Florida's Wood Storks

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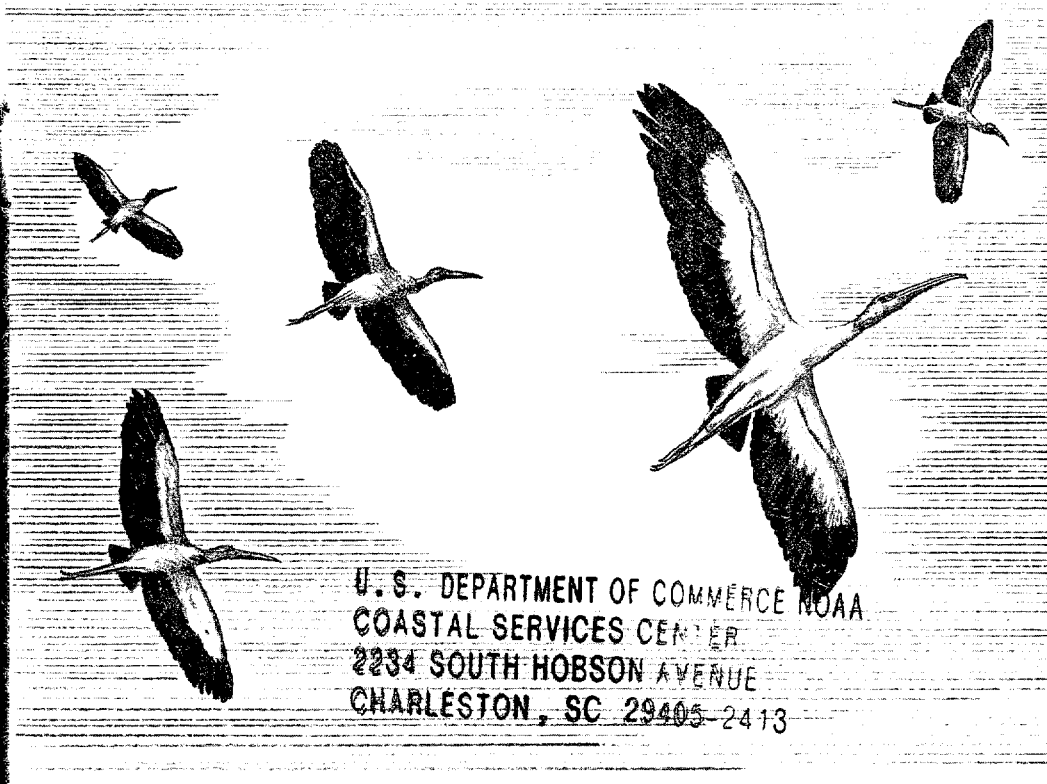
FLORIDA POWER & LIGHT COMPANY

Florida's Wood Storks



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Population Decline 1

The wood stork *(Mycteria americana)* is an impressive wading bird that can be easily recognized by its large size, stout curved bill and white plumage trimmed in black. Worldwide, there are 17 species of storks but only the wood stork is regularly found in the United States.

Until the last few decades, wood storks were a common sight in the wetlands of Florida, largely because they were spared by the plume hunters that decimated many of Florida's wading bird populations at the beginning of this century. Wood storks were considered unmarketable because they lack the elaborate breeding plumage that could be used for fashionable ladies' hats. In 1910, the plume trade was outlawed and wading bird populations rebounded. By the 1940's, wading bird populations seemed so stable that conservationists had stopped monitoring them[1]. However, although largely unnoticed at first, changes were taking place in the ecology of Florida that would disrupt the delicate relationship between wood storks and the natural cycle of the wetlands.

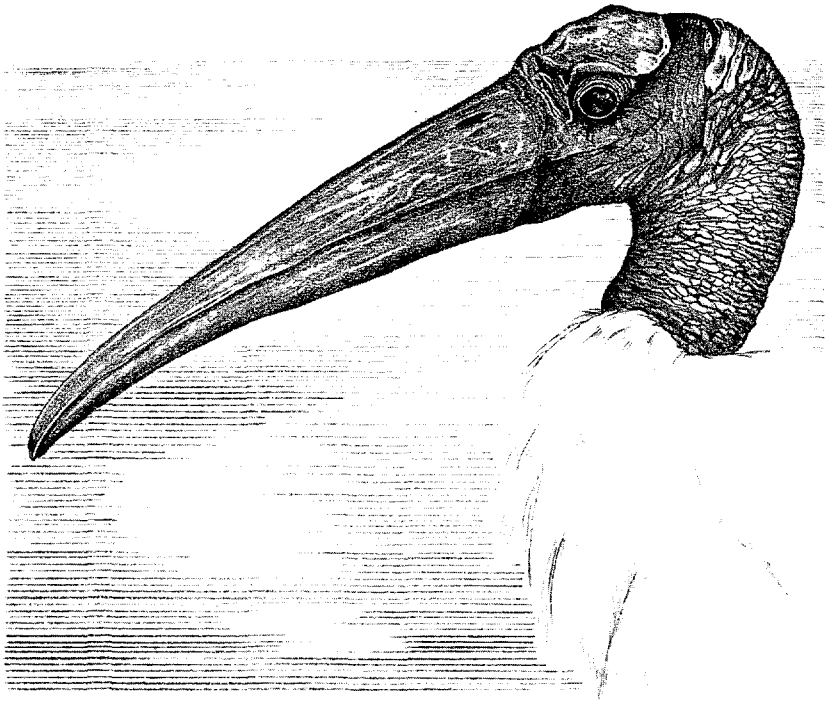
Although experts disagree on exact figures, the total number of wood storks in the United States in the 1930s is believed to have been about 60,000[2]; by 1960, only an estimated 11,000 pairs nested in Florida[1]. Today, according to estimates by the National Audubon Society, there are about 4,000 to 5,000 nesting pairs left in the United States[3]. If this trend continues, by the end of the century the wood stork will no longer nest in the United States. In response to this drastic decline, the federal government in March 1984 officially listed the wood stork as an endangered species[4].

