the more critical times to provide additional food resources. Ideally a coordinated effort over a large geographic area, extending from breeding season through migration to wintering grounds, would provide the greatest benefit to the wood storks.

3. Conduct applied research necessary to accomplish recovery goals. Recovery efforts for the wood stork would be more effective with a complete understanding of population biology, movement patterns of U.S. and neighboring populations of storks, foraging ecology and behavior, the importance of roost sites, and the possible impacts of contaminants.

3.1. Determine movement patterns of U.S. and neighboring populations of storks. Movement patterns of wood storks are poorly known.

3.1.1 Determine movement patterns for fledglings and other subadult storks. Determining these patterns for fledglings and other sub-adult storks would provide needed information concerning their behavior, habitat utilization, and potential threats to their survival.

3.1.2. Determine movement patterns of post breeding adults. Movement patterns of post-breeding adults should also be examined as they will provide information concerning the important habitat characteristics of where these birds winter and their possible condition when they return to breed (Did they winter in an area where heavy rainfall may have limited food availability, resulting in poor breeding condition?).

3.1.3. Determine origins of non-breeding populations. Wood storks are regularly seen in the lower Mississippi valley and the southwest region of the U.S. The origins of these non-breeding populations should be determined to clarify if they are storks from Mexico wintering in the U.S. and if so, do they mix with U.S. populations?

3.2. Determine population genetics. Studies of the population genetics of the U.S. stork population can provide answers concerning the interrelatedness of stork colonies. Such information will help document regional population movements and shifts, and determine if increases in northern populations are the result of increased productivity in that region, increased immigration from southern populations, or both. Better knowledge of the genetic interrelatedness of the southeastern stork population will assist in answering management questions such as:

a. Should coastal colonies be managed differently than inland colonies?

b. What are the important source colonies for new colonies?

c. What becomes of colonies/populations/storks that fail to breed one year and where do they go when and if they breed?

d. What are important (i.e., genetically unique or diverse) colonies for protection/acquisition?

3.3. Monitor productivity of stork populations. There is a need to systematically determine reproductive success (# fledged young/nest and #fledged young/successful nest) within a majority of the colonies in the same year(s) to better estimate productivity of the breeding population and to determine when (or if) the population meets criteria for downlisting or delisting.

3.4. Monitor survivorship of stork populations. This parameter is one of the least understood, and research on this topic may provide more new insights into population dynamics than any other effort. We need to determine survivorship of fledged young to adulthood to better gauge what amount of productivity is required to maintain or increase regional population size. This could be accomplished through either a massive, multi-year leg banding (or wing tagging) effort in multiple colonies, radio-instrumenting a certain number of birds, or possibly by surveys during the non-breeding season to determine the adult:sub-adult ratio.

3.5 Determine extent of competition/cooperation between wood storks and other wading birds in mixed nesting colonies. Many storks nest in established wading bird colonies. More information is needed on the benefits/drawbacks of storks nesting in mixed colonies.

3.6. Determine foraging ecology and behavior. Foraging ecology of wood storks has only been well-studied in the Everglades (in the 1970's) and for the Birdsville Colony in east-central Georgia.

3.6.1 Reevaluate foraging studies in ENP. Foraging studies on storks in ENP were done in the 1970's. This issue should again be addressed since restoration of this area is vital to the overall recovery of this species, is important as a wintering area for northern birds, and has recently been documented to have contaminant problems (mercury) (Sundlof et al. 1994).

3.6.2. Study foraging ecology along the coast. Over half of the U.S. population now breeds in the coastal zone of Georgia, South Carolina, and central and northern Florida. The foraging ecology of storks in these areas should be studied.

3.6.3. Determine foraging requirements during the non-breeding season. Research concerning the foraging ecology of this species should also examine foraging requirements during the wintering or non-breeding period. In some years, the inland marshes of the Everglades have supported the majority of the U.S. population of wood storks. Bancroft et al. (1992) reported that during non-breeding seasons in 1985-1989, up to 55% of the entire U.S. population may have relied on the Water Conservation Areas, which comprise only a portion of the Everglades system, to meet their foraging requirements. Understanding processes that determine whether storks in the non-breeding season are concentrated on a small area of habitat or dispersed throughout their entire winter range, will provide management flexibility and decrease the likelihood of negative impacts to a large proportion of the population during a single season.

3.6.4. <u>Continue studies on nocturnal foraging activities.</u> Preliminary studies by Bryan (1995) indicate that storks are active night-time feeders. The prevalence of nocturnal foraging activity by this species needs to be studied both seasonally and geographically. This is important in a regulatory sense in that foraging areas may need to be protected from human disturbance "around the clock."

