

---

# Cyclic Drought, Dispersal, and the Conservation of the Snail Kite in Florida: Lessons in Critical Habitat

JEAN E. TAKEKAWA\*

Loxahatchee National Wildlife Refuge  
Rt. 1, Box 278  
Boynton Beach, FL 33437, U.S.A.

STEVEN R. BEISSINGER†

School of Forestry and Environmental Studies  
Yale University  
New Haven, CT 06511, U.S.A.  
and  
Department of Zoological Research  
National Zoological Park  
Smithsonian Institution  
Washington, D.C. 20008, U.S.A.

**Abstract:** *Studies of the dispersal of the Florida Snail Kite, an endangered hawk that inhabits flooded wetlands and feeds almost solely on apple snails, illustrate the problems associated with protecting habitats for migratory and wandering species with disjunct habitat requirements. Before a drought in 1985, most kites were sighted in the large tracts of Everglades that were used for nesting. During the drought, however, 60 percent of the sightings of kites reported to our sighting hotline were from smaller wetlands and other drought-related habitats, mostly in Palm Beach and surrounding counties. Although these small wetlands are important emergency habitats used by kites to survive during drought, they are not designated as "critical habitat" and are being developed at a rapid rate. We discuss the problems of uncertainty, cumulative effects, and compromise in the process of evaluating development proposals and protecting small, isolated habitats. We identify key sites used by kites during drought and suggest ways to conserve this species in Florida by mitigating drought-induced population crashes. The usefulness of sighting hotlines for assessing dispersal data is also evaluated.*

**Resumen:** *Estudios realizados sobre el Halcón Caracolero de Florida, un ave en peligro de extinción que habita áreas pantanosas y se alimenta de caracoles, ilustra los problemas asociados con la protección de hábitats de especies migratorias y nómadas que requieren de hábitats disyuntos. Anteriormente a una sequía en el año 1985, la mayoría de halcones caracoleros se observaban en las áreas extensas de la región pantanosa de los Everglades a donde nidificaban. Sin embargo, durante la sequía, el 60% de los halcones observados se localizaron en áreas pantanosas más pequeñas ubicadas, en su mayoría en la región de Palm Beach y en condados vecinos. A pesar de que estas pequeñas áreas sirven como importantes refugios de emergencia para los halcones durante épocas de sequía, estas no están designadas como "hábitat crítico" y están siendo rápidamente transformadas por las presiones de desarrollo. Se discuten problemas de incertidumbre, de efectos acumulativos, y de transigencia en la evaluación de propuestas para el desarrollo y en la protección de pequeños hábitats aislados. Hemos identificado áreas de refugio, usadas por los halcones durante la época de sequía y sugerimos maneras para conservar esta especie en Florida mitigando las grandes disminuciones de la población causadas por las sequías. También se evalúa la utilidad de una red de comunicación para el reporte de observaciones que sirva para la evaluación de datos de dispersión.*

---

\* Present address: San Francisco Bay National Wildlife Refuge, Box 524, Newark, CA 94560, U.S.A.

† Correspondence should be sent to Steven R. Beissinger.

Paper submitted 4/11/88; revised manuscript accepted 1/6/89.

## Introduction

Habitat protection is essential for preserving biological diversity, and it is especially important for endangered species. The constancy of habitat or patch residence varies tremendously between species. Habitat protection is simplest for sedentary species that rarely leave their primary habitat. Migratory species have different breeding and wintering habitats, often crossing political or administrative borders. Habitat use by sedentary and migratory species usually follows a regular and predictable cycle based on annual endogenous (biological) rhythms or exogenous climatic events. Wandering species, however, may have no discrete migratory pattern or path. Like migratory species, wandering species frequently use disjunct patches of habitat but do so in an irregular fashion, one that is often not based on any daily or annual rhythm of biological events. These species may be hardest to protect.

We have been studying a wandering species with disjunct habitat needs, the Snail (Everglade) Kite (*Rostrhamus sociabilis*). This neotropical hawk is best known for its highly specialized diet consisting almost solely of freshwater snails (Bent 1937; Beissinger 1988). The Snail Kite was also one of the first species placed on the Federal Endangered Species List in 1967, and critical habitat was registered in 1977 (U.S. Fish and Wildlife Service 1986). Originally ranging