The rapid decline of wood storks over the past decades has been caused by habitat disruption which has resulted in lowered reproduction. To understand how this has occurred we must examine the biology of the wood stork, the complex ecosystem on which it depends, and the effect of man's activities on this relationship.

Appearance

It would be difficult to mistake the wood stork for any other wading bird. Standing about 1 meter (3.3 feet) tall with

a wing spread of 1.5 meters (5 feet), the wood stork weighs about 2 to 3 kilograms (4 to 7 pounds). Males are usually slightly larger than females but otherwise the sexes are indistinguishable. The plumage is white except for the short black tail and the black feathers that border the wings. During the breeding season, adults develop patches of pale-pink feathers under the wings and the flesh-colored feet become bright pink. The feathered body contrasts sharply with the long, naked, dark legs and light-colored feet and, in the adult, the naked, dark grey, wrinkled head and upper neck. The skin on the unfeathered head is formed into small scale-like plates. The massive, long bill, which is stout at the base and curved slightly toward the body, is yellowish in the young and black in the adults. Because of the appearance of the head and upper neck, the wood stork is sometimes called "flinthead" or "ironhead." Other common names are wood ibis and gannet, although wood stork now is the accepted common name.



The head and neck of a mature wood stork is naked and the skin is formed into dark-grey scale-like plates. The massive bill is yellowish in the young and black in the adults.

In flight, the wood stork can be recognized by its size, contrasting white and black plumage, and its habit of flying with neck and legs extended. Wood storks walk on land by using a high-stepping gait, much as they do in water[5]. As each foot is lifted the toes are brought together and as the

Wood storks are about 1 meter (3.3 feet) tall and can be easily recognized by their contrasting white and black plumage, naked head and massive, long bill.

foot moves back down the toes spread. When taking off from the ground, wood storks take several running jumps but, when flying from a perch, they spring into the air in one motion.

Distribution

Wood storks are found in tropical and subtropical wetlands in regions characterized by seasonal fluctuations in rainfall and water levels. They nest from coastal South Carolina, southeast Georgia, Florida and Mexico south through Central and South America to northern Argentina[6]. Wood storks breeding in the United States are at the northern end of the species' range. Wood storks no longer breed in Texas, Louisiana, Mississippi and Alabama as they once did and most nesting in the United States now occurs in south and central Florida. The largest nesting colonies are found in the Big Cypress region of Lee, Hendry and Collier counties. The National Audubon Society's Corkscrew Swamp Sanctuary in this area supports the largest colony in the United States. Smaller numbers nest in the Everglades National Park in southern Monroe and Dade counties. Central and northern Florida, as well as sections of east central Florida, also support nesting colonies[7] and, just within the last few years, several new colonies have been noted in Georgia and coastal South Carolina. One of the Georgia colonies contains over 100 nesting pairs[8].

Wood storks are colonial birds that nest in large rookeries and feed in flocks. Early in this century, it was estimated that over 14,000 birds were nesting in a single colony[1] and in the middle 1930s, 20,000 wood storks nested in the Big Cypress region. Wood storks also nest in small colonies of only a few pairs. Sometimes, these smaller colonies are satellites of larger rookeries. Colonies are often located in large remote swamps but wood storks will also nest in small swamps near agricultural or residential areas[9].

In the summer and fall, after the nesting season, the storks that nest in the southeastern United States disperse west as far as Mobile Bay and up the Atlantic seaboard to North Carolina. Wood storks are often seen along the Texas and Louisiana coasts but these are birds that nest in Mexico. The southeastern United States and Mexican populations

do not interbreed so there is little chance that wood storks from Mexico or Central or South America could add to the population of storks in the United States[1].

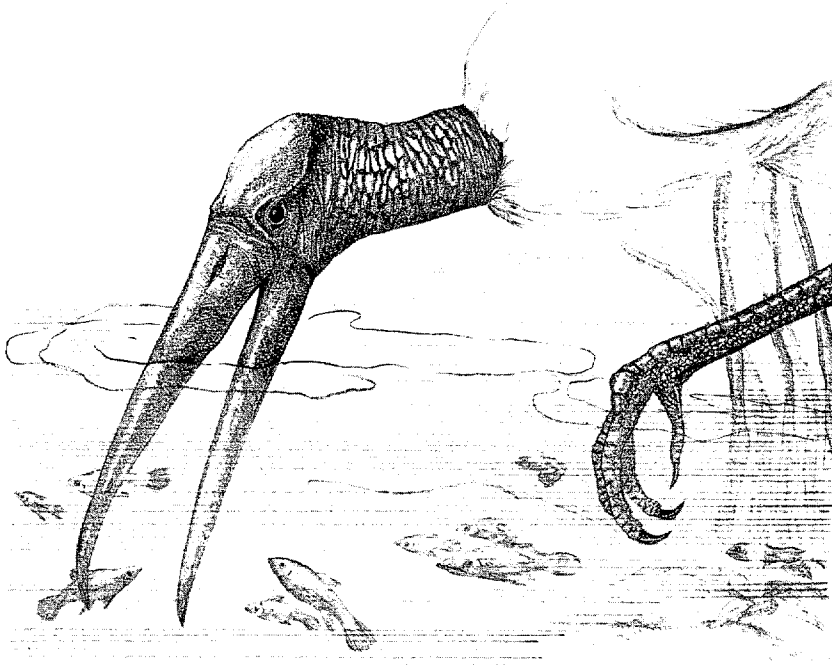
Feeding

An understanding of the feeding behavior of wood storks is central to realizing why the species is in decline in the United States[10]. Wood storks feed by wading in shallow water where they catch fish and occasionally catch crayfish, salamanders, tadpoles, frogs and insects. Baby alligators[11] and small snakes[12] are also occasionally caught but fish are by far the most important prey. The method used by wood storks to catch food differs from most other wading birds and is called "grope-feeding" or "tacto-location"[6] because vision is not used to locate or catch prey.