3.6.5. <u>Determine impacts of artificial feeding areas on nest success, production and survival of newly fledged birds.</u> A coordinated effort among wildlife and fisheries biologists is needed to determine optimum stocking densities, species to stock, need for supplemental stocking, time of drawdown, and the impacts to wood stork recovery.

3.7. <u>Determine the importance of roost sites.</u> Recent surveys of the Georgia and South Carolina coasts documented the presence of a large number of stork roost sites, but only a limited number of roosts were inhabited repeatedly by numerous storks. Research concerning the function and use of such sites/habitats, which may be limited or threatened, is needed. These studies could also assess foraging habitats utilized from these sites, thus providing important information during the wintering period.

3.8. <u>Determine the impacts of contaminants on stork populations.</u> Potential impacts from contaminants need to be reconsidered in light of recent findings concerning the amount of mercury present in the Everglades ecosystem and the discovery of severe impacts of DDT/DDE based estrogen-mimicking compounds on wildlife in a large Florida wetland (Guillette et al. 1994, Sundloff et al. 1994).

3.8.1. <u>Conduct mercury studies in South Florida.</u> Studies should be conducted in the South Florida ecosystem to document effects of mercury on wood storks or suitable surrogate species.

3.8.2. <u>Conduct contaminant studies throughout the region.</u> Develop baseline contaminant information from a variety of colony sites throughout the region to determine if further studies are needed.

4. <u>Increase public awareness.</u>

4.1. <u>Increase awareness and appreciation through educational materials.</u> Wood storks utilize a wide variety of wetland habitats. Additionally, they are visually unique and generate interest from the general public. These factors make the wood stork an excellent choice for the subject of environmental education materials and programs.

4.1.1. <u>Develop and distribute educational materials.</u> Currently, there are several brochures, videos, and educational packets available that focus on wood storks. This information needs to be kept up to date. New educational material should be developed to increase the awareness of a larger audience.

4.1.1.1. <u>Develop information for private landowners.</u> As recommended in task 1.3.2., provide material to private landowners that explains wood stork ecology and suggests management practices that would benefit wood stork habitat.

4.1.1.2. Develop educational material for schools. Since wood storks occur in Florida, Georgia, and South Carolina, it would be cost effective to develop educational materials that could be used in schools in all three States.

4.1.1.3. Develop material for policy makers and elected officials. The wood stork should be included as part of a larger effort to inform and educate policymakers and elected officials of the importance of maintaining and protecting wetland habitats.

4.2. Provide opportunities for the public to view wood storks in captivity. Maintaining wood storks in captivity should be for the sole purpose of public education, awareness, and research to enhance survival of the species. Currently, there are nearly two dozen American wood storks in captivity in North American zoos and related facilities.

4.2.1. Maintain captive populations for the purpose of education, awareness, and research. The Service's draft policy on controlled propagation (U.S. Fish and Wildlife Service and National Marine Fisheries Service 1996) sanctions captive propagation of listed species when recommended in an approved recovery plan and supported by an approved genetics management plan. Captive propagation of wood storks is not considered necessary for the purpose of supplementing wild populations through reintroduction programs. Captive breeding and rearing efforts will not be made for this purpose. However, good captive management of wood storks may result in reproduction. The resulting progeny may be used to supplement other captive populations under specific approval of the Service. If available space within captive facilities becomes saturated, further production of offspring should be prevented within the scope of laws governing captive endangered wildlife.

4.2.2. Develop policy on rescue, rehabilitation and release of injured wood storks. The Service, in conjunction with the American Zoological Association, should develop policy for dealing with wood storks that are rescued from the wild. Adult wood storks are not as frequently received by licensed wildlife rehabilitators as other wetland bird species. Opportunities for rescue may most likely occur when field personnel are in the colonies and witness distress. This may be as a result of nest abandonment when food sources become scarce or when chicks fall out of the nest for reasons such as adult bird interactions or wind storms. Where possible, field personnel should return downed chicks to the nest. When replacement is not viable, the usual protocols for triage and rehabilitation should be followed in placement with a licensed wildlife rehabilitator.

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PART III. IMPLEMENTATION SCHEDULE

The following Implementation Schedule lists and ranks tasks and estimates costs for the recovery program of the U.S. population of wood storks over the next 3 years. This schedule will be reviewed annually until the recovery objective is met, and priorities and tasks will be subject to revision.

Key to Implementation Schedule Column 1

Task priorities are set according to the following standards:

Priority 1 - An action that must be taken to prevent extinction or to prevent the species from declining irreversibly in the forseeable future.

Priority 2 - An action that must be taken to prevent a significant decline in species population/habitat quality or some other significant negative impact short of extinction.