The wood stork feeds in water about 15-50 centimeters (6-20 inches) deep and often this water is muddy or filled with vegetation so that fish cannot be seen. Walking forward at about one or two steps per second, the stork avoids becom-

Wood storks are colonial birds that roost and nest together in the tops of trees. Early in this century, colonies of over 14,000 birds were reported; today the largest colonies number only in the hundreds.

ing entangled in weeds by flexing its toes as it lifts its foot and then extending the toes as the foot is placed in the water again. At the same time, the bill is submerged up to the breathing passages at the base of the bill and opened about 7 millimeters (3 inches). As the bird walks forward the bill is swept from side to side. If the vegetation is thick the bill may be lifted with each step; if not, it remains in the water. When a fish is touched, the bill snaps shut rapidly. The average response time of this reflex is about 25 milliseconds, making it one of the fastest reflexes known in vertebrates[13]. The force of this reflex, combined with the sharp edges of the bill, prevent prey from escaping. Once a fish has been caught, the stork raises its head and the prey is swallowed with a quick backward jerk of the head.



When a fish touches the partially opened bill of a feeding wood stork a response is triggered that snaps the bill shut. Foot-stirring is used to startle fish from out of the weeds. This feeding method is very efficient but requires a concentrated supply of fish. Seasonally drying ponds have traditionally provided this food source.

Wood storks often use a foot-stirring technique to improve feeding efficiency, particularly if vegetation is thick. Just before the foot is placed down, it is pumped up and down a few times to startle fish from out of the weeds and into the open bill. The turbulence created may also attract fish. As an added method of startling prey, one or both wings are sometimes opened and held over the water surface for a few seconds. Wing- flicking, as it is called, is not as widespread a behavior among storks as is foot-stirring.

Despite the apparent randomness of its feeding method, the wood stork is choosy about the size of its prey. Fish over 3.5 centimeters (about 1.5 inches) in length are usually taken and preferred fish include flag fish, sailfin mollies, marsh killifish, sunfishes[14] and, in some areas, gar[15]. Mosquitofish, although common, usually are not eaten as often as one would predict. This may be because mosquitofish feed at the surface and so are not as readily available or they may be too small to trigger the bill-snapping reflex[16]. Woodstorks are opportunistic feeders that will prey on any fish if they are the right size. Wood storks have been observed feeding on walking catfish in drying ditches in south Florida and on marine catfish being discharged from a dredge.

Five categories of wetlands have been identified as important wood stork feeding areas: cypress domes and strands, wet prairies, scrub cypress, freshwater marshes and sloughs, and sawgrass marshes[2]. Wood storks also feed in roadside ditches and shallow canals[13]. Marine and estuarine areas are used for feeding by birds nesting near the coast. During the breeding season, feeding areas must be within flying distance of the rookery.

Food Availability and Wetland Cycles

A non-visual method of feeding is clearly an advantage in a shallow, turbid, weed-choked marsh. The disadvantage, however, is that prey must be concentrated for this method to be effective enough to provide sufficient food, especially during the breeding season. Wood storks are big eaters and during the breeding season require huge amounts of food.

For instance, a captive wood stork ate over 650 small fish in 35 minutes[11]. It has been conservatively estimated that a pair of wood storks needs about 200 kilograms (440 pounds) of fish in one breeding season to feed themselves and to fledge their young[13]. The source of this food is seasonally drying wetlands.

Much of Florida's approximately 140,000 square kilometers (54,000 square miles) is low, flat land that floods during the rainy season, which normally occurs from June through September. During this period, Florida receives about half of its annual 127-152 centimeters (50 to 60 inches) of rain[13]. This water forms a vast sheet over thousands of acres and small changes in water depth result in large changes in water surface area. The fish that wood storks feed on are stimulated to reproduce and grow by the expanding habitat created by the wet season. During a normal year, the rains taper off by October and slowly the waters begin to recede. The fish that were once spread out over large areas begin to concentrate in ponds and sloughs. In the Big Cypress area, the sheet

One or both wings are sometimes flicked open while feeding to startle prey.

of water fragments into hundreds of disconnected, individual ponds that slowly shrink as the dry season progresses.

Foraging storks follow the dry-down that begins in upland ponds and continues to lowland ponds, wet prairies and coastal areas. Late in the season when upland ponds are dry, marshes, irrigation ditches, receding canals and ponds in the middle of sloughs may be available. Holes dug by alligators are another source of water and fish during the dry season[15,17]. In the Everglades, storks feed on fish concentrated along the drying edge of gently sloping marshes[18]. Near Corkscrew Swamp, fish densities of almost 8000 fish per square meter (6000/square yard) have been recorded in drying ponds[13].

Non-nesting birds also require concentrated food sources but, without the demands of young and the need to feed within flying distance of the nest, their food requirements are lower and they can roam freely throughout the state. When not breeding, many storks feed in coastal marshes where the receding tide concentrates fish in pools and sloughs.

Successful Breeding and Water Levels

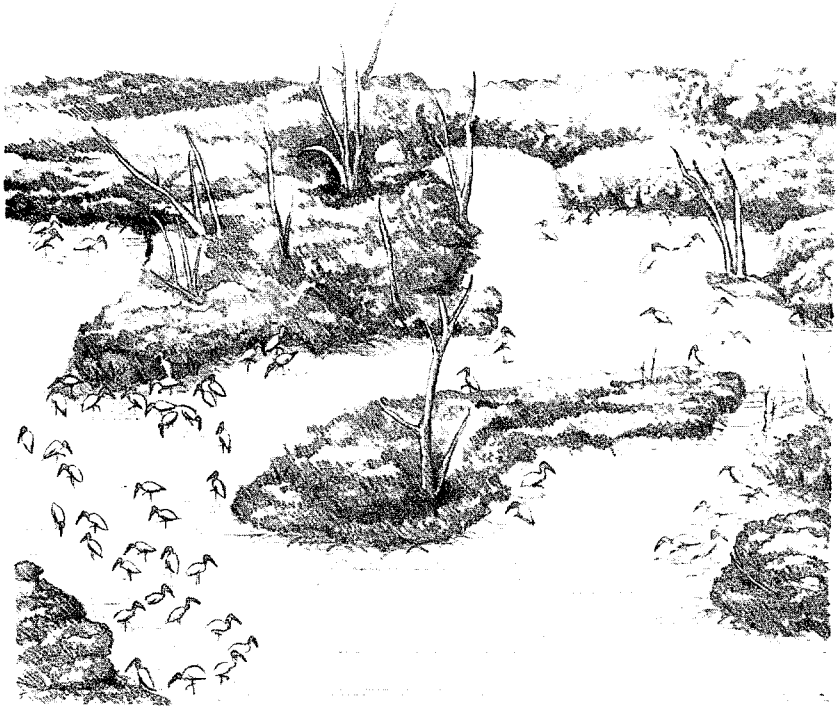
The breeding cycle of the wood stork is carefully synchronized with the cycle of the wetlands in order to ensure that the maximum food supply occurs while the young are being raised. For most birds that nest in the temperate zone, the breeding cycle is regulated primarily by day length but, in the tropics and subtropics, this does not hold true. In the case of the wood stork, complex factors including water levels and food availability seem to regulate the cycle. In Corkscrew Swamp, egg laying begins each year when the water has receded to a specific level, regardless of the date[13]. In the Everglades, it is the rate of water level decline that triggers breeding[18]. In central and northern Florida, the factors that cue reproduction are not as well known, but day length and temperature probably play a role.

Regardless of the cues used, to nest successfully the wood stork must time its reproductive cycle so that the highest fish densities occur when the food needs of the growing

young is highest. Also, the young must be fledged and on their own before the summer rains begin and disperse the fish. Widespread nesting failures can result from droughts in the wet season, heavy rains during the dry season, or inappropriate manipulation of water levels in association with water management programs. During the first two months of nesting, water level rises of 3 centimeters (1 to 2 inches) or more have been correlated with nest desertion in the Everglades National Park rookeries[18].

Nesting Cycle

Nests are built in the tops of trees in cypress or mangrove swamps. More recently, nests have been found in trees in artificial impoundments and even in exotic vegetation such as Brazilian pepper and Australian pine. Nesting also has



Wood storks rely on drying ponds as a source of concentrated food. The breeding cycle is carefully synchronized with the drying of the wetlands so that the maximum food supply occurs while the young are being raised. The widespread loss of wetlands has resulted in drastically reduced wood stork populations.

been seen in prickly pear cactus. In Corkscrew Swamp, nests are built in the tops of bald cypress trees 20 to 25 meters (65 to 80 feet) tall but, in other colonies, the trees are much shorter. As protection against terrestrial predators, storks will not nest unless they are on an island surrounded by water or in tall trees over water[19]. A rookery in a man-made impoundment was decimated when a dike broke and the water drained out, allowing access by raccoons[20].

Depending on water conditions and location, wood storks begin nesting as early as November or as late as May. Storks begin moving into the vicinity of the colony several weeks before nesting begins. Many birds gather in extreme southwest Florida prior to moving into some of the south Florida colonies[21]. In some years, no nesting is attempted or colonies are abandoned partway through the season. Generally, for nesting to be successful in south Florida, colonies must begin forming between November and January[18]. North of Lake Okeechobee, nesting usually does not begin until March and, in extreme north Florida and Georgia, nesting begins in April or May. Some late nestings may be renesting attempts following earlier failures.

It takes about 130 to 150 days to complete the reproductive cycle, so wood storks spend about a third of the year in breeding-related activities. Some large colonies may be active for 8 or 9 months out of the year if birds are in different stages of their cycle. The only period during which nesting activity is rare in Florida is September and October[13].

Courtship

Pair formation takes place in the colony and there is no evidence to suggest that wood storks mate for life as do some other stork species. The courtship ritual begins when the male wood stork occupies a likely nesting spot and aggressively challenges all trespassers[22]. As the two sexes look alike, about the only way a male can tell if an intruder is a potential mate is by its response. A rival male will extend his neck, grab at his opponent with his bill and then clatter his bill loudly a few times. The opposing birds move carefully so that the point is made without much bodily contact. If a female approaches, she edges forward slowly with her bill held open in a gape and usually with her body almost horizontal and her wings spread. Initially, the female is repelled

but, after repeated approaches, the male may respond by fiddling with nearby twigs, swaying his head, or rhythmically preening his feathers[23]. If the match seems agreeable to both parties, they raise their heads up and down with bills agape in the wood stork greeting.

Several males may roost temporarily on a nest site but, once a pair has claimed the site, the unsuccessful males will move on to another tree taking along the courting females. These groups of unpaired adults are a conspicuous feature of larger colonies at the beginning of the breeding season.

As pairs are formed in the colony there is much aggressive and sexual posturing, although this behavior is not as elaborate or ritualized as in some species of storks. Pair formation behavior serves to stimulate the birds for breeding and synchronize the colony[21]. Copulation takes place once a pair

During courtship, the male wood stork stakes out a potential nest site and challenges all trespassers. An interested female will approach with her bill held open in a gape and her wings spread. The male may respond by pretending to preen his feathers. If a rival male approaches, a noisy dispute will ensue.

has formed and may continue during nest building. During copulation, which lasts only about 15 seconds, the male clatters his bill rapidly while striking his bill roughly back and forth against the bill of the female[23]. The sound produced is very distinctive amid the din of the rookery.

After a pair is formed, nest construction is begun. The nest, which takes about three days to build, is constructed of sticks, vines, leaves and Spanish moss and lined with green leaves or sprigs of cypress. The male bird usually collects the materials and the female builds the nest.