Priority 3 - All other actions necessary to provide for full recovery of the species.

Key to Agency Designations in Column 5

USFWS - U.S. Fish and Wildlife Service
- ES - Ecological Services
- FSH - Division of Fisheries
- DEC- Division of Environmental Contaminants
- Ref. - Division of Refuges and Wildlife
- LA - Division of Realty (Land Acquisition)
- LE - Division of Law Enforcement
- PA - Division of Public Affairs

FGFC - Florida Game and Fresh Water Fish Commission
GADNR - Georgia Department of Natural Resources
SCDNR - South Carolina Department of Natural Resources
SREL - Savannah River Ecology Laboratory
TNC - The Nature Conservancy
TGC - The Georgia Conservancy
ACOE - Army Corps of Engineers
FDEP - Florida Department of Environmental Protection
EVER - Everglades National Park, National Park Service
BICY - Big Cypress National Preserve
NAS - National Audubon Society
AZA - American Zoological Association

IMPLEMENTATION SCHEDULE

Recovery Task Priority	Task Number	Task Description	Task Duration	Responsible Party		Cost (thousands)			Comments
				FWS	OTHER	FY1	FY2	FY3	
1	1.1.1	Locate nesting habitat.	5 YR	ES	FGFC, GADNR, SCDNR, SREL	15	15	15	5K/state/year. Begin new 5yr cycle in yr 2001.
1	1.1.2.	Locate roosting and foraging habitat.	2-3 YR	ES	" "	10	10	10	See Bryan 1995.
1	1.3.1.	Inform landowners.	Continuous	ES	All parties	Staff Time			
1	1.5.	Protect sites from disturbance.	Continuous	ES	FGFC, GADNR., SCDNR	Staff Time			
1	1.6.	Use existing regulatory mechanisms to protect habitat.	Continuous	ES	FGFC, GADNR, SCDNR, FDEP, ACOE,	Staff Time			
1	3.3.	Monitor productivity of stork populations.	Once every 5 YR	ES	" "	30			10K per state
2	1.2.	Prioritize habitat.	1 YR	ES	All parties	Staff Time			
2	1.3.2.	Provide assistance and support to landowners in managing property.	Continuous	ES FSH	FGFC, GADNR, SCDNR, TGC	?	?	?	Cannot determine specific costs at this time. Assistance would be on a site by site basis.
2	1.3.3.	Develop management plans for private lands.	Continuous	ES REF FSH	FGFC, GADNR, SCDNR	Staff Time			

Recovery Task Priority	Task Number	Task Description	Task Duration	Responsible Party		Cost (thousands)			Comments
				FWS	OTHER	FY1	FY2	FY3	
2	1.4.	Acquire land.	Continuous	LA REF	FGFC, GADNR, SCWMR, TNC	?	?	?	Cannot determine specific costs at this time. Need to complete task 1.2. first.
2	2.1.1.	Analize report on S. FL restoration.	1 YR	ES	ENP	10	10		Initiated
2	2.1.2.	Develop models of colony dynamics in S. FL wetlands.	1 YR	ES	ENP	25	25		On-going. Funding will allow completion and evaluation of model.
2	2.1.3.	Provide feedback for adaptive restoration planning.	1 YR	ES	ENP				Part of the long-term restoration planning
2	2.1.4.	Organize systematic census in Big Cypress Region.	5 YR	ES	NAS BICY	20	20	20	Should occur in all years of statewide census.
2	2.2.1.	Improve colony success/productivity by impounding suitable sites.	Continuous	ES	All parties				Costs must be calculated on a site by site basis.
2	2.1.1.	Determine structural and vegetative characteristics of impounded sites.	2 YR	ES	FGFC GADNR SCDNR SREL	20	20		
2	2.1.2.	Conduct long-term monitoring.	10 YR	ES	" "	15	15	15	
2	2.3.1.	Encourage impoundment management on public and private lands.	Continuous	ES REF FSH	FGFC GADNR SCDNR				Costs incorporated into existing waterfowl impoundment management
2	3.1.1.	Determine movement patterns of fledglings and sub-adults.	4 YR	ES	" "	35	35	35	
2	3.1.2.	Determine movement patterns of post-breeding adults.	4 YR	ES	" "				Combine with task 3.1.1.

Recovery Task Priority	Task Number	Task Description	Task Duration	Responsible Party		Cost (thousands)			Comments
				FWS	OTHER	FY1	FY2	FY3	
2	3.2.	Determine population genetics.	2 YR	ES	" "				Ongoing
2	3.4.	Monitor survivorship.	Once every 5 YR	ES	" "	?	?	?	Costs depend upon method used for study.
2	3.5.	Determine extent of competition/cooperation between storks and other wading birds.	2 YR	ES	FGFC, GADNR, SCDNR, SREL	15	15	15	
2	3.6.2.	Study foraging ecology along the coast.	2 YR	ES	FGFC, GADNR, SCDNR, SREL	30	30	30	
2	3.6.4.	Continue studies of nocturnal foraging activities..	2 YR	ES	" "	20	20	20	Ongoing
2	3.7.	Determine importance of roost sites.	2 YR	ES	" "				Could be combined with several other tasks
2	3.8.	Determine impacts of contaminants.	2 YR	ES, DEC	" "	100			
3	2.2.3	Use artificial nest structures to attract storks to suitable habitat.	Continuous	ES REF	FGFC, GADNR, SCDNR				Average cost per structure is $500.
3	2.3.2.	Determine optimal drawdown time of impoundments.	3 YR	ES REF FSH	" "	20	20	20	
3	3.1.3.	Determine origins of non-breeding populations.	4 YR	ES	" "				
3	3.6.1.	Re-evaluate foraging studies in ENP.	1 YR	ES	EVER	75	75	75	Ongoing

Recovery Task Priority	Task Number	Task Description	Task Duration	Responsible Party		Cost (thousands)			Comments
				FWS	OTHER	FY1	FY2	FY3	
3	3.6.3.	Determine foraging requirements in non-breeding season.	2 YR	ES	" "				Combine with task 3.5.2.
3	3.6.5.	Determine impacts of artificial feeding areas.	2 YR	ES REF FSH	GADNR SCDNR SREL	20	20	20	
3	4.1.1.	Develop and distribute educational materials.	Continuous	ES, PA	FGFC, GADNR, SCDNR,	10	10	10	Complete task 4.1.1.1. in FY1, 4.1.1.2. in FY2 and 4.1.1.3. in FY3
3	4.2.	Provide opportunities for the public to view wood storks in captivity.	Continuous	ES, LE	AZA				

List of Reviewers

Names in **bold type** denote those agencies/individuals who provided written comments on the draft revision of this plan.

Dr. Robert Baker
Director Natural Science Research Laboratory
Department of Biological Science
Texas Tech University
Box 43131
Lubbock, TX 79409

Mr. Dan Botts
Florida Fruit and Vegetable Association
P.O. Box 20155
4401 E. Colonial Drive
Orlando, FL 32814

Ms. Sherry Branch
Sea World
7007 Sea World Drive
Orlando, FL

Dr. I. Lehr Brisbin
Savannah River Ecology Laboratory
P.O. Drawer E
Aiken, SC 29802

Dr. Joan Browder
National Marine Fisheries Service
75 Virginia Beach Drive
Miami, FL 33149

Mr. A. Lawrence Bryan
Savannah River Ecology Lab
Drawer E
Aiken, SC 29802

Mr. Thomas D. Bryce
Fish and Wildlife Branch
DEH. ATTN: AFZP-DEN-W
Ft. Stewart, GA 31314-5000

Mr. Carl Burch
Miami Metrozoo
12400 SW 152 Street
Miami, FL 33177

Mr. Steve Calver
U.S. Army Corps of Engineers
Savannah District
P.O. Box 889
Savannah, GA 31402

Mr. Dan Connelly
National Audubon Society
4542 Silver Bluff Road
Jackson, SC 29831

Dr. Malcolm Coulter
SIS
P.O. Box 48
Chocorua, NH 03817

Mr. John Crawford
UGA Marine Extension Service
P.O. Box 13687
Savannah, GA 31406

Mr. Doug Dallas
GA Dept. of Transportation
3993 Aviation Circle
Atlanta, GA 30336

Executive Director
The Nature Conservancy
2699 Lee Road, Suite 500
Winter Park, FL 32789

Ms. Lori Duncan
U.S. Fish and Wildlife Service
P.O. Box 12559
Charleston, SC 29412

Mr. Rick Eager
U.S. Fish & Wildlife Service
P.O. Box 69
Wadmalaw Island, SC 29487

Mr. John Fowler
Chehaw Wild Animal Park
105 Chehaw Park Road
Albany, GA 31701

Dr. Marion H. Fuller
Chief, Bureau Of Pesticides
Florida Department of Agriculture and
Consumer Services
Rm. 170, Conner Building
3125 Conner Boulevard
Tallahassee, FL 32399-1650

Dr. Dale E. Gawlik (for Dr. Tom Fontaine)
South Florida Water Management District
P.O. Box 24680
West Palm Beach, FL 33416-24680