Raising the Young

Two to five, usually three, cream-colored eggs about 68 millimeters (2.7 inches) in length are laid 1 to 2 days apart. Incubation begins as soon as the first one or two eggs are laid and takes 28 to 32 days. The eggs hatch several days apart in the order in which they were laid. As a result, nestlings differ in size in the first few weeks and competition for food is fierce. Younger birds usually get to feed only after the older ones are satiated. If food is scarce, the older chicks will consume most of the food and younger ones will die. In this way, at least one or two of the chicks have a chance to survive rather than all of them starving[13].

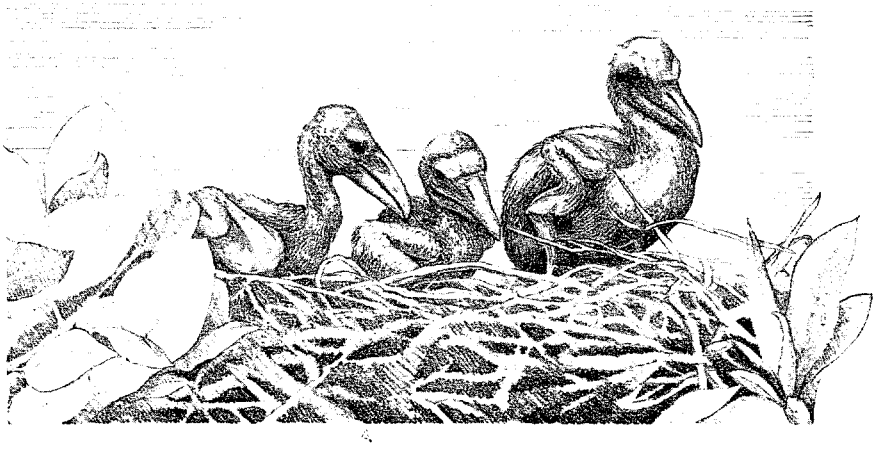
During incubation and the first three weeks of life, eggs and young birds are vulnerable to the weather and predators. Attacks from fish crows and unpaired or immature wood storks are frequent[24]. During this time, parents take turns flying to feeding grounds for food and guarding the nest. A returning parent often will bring a stick to add to the nest, and the waiting bird will greet its mate by rising, cocking its tail over its back and uttering a "fizzing" sound through its open bill[25]. Food is carried in the throat and regurgitated whole onto the floor of the nest. The young are born helpless but a well-developed digestive system allows them to consume enormous quantities of food. By two days old, young birds can visually locate and grab at food on the nest floor.

When first hatched, the young birds each weigh about 62 grams (2 ounces) and are covered with a sparse pale gray down that becomes thick and wooly by about the tenth day. The young are brooded for the first few days but, once they are covered with down, brooding occurs only during cooler

weather[11]. The young chicks beg by crouching in the nest with wings spread slightly and nodding their heads up and down while uttering a braying sound. The begging cry gets deeper and louder as the chicks grow older. Chicks will beg as long as a parent is near the nest even if they have been well fed. Week-old chicks are fed about 15 times a day. As the birds get older, the number of feedings decreases but the amount in each feeding increases.

Up to three weeks of age, nestlings will crouch in the bottom of the nest if anything approaches. By three or four weeks, nestlings are about half the size of the adults and can aggressively defend themselves against predators. Other birds in the colony often will join in repelling attacks. Rapid early growth means hard work for the parents but also assures that this vulnerable, helpless stage is as short as possible[24]. By eight weeks the young are vigorously exercising their wings and by nine weeks are ready to leave the nest. The young birds then spend another week or two taking short flights and returning to the nest to feed. At this stage they resemble an adult in size but the head is still feathered and the bill is yellow.

During the 60 to 65 days that a young wood stork is dependent on its parents, it may consume 16.5 kilograms (36 pounds) of food. More than half of this is consumed during



Weighing about 62 grams (2 ounces) when hatched, young wood storks are helpless and unable to fly. Before they leave the nest each chick can consume 16.5 kilograms (36 pounds) of food. The young are ready to leave the nest 60 to 65 days after hatching.

the middle third of the nesting period[24]. Thus, the greatest demand on parents is just before the young can be left alone because the chicks are growing rapidly and only one parent can forage for food at a time.

Fledglings and Immature Birds

Little is known about young birds after they have left the nest except that they follow the adults to summer feeding areas. Although young birds know instinctively how to feed, they may need experienced birds to show them where to feed. Young birds from a colony that was deserted just before the young were fledged were seen feeding in inappropriate places such as puddles in a tomato field[21]. Mortality rates are high in the first year, particularly if food is scarce or rains come too soon.

Immature storks retain their yellowish bills and feathered head and neck until at least their third summer and sexual maturity is reached at about four years. Nesting may be attempted during the fourth year but it is often not successful until the following year.

Long-Distance Flyers

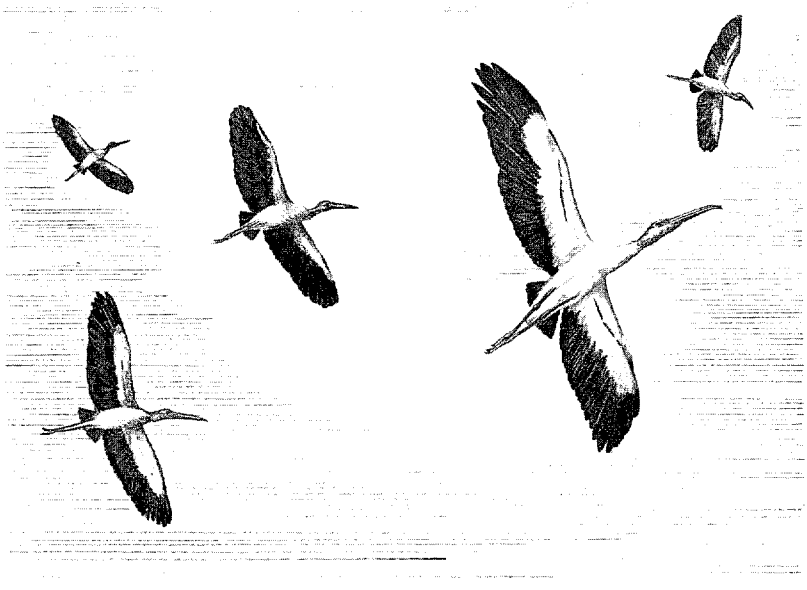
Because storks rely on concentrated food sources during the breeding season, they must find new feeding grounds as conditions change. Often this means traveling great distances in search of food. Wood storks have been observed feeding 130 kilometers (80 miles) from their colony[14]. In some areas it has been noted that storks foraged the greatest distance from the rookery at the beginning and end of the season and nearer the rookery in the middle of the season when food demand was highest[26].