Mr. John Godbee
Union Camp Corporation
P.O. Box 1391
Savannah, GA 31402

Mr. Williams Ralph Graham
Sea Island
P.O. Box 30051
Sea Island, GA 31561

Mr. Mike Harris
GA Dept. of Natural Resources
Nongame Species
1 Conservation Way
Brunswick, GA 31523

Ms. Deborah Harris
U.S. Fish and Wildlife Service
Federal Building, Rm. 334
801 Gloucester Street
Brunswick, GA 31520

Mr. Royce Hayes
St. Catherine's Island
Route 1, Box 207-Z
Midway, GA 31320

Refuge Manager
Merritt Island National Wildlife Refuge
U.S. Fish and Wildlife Service
P.O. Box 81
Oak Hill, FL 32759

Mr. Kevin McIntyre
Little St. Simons Island
P.O. Box 1078
St. Simons Island, GA 31522

Ms. Emmy Minor
Rt. 3 Box 3261
Townsend, GA 31331

Mr. Tom Murphy
South Carolina Department of Natural
Resources
Star Route 2, Box 167
Green Pond, SC 29446

Mr. John Ogden
South Florida Water Management District
Florida International University
Bldg. OE, Room 148, University Park
Miami, FL 33199

Mr. Jim Ozier
Georgia Department of Natural Resources
Non-game Species Program
Route 5, Box 180
Forsyth, GA 31029

Ms. Barbara K. Passmore
900 Pineridge Dr.
Valdosta, GA 31558

Colonel Terry L. Rice
District Engineer
Jacksonville District
U.S. Army Corps of Engineers
P.O. Box 4970
Jacksonville, FL 32232

Mr. John Robinette
U.S. Fish and Wildlife Service
Savannah Coastal Refuges
1000 Business Center Drive
Parkway Business Center, Suite 10
Savannah, GA 31405

Mr. Mark Robson
Florida Game and Fresh Water Fish Commission
551 North Military Trail
West Palm Beach, FL 33415

Dr. Jim Rodgers
Florida Game and Fresh Water Fish Commission
4005 S. Main Street
Gainesville, FL 32601

Dr. Peter Rosendahl
Flo-Sun, Inc.
316 Royal Poinciana Plaza
Palm Beach, FL 33480

Corkscrew Swamp Sanctuary
Route 6, Box 1875-A
Naples, Florida 33964

Mr. Jim Schmidt
Union Camp-Satilla Forest
Route 11 Box 938
Brunswick, GA 31520

Ms. Becky Shortland
The Georgia Conservancy
711 Sandtown Road
Savannah, GA 31410

Florida Audubon Society
The Greater Mall
460 Highway 436, Suite 200
Casselberry, FL 32707

National Audubon Society
Everglades Office
160 N.W. 176th St., #202
Miami, FL 33169

Dr. Beth Stevens
Zoo Atlanta
800 Cherokee Ave. SE
Atlanta, GA 30315

Mr. Jonathan Streich
The Nature Conservancy
1401 Peachtree St., NE
Suite 236
Atlanta, GA 30309

Ms. Lisa Suatoni
Natural Resources Defense Council
40 West 20th Street
New York, NY 10011

Mr. Buck Thackery
Big Cypress National Preserve
Star Route Box 110
Ochopee, FL 33941

Ms. Jane Tutton
U.S. Fish and Wildlife Service
South Florida Ecosystem Office
P.O. Box 2676
Vero Beach, FL 32961

Ms. Lisa Westberry
GA Dept. of Transportation
3993 Aviation Circle
Atlanta, GA 30336

Dr. J. Ross Wilcox
Chief Ecologist, Environmental Affairs
Florida Power and Light Corporation
P.O. Box 088801
11770 U.S. Highway 1
North Palm Beach, FL 33408-8801

Mr. Don Wood
Florida Game and Freshwater Fish
Commission
620 South Meridian Street
Tallahassee, FL 32301

Mr. Darian Yawn
Union Camp-Sapelo Forest
Route 2, Box 2056
Townsend, GA 31331

APPENDIX A
RESULTS FROM REGIONAL SURVEY
(1991 - 1995)

YEAR	STATE	COUNTY	NAME	NUMBER
1991	FL	ALACHUA	RIVER STYX	40
1991	FL	BREVARD	GRANT FARM ISLAND	60
1991	FL	BREVARD	BLUEBILL	4
1991	FL	BREVARD	HALL ISLAND	1
1991	FL	BREVARD	HAULOVER	0
1991	FL	BREVARD	SW LAKE WASHINGTON	60
1991	FL	BREVARD	US192	12
1991	FL	CHARLOTTE	MORGANTOWN	60
1991	FL	COLLIER	CORKSCREW SWAMP	300
1991	FL	COLUMBIA	FALLING CREEK	80
1991	FL	COLUMBIA	OLENO	42
1991	FL	DUVAL	CEDAR POINT ROAD	9
1991	FL	DUVAL	DEE DOT RANCH	250
1991	FL	HARDEE	EL CLAIRE RANCH	400
1991	FL	INDIAN RIVER	PELICAN ISLAND	110
1991	FL	LAKE	LAKE YALE	40
1991	FL	LEON	CHAIRES	225
1991	FL	LEON	OCHLOCKNEE RIVER	160
1991	FL	MONROE	CUTHBERT, ENP	150
1991	FL	NASSAU	NASSAUVILLE	5
1991	FL	PALM BEACH	LOXAHATCHEE 1	4
1991	FL	PALM BEACH	LOXAHATCHEE 2	30
1991	FL	POLK	LAKE ROSALIE	20

YEAR	STATE	COUNTY	NAME	NUMBER
1991	FL	SARASOTA	NORTH PORT CHARLOTTE	75
1991	FL	ST LUCIE	WESCOTT GROVE RESERVOIR	40
1991	FL	ST LUCIE	CYPRESS CREEK	150
1991	**FL**	**TOTAL NUMBER OF NESTS**		**2467**
1991	GA	BROOKS	BLACK WATER	361
1991	GA	CAMDEN	BLACK HAMMOCK	150
1991	GA	CAMDEN	CUMBERLAND ISLAND	40
1991	GA	GLYNN	LITTLE ST. SIMONS	21
1991	GA	GLYNN	HERRINGTON POND	22
1991	GA	JENKINS	BIG DUKES POND	272
1991	GA	MCINTOSH	HARRIS NECK	52
1991	GA	MCINTOSH	BLACKBEARD ISLAND	36
1991	**GA**	**TOTAL NUMBER OF NESTS**		**942**
1991	SC	COLLETON	JACKSONBORO	242
1991	SC	COLLETON	WHITE HALL II	259
1991	SC	HAMPTON	YEMASSEE I	163
1991	**SC**	**TOTAL NUMBER OF NESTS**		**664**
1991	**REGIONAL TOTAL**			**4073**
1992	FL	COLLIER	CORKSCREW SWAMP	1800
1992	FL	DADE	L-28 CROSSOVER	158
1992	FL	DADE	TAMIAMI TRAIL WEST	123
1992	FL	DADE	TAMIAMI TRAIL EAST	130
1992	FL	MONROE	ROOKERY BRANCH, ENP	9
1992	FL	MONROE	CUTHBERT,ENP	275

YEAR	STATE	COUNTY	NAME	NUMBER
1992	FL	MONROE	RODGERS RIVER BAY, ENP	22
1992	FL	MONROE	LANE RIVER, ENP	1
1992	**FL**	***No data collected for central and north Florida**		**2518***
1992	GA	BROOKS	BARWICK	55
1992	GA	BROOKS	BLACK WATER	434
1992	GA	CAMDEN	BRAILEY SWAMP	50
1992	GA	GLYNN	HERINGTON POND	18
1992	GA	JENKINS	BIG DUKES POND	245
1992	GA	LIBERTY	SUNBURY	20
1992	GA	MCINTOSH	BLACKBEARD ISLAND	55
1992	GA	MCINTOSH	HARRIS NECK	150
1992	GA	THOMAS	HEARD'S POND	64
1992	**GA**	**TOTAL NUMBER OF NESTS**		**1091**
1992	SC	COLLETON	JACKSONBORO	37
1992	SC	COLLETON	WHITE HALL II	307
1992	SC	HAMPTON	YEMASSEE I	131
1992	**SC**	**TOTAL NUMBER OF NESTS**		**475**
1992	**REGIONAL TOTAL (no data for central & north FL)**			**4084***
1993	FL	ALACHUA	RIVER STYX	55
1993	FL	BREVARD	612127	110
1993	FL	BREVARD	US192	60
1993	FL	BREVARD	GRANT FARM ISLAND	150
1993	FL	BREVARD	SW LAKE WASHINGTON	185
1993	FL	COLLIER	CORKSCREW SWAMP	426
1993	FL	COLUMBIA	FALLING CREEK	150