To travel these distances, storks take advantage of vertical air currents, or thermals[27]. Flapping to an altitude of up to several hundred meters (1000 feet), a stork reaches a point where the rising air currents can support its weight, allowing the bird to spiral upward. Wood storks from Corkscrew Swamp were observed at an altitude of 1525 meters (5000 feet)[26]. At altitudes of 600 meters (2000 feet) or more, storks can glide for miles without flapping their wings. By using

air currents, wood storks save valuable energy but are limited to traveling from mid-morning to mid-afternoon when thermal currents are strongest. Often storks will remain in feeding areas overnight and return to the colony the next morning when thermal currents have formed again. Birds descending from high altitudes can perform amazing dives, rolls and turns.

Storks tend to leave the colony in groups and, once a stork has located a thermal current, others in the colony will join in spiraling upward and gliding in formation to feeding grounds. The size and conspicuous coloration of these birds make them easy to spot from the air and this may enable gliding storks to locate others that have found good feeding areas. Observations with decoys have shown that wood storks are attracted to wading birds on the ground. In this way, each individual bird need not expend its energy to locate thermals and suitable feeding areas.

Wood storks use a flapping flight to fly around the colony early or late in the day and for feeding flights on cloudy days



Wood storks can travel great distances in search of food by taking advantage of vertical air currents, or thermals. Once at high altitudes, wood storks glide for miles with head and legs outstretched.

or at night when thermals do not form. Flapping flights usually consist of about 8 to 12 wing beats alternated with short periods of gliding flight. Storks in flapping flight have been clocked up to 53 kilometers/hour (33 miles/hour).

Social Behavior

Young and old birds alike spend much of their time preening their feathers. Oil from the preen gland at the base of the tail is worked through the feathers by the head and bill. Wood storks commonly can be seen preening the feathers of the breast and neck with lateral strokes of the bill and females often preen the head and neck of their mates. Sometimes a bird will bend its head all the way back so that the top of the head rests on its back. By rotating its head from side to side the feathers on the back and the skin of the head are preened. Storks may spend hours perched in nesting trees or standing next to their mates on the nest. Spread-wing postures are common and may serve to dry the feathers, regulate body temperature, shade the eggs or young, provide balance and act as social displays[28].

Wood storks have several displays that are used in pair formation, courtship, and to express anxiety or aggression. Often the elements of these ritualized displays are variations of maintenance behavior such as wing-spreading or preening. The intensity of the displays reaches its peak during courtship and pair formation as the birds compete for nesting sites and mates.

Storks away from the nest usually ignore one another but, if a conflict develops, the aggressor will move toward the trespasser with the body horizontal and bill gaping. The birds may fight with their bills as if fencing until one of the birds concedes defeat and withdraws in an erect posture with the wings tightly folded. A stork will respond to the approach of a disturbing object such as a human by arching its neck forward and peering intently at the intruder. This behavior is quickly copied by nearby birds and may serve as a warning. One of the most common displays is an up and down movement that is used as a greeting at the nest or in feeding areas. The head is raised to near vertical, the bill is gaped and the head moves down and forward and from side to side. This is often accompanied by a hissing noise.

Controlling Body Temperature 18

High air temperatures can be a problem for wood storks because they nest in the open tops of trees in warm climates. Feathers are such an effective insulation that it is difficult for birds to dissipate heat from their bodies. Storks have several methods of dealing with this stress. Parents keep young birds cool by shading them from the sun and by carrying water in their throats back to the nest to dribble over the young. The nestlings swallow some of this water but most of it serves to cool the young birds as it evaporates from their heads and bodies. Wood storks also pant to dissipate heat through the lining of the bill and throat.

When temperatures are high, storks in a colony develop white chalky legs as a result of excreting frequently. Laboratory experiments have shown that this is a temperature-regulating mechanism and that wood storks can excrete on their legs as often as once per minute[29]. This excreta is more watery than usual and the behavior by which it is discharged differs from normal defecation. By 12 days old, nestlings also display this behavior. Excreting on the legs cools the bird through evaporation and is a widespread practice among the storks of the world. To conserve body heat, as when wading in cool water, the blood supply to the legs can be regulated so that the temperature of the legs is lower than that of the body[29].

Mortality Factors

The life expectancy of wood storks is believed to be at least ten years. Captive individuals of similar species of storks have lived over twenty years[15]. However, mortality can be particularly high during the first few months of life. As a result, the number of nestlings fledged per pair varies considerably. Eggs and nestlings are subject to predation, nests can fall or be blown from the trees, and eggs and young birds fall from the nest where they may be eaten by waiting alligators attracted by the rain of debris from the rookery overhead[1]. Disturbance of the rookery by humans during the first few weeks of the nesting season may cause both parents to flee the nest. This exposes the young to predators such as fish crows that are not deterred by human intruders.

When food availability is poor, fewer young are fledged per nest. Within recent decades the frequency of total colony failures has increased and it is believed that this is due to the decline in food resources. Limited information suggests that not only has the rate of fledgling survival decreased but that the number of eggs laid per nest also has decreased[2]. Mortality is also high during the first year after the fledglings leave the nest, particularly in poor years when food supplies are low and fledglings may be in a poor nutritional state.

The accumulation of pesticides and herbicides has been implicated in the decline of many birds, particularly those at the top of the food chain such as wood storks that feed on fish. So far no direct link has been shown between pesticides in the environment and fledgling or adult survival. Tests have shown that DDT and mercury are present in wood stork eggs and that eggshells are somewhat thinner than they were in the first part of this century, but there is no correlation between the level of these toxins and fledgling success[30]. However, pesticides have sublethal effects on both birds and fish. This means that although a chemical does not cause death it may, over time, affect the fitness and viability of an animal. The concentration of these chemicals is magnified with each level of the food chain. As an example, birds feeding on forage fish in waters subject to agricultural runoff have higher levels of toxins in their tissue than do the fish on which they feed. Pesticides also may reduce the diversity of fish in a habitat so that fewer species are available as food for storks.

The fact that wood stork populations are low poses risks. A smaller population is more vulnerable to natural and man-made catastrophies. In addition, colonial birds such as the wood stork may require a certain number of birds to cue the nesting season, complete the cycle and find food[15].

Habitat Disruption and Reproductive Decline

Reviews of mortality factors have shown that the primary reason for the decline of the wood stork population in the United States is not excessive mortality but inadequate reproduction. In recent years, annual production has averaged

about 0.77 young per pair of breeding adults. This reproductive rate is inadequate to maintain a stable population in view of natural mortality and so the population is declining at about 4.4 percent a year[2].

The reason for this low reproduction is inadequate food, which affects all phases of the breeding cycle. Food resources influence when nesting begins, the percentage of adults that attempt to nest, the number of fledglings that survive and the mortality rate of young in their first year[15]. Also, poorly nourished birds entering the breeding season are probably less able to nest successfully.

The decline in food is caused by the disruption and drainage of wetlands. Since the beginning of this century, over half of the wetlands in southwest Florida have been drained and, at an alarming rate, are being converted into suburbs, farms and pastures[15]. The water resources of Florida are controlled by five independent Water Management Districts that regulate channels, dikes and impoundments and, therefore, wetland cycles in much of the state. These areas are managed for flood control, game, agriculture, industry, mining and urban needs so that the requirements of wading birds and other non-game species so far have received low priority.

On the basis of area alone, it appears that there are enough wetlands left to support more birds, but most of these wetlands are impounded, partially drained or altered in some way. As a result, the number or kinds of fish in them is reduced, the fish are dispersed or the wetlands are not suitable for wading. The total acreage of the types of wetlands that serve as important wood stork feeding sites has been reduced by over 35 percent since 1900[2].

Successful reproduction depends on: ample summer rains to create large areas of water where fish can breed and multiply; an end to heavy rains by October so that wetlands can begin to dry; and few or no heavy rains during the winter and early spring[15]. In the past, the vast wetlands of Florida could store water through a dry year. Now a dry year can mean that large areas become completely dry so that fewer fish are available for breeding. The larger fish that are preferred by wood storks may be more than one year old and these populations may not survive from year to year or through a drought[16]. As a result, even if rainfall is normal following a dry year, fish populations will be low. Some fish such as the marsh killifish, which is an important food for

wood storks in Everglades National Park, produce eggs that can survive desiccation during the dry season. Other fish, such as sunfishes, cannot tolerate the low oxygen levels of drying ponds and must repopulate each year from larger, more permanent water bodies[15]. In areas with extensive drainage, the rainy season does not flood the large areas that allow fish from permanent ponds to reach the small depressions that become ponds during the dry-down.

Wood storks also face a decline in suitable nesting areas. Extensive logging has removed many of the large cypress trees in which they once nested. Widespread habitat disruption means that nesting sites within flying range of adequate food are in short supply. As a result of these changes there has been a shift in the nesting patterns of wood storks, particularly in central and northern Florida. Many birds now nest in man-made impoundments created for flood control, mining, agriculture, recreation and industry. These areas are less stable for rookeries because they are managed for other purposes and often the trees in them are dead from prolonged flooding. In addition, the presence of humans in these areas is disturbing to nesting birds[2].

Legal Protection

The wood stork is listed as endangered in Florida and Georgia, threatened in South Carolina and of special concern in Alabama. Under the federal Migratory Bird Treaty Act of 1981, it is prohibited to take or possess this bird or its eggs except by permit. This act, however, does not prohibit the adverse modification of habitat. The federal Endangered Species Act, however, protects the species as well as prohibits any actions funded or authorized by the federal government that would jeopardize it either directly or by modifying its habitat[4]. The Fish and Wildlife Service, which administers the Endangered Species Act, decided not to designate specific critical habitats for the wood stork because rookeries and feeding areas change over time and cover a large area. Additionally, publication of critical habitat maps, as required by the Endangered Species Act, could subject rookeries to human disturbance or vandalism. However, even though critical habitats have not been designated, projects involving federal participation must take into account the effect of wetland disturbance on wood storks.

Outlook for the Future

We know enough about the biology of the wood stork to know why it is in decline and what needs to be done. The difficulty is that the wood stork's decline is related to habitat loss and, therefore, solutions have economic, social and political impacts. How to implement a recovery in the face of ever increasing demands for land and water for agricultural, industrial and residential uses is still an unanswered question. Listing of the species as endangered was a first step in the recognition of the problem. A wood stork recovery plan, developed under the direction of the Fish and Widlife Service, lists actions that need to be taken. Continued research, monitoring of colonies, water management, and acquisition of important nesting areas are high priorities. Studies by the National Audubon Society suggest that artificial ponds may be managed as a food supply for nesting wood storks but logistical and financial aspects remain to be resolved.

To solve the problem of wetland disruption, however, will require the coordinated efforts of water management districts, federal, state and local governments and the support and understanding of the public. The recent passage by the state of Florida of the "Warren S. Henderson Wetlands Protection Act of 1984" broadens the authority of the Department of Environmental Regulation to consider the impact of dredge and fill permit applications on fish and wildlife. The "Save our Rivers" Program, implemented by the State of Florida, provides funding to the Water Management Districts to acquire property for wetland restoration. Plans are underway in the St. Johns River Water Management District to develop marsh conservation areas that will restore some of the wetlands lost to agriculture and flood control measures and provide habitat for many species, including the wood stork.