YEAR	STATE	COUNTY	NAME	NUMBER
1993	FL	DADE	PAUROTIS POND, ENP	25
1993	FL	DADE	EAST RIVER, ENP	15
1993	FL	DUVAL	CEDAR POINT ROAD	85
1993	FL	DUVAL	DEE DOT RANCH	260
1993	FL	HARDEE	EL CLAIRE RANCH	320
1993	FL	HERNANDO	WEEKI WACHEE	12
1993	FL	INDIAN RIVER	PELICAN ISLAND	225
1993	FL	LAKE	LAKE YALE	275
1993	FL	LEON	CHAIRES	230
1993	FL	LEON	OCHLOCKNEE RIVER	115
1993	FL	MANATEE	AYERS POINT	140
1993	FL	ORANGE	LAKE MARY JANE	100
1993	FL	PASCO	DEVIL'S CREEK	120
1993	FL	PASCO	LITTLE GATOR CREEK	60
1993	FL	POLK	616114	75
1993	FL	POLK	REEDY CREEK	230
1993	FL	POLK	LAKE ROSALIE	80
1993	FL	POLK	28048122	230
1993	FL	SARASOTA	NORTH PORT CHARLOTTE	520
1993	FL	ST LUCIE	CYPRESS CREEK	375
1993	FL	ST LUCIE	WESCOTT GROVE RESERVOIR	25
1993	FL	ST JOHNS	606109	170
1993	**FL**	**TOTAL NUMBER OF NESTS**		**4262**
1993	GA	BROOKS	BLACK WATER	511

YEAR	STATE	COUNTY	NAME	NUMBER
1993	GA	CAMDEN	CUMBERLAND ISLAND	25
1993	GA	CAMDEN	BRAILEY SWAMP	143
1993	GA	CAMDEN	BLACK HAMMOCK	120
1993	GA	GLYNN	ST. SIMONS	103
1993	GA	JENKINS	CHEW MILL POND	44
1993	GA	JENKINS	BIG DUKES POND	330
1993	GA	LIBERTY	ST. CATHERINES	6
1993	GA	MCINTOSH	HARRIS NECK	162
1993	GA	MCINTOSH	BLACKBEARD ISLAND	90
1993	GA	THOMAS	HEARD'S POND	115
1993	**GA**	**TOTAL NUMBER OF NESTS**		**1649**
1993	SC	COLLETON	JACKSONBORO	229
1993	SC	COLLETON	WHITE HALL II	294
1993	SC	HAMPTON	YEMASSEE I	283
1993	**SC**	**TOTAL NUMBER OF NESTS**		**806**
1993	**REGIONAL TOTAL**			**6729**
1994	FL	ALACHUA	RIVER STYX	175
1994	FL	BREVARD	612127	140
1994	FL	BREVARD	SW LAKE WASHINGTON	105
1994	FL	BREVARD	GRANT FARM ISLAND	100
1994	FL	COLLIER	CORKSCREW SWAMP	450
1994	FL	COLUMBIA	FALLING CREEK	110
1994	FL	DUVAL	CEDAR POINT ROAD	30
1994	FL	DUVAL	DEE DOT RANCH	300
1994	FL	HARDEE	EL CLAIRE RANCH	240

YEAR	STATE	COUNTY	NAME	NUMBER
1994	FL	HERNANDO	WEEKI WACHEE	16
1994	FL	HILLSBOROUGH	611163	8
1994	FL	INDIAN RIVER	PELICAN ISLAND	110
1994	FL	LAKE	LAKE YALE	90
1994	FL	LEON	OCHLOCKNEE RIVER	95
1994	FL	LEON	CHAIRES	130
1994	FL	MONROE	RODGERS RIVER BAY, ENP	50
1994	FL	MONROE	PAUROTIS POND	110
1994	FL	ORANGE	LAKE MARY JANE	105
1994	FL	PASCO	LITTLE GATOR CREEK	9
1994	FL	PASCO	DEVIL'S CREEK	160
1994	FL	POLK	REEDY CREEK	230
1994	FL	POLK	LAKE ROSALIE	50
1994	FL	POLK	28048122	210
1994	FL	POLK	616114	130
1994	FL	SARASOTA	NORTH PORT CHARLOTTE	170
1994	FL	ST. LUCIE	CYPRESS CREEK	265
1994	**FL**	**TOTAL NUMBER OF NESTS**		**3588**
1994	GA	BROOKS	BLACKWATER	375
1994	GA	CAMDEN	BRAILEY SWAMP	92
1994	GA	CAMDEN	CUMBERLAND ISLAND	25
1994	GA	CAMDEN	BLACK HAMMOCK	30
1994	GA	CAMDEN	RAYLAND	25
1994	GA	GLYNN	ST. SIMONS	149