Wood storks are so closely attuned to the natural cycles of Florida's wetlands that their well-being is an indicator of the health of our wetlands themselves[18]. The disappearance of the wood stork would signal the loss of a valuable resource. Estimates are that we have less than twenty years before this comes to pass.

How You Can Help

As an individual, there are many things that you can do to promote the well-being of wildlife, including wood storks. Become informed through reading, classes and observation. Join conservation groups such as the Florida Audubon Society or The Nature Conservancy and actively participate. Let your local, state and federal representatives know that you support conservation and the protection of wetlands. When observing wildlife be considerate, you are a visitor in their home.

As the human population of Florida continues to grow, the pressure on our remaining wetlands will increase. Only an informed and active citizenry can ensure that the needs of wood storks and other species that depend on wetlands are recognized.

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Additional Information Available from FPL

Publications

Boater's Guide to Manatees
The West Indian Manatee in Florida
Florida's Sea Turtles

16-mm Films

Silent Sirens: Manatees in Peril
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These materials may be obtained by writing to:
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Citations

1. Ogden, J.C. 1983. The abundant, endangered flinthead. Audubon 85(1):90-101.

2. Ogden, J.C., and B.W. Patty. 1981. The recent status of the wood stork in Florida and Georgia. Pages 97-102 *in* R.R. Odom and J.W. Guthrie, eds. Proceedings of the Nongame and Endangered

Wildlife Symposium, August 13-14, 1981. Athens, Georgia. Georgia Department of Natural Resources Game and Fish Division, Technical Bulletin WL5.

3. Patty, B.W. (Personal Communication) Research Department, National Audubon Society, Tavernier, Florida. 1984.

4. Federal Register. Feb. 28, 1984. Vol. 48(40):8402-8404.

5. Kahl, M.P., Jr. 1972. Comparative ethology of the Ciconiidae. The wood storks (Genera *Mycteria* and *Ibis*). Ibis 114:15-29.

6. Ogden, J.C. 1978. The wood stork. Pages 3-4 *in* Rare and Endangered Biota of Florida. Volume Two: Birds (H.W. Kale, ed.) University Presses of Florida, Gainesville.

7. Clark, E.S. 1978. Factors affecting the initiation and success of nesting in an east-central Florida wood stork colony. Pages 178-188 *in* Proceeding 1978 Conference of the Colonial Waterbird Group. New York, New York.

8. Murdock, N. (Personal Communication) U.S. Fish and Wildlife Service, Asheville, North Carolina. 1984.

9. Nesbitt, S.A. 1974. A new north Florida wood stork colony. Florida Field Naturalist, Spring Issue Vol. 2:14-15.

10. Unless cited, feeding behavior information is from Kahl, Jr., M.P., and L.J. Peacock. 1963. The bill-snap reflex: a feeding mechanism in the American wood stork. Nature 99(4892):505-506.

11. Kahl, M.P., Jr. 1963. Food ecology of the wood stork in Florida. A study of behavioral and physiological adaptations to seasonal drought. Doctoral Dissertation. University of Georgia. 113 pp.

12. Rand, A.L. 1956. Foot-stirring as a feeding habit of wood ibis and other birds. The American Midland Naturalist 55(1): 96-100.

13. Kahl, M.P, Jr. 1964. Food ecology of the wood stork (*Mycteria americana*) in Florida. Ecological Monographs 34(2):97-117.

14. Ogden, J.C., J.A. Kushlan and J.T. Tilmant. 1978. The food habits and nesting success of wood storks in Everglades National Park, 1974. U.S. Department of Interior, National Park Service. Natural Resources Report Number 16. 25 pp.

15. Browder, J.A. 1976. Water, wetlands and wood storks in southwest Florida. Doctoral Dissertation. University of Florida. 387 pp.

16. Ogden, J.C., J.A. Kushlan and J.T. Tilmant. 1976. Prey selectivity by the wood stork. The Condor 78:324-330.

17. Kushlan, J.A. 1974. Observations on the role of the American alligator (*Alligator mississippiensis*) in the southern Florida wetlands. Copeia 4:993-996.

18. Kushlan, J.A., J.C. Ogden and A.L. Higer. 1975. Relation of water level and fish availability to wood stork reproduction in the southern Everglades, Florida. U.S. Department of Interior, Geological Survey. Open File Report 75-434. 56 pp.

19. Clark, E.S., and R.C. Lee, Jr. 1982. History and status of wood stork nesting on Merritt Island National Wildlife Refuge, Florida, 1972-1981. U.S. Department of Interior Fish and Wildlife Service.

20. Rodgers, J.A., Jr. (Personal Communication) Florida Game and Fresh Water Fish Commission, Wildlife Research Laboratory, Gainesville, Florida. 1984.

21. Sprunt, A. (Personal Communication) Research Department, National Audubon Society, Tavernier, Florida. 1984.

22. Unless cited, courtship behavior information is from 5.

23. Kahl, M.P, Jr. 1971. Social behavior and taxonomic relationships of the storks. The Living Bird 10:151-170.

24. Kahl, M.P, Jr. 1962. Bioenergetics of growth in nestling wood storks. The Condor 64(3):169-183.

25. Palmer, R.S., ed. 1962. Handbook of North American Birds. Vol. I. Yale University Press. 567 pp.

26. Browder, J.A. 1984. Wood stork feeding areas in southwest Florida. Florida Field Naturalist 12(4):81-96.

27. Unless cited, flying information from 11,13.

28. Kahl, M.P., Jr. 1971. Spread-wing postures and their possible functions in the Ciconiidae. Auk 88(4):715-722.

29. Kahl, M.P., Jr. 1963. Thermoregulation in the wood stork, with special reference to the role of the legs. Physiological Zoology 36(2):141-151.

30. Fleming, W.J., J.A. Rodgers, Jr. and C.J. Stafford. 1984. Contaminants in wood stork eggs and their effects on reproduction. Florida, 1982. Colonial Waterbirds 7:88-93.

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