YEAR	STATE	COUNTY	NAME	NUMBER
1994	GA	JENKINS	BIG DUKES POND	230
1994	GA	JENKINS	CHEW MILL POND	65
1994	GA	LIBERTY	ST. CATHERINES	6
1994	GA	MCINTOSH	SLIVKA	30
1994	GA	MCINTOSH	BLACKBEARD ISLAND	76
1994	GA	MCINTOSH	HARRIS NECK	181
1994	GA	QUITMAN	BENTLEY	60
1994	GA	THOMAS	HEARD'S POND	124
1994	**GA**	**TOTAL NUMBER OF NESTS**		**1468**
1994	SC	BAMBERG	LEMON CREEK	2
1994	SC	CHARLESTON	WASHO RESERVE	78
1994	SC	CHARLESTON	TEA FARM	136
1994	SC	COLLETON	WHITE HALL II	372
1994	SC	COLLETON	JACKSONBORO	64
1994	SC	HAMPTON	YEMASSEE I	57
1994	SC	HAMPTON	BUCKFIELD	3
1994	**SC**	**TOTAL NUMBER OF NESTS**		**712**
1994	**REGIONAL TOTAL**			**5768**
1995	FL	ALACHUA	RIVER STYX	250
1995	FL	BREVARD	MICCO NORTH	36
1995	FL	BREVARD	US 192 EAST	25
1995	FL	BREVARD	SW LAKE WASHINGTON	300
1995	FL	BREVARD	612127	275
1995	FL	BREVARD	US 192 WEST	50
1995	FL	BREVARD	MICCO SOUTH	12

YEAR	STATE	COUNTY	NAME	NUMBER
1995	FL	BREVARD	VALKARIA	25
1995	FL	COLLIER	CORKSCREW	864
1995	FL	COLUMBIA	FALLING ROCK	110
1995	FL	DUVAL	CEDAR POINT ROAD	120
1995	FL	DUVAL	DEE DOT RANCH	325
1995	FL	HARDEE	EL CLAIR	415
1995	FL	HERNANDO	CROOM	175
1995	FL	HILLSBOROUGH	611163	115
1995	FL	INDIAN RIVER	PELICAN ISLAND	230
1995	FL	LAKE	LAKE YALE	65
1995	FL	LEON	OCHLOCKONEE	144
1995	FL	LEON	CHAIRES	179
1995	FL	MANATEE	AYERS POINT	33
1995	FL	MARTIN	SEWEL POINT	65
1995	FL	MONROE	PAUROTIS POND	105
1995	FL	ORANGE	LAKE MARY JANE	175
1995	FL	PALM BEACH	SWA CATCHMENT	27
1995	FL	PASCO	DEVIL'S CREEK	210
1995	FL	PASCO	LITTLE GATOR CREEK	200
1995	FL	POLK	616114	110
1995	FL	POLK	REEDY CREEK	190
1995	FL	POLK	LAKE ROSALIE	115
1995	FL	SARASOTA	NORTH PORT CHARLOTTE	500
1995	FL	ST. JOHNS	606109	60

YEAR	STATE	COUNTY	NAME	NUMBER
1995	FL	ST. LUCIE	WESCOTT GROVE RESERVOIR	8
1995	FL	ST. LUCIE	CYPRESS CREEK	10
1995	**FL**	**TOTAL NUMBER OF NESTS**		**5523**
1995	GA	BROOKS	BLACKWATER	310
1995	GA	BROOKS	BENTLEY	82
1995	GA	BROOKS	BARWICK	8
1995	GA	CAMDEN	BRAILEY SWAMP	40
1995	GA	CAMDEN	BLACK HAMMOCK	119
1995	GA	CHARLTON	LITTLE BUFFALO CREEK	1
1995	GA	GLYNN	ST. SIMONS	165
1995	GA	JENKINS	BIG DUKES POND	245
1995	GA	LIBERTY	ST. CATHERINES	8
1995	GA	LONG	MALCOLMS ROOKERY	21
1995	GA	MCINTOSH	HARRIS NECK	126
1995	GA	MCINTOSH	SLIVKA	50
1995	GA	MCINTOSH	BLACKBEARD ISLAND	60
1995	GA	SCREVEN	JACOBSONS LANDING	25
1995	GA	THOMAS	HEARD'S POND	146
1995	**GA**	**TOTAL NUMBER OF NESTS**		**1501**
1995	SC	CHARLESTON	WASHO RESERVE	101
1995	SC	CHARLESTON	TEA FARM	8
1995	SC	COLLETON	JACKSONBORO	120
1995	SC	COLLETON	WHITE HALL II	415
1995	SC	HAMPTON	YEMASSEE I	116
1995	SC	HAMPTON	BUCKFIELD	69

YEAR	STATE	COUNTY	NAME	NUMBER
1995	SC	TOTAL NUMBER OF NESTS		829
1995	REGIONAL TOTAL			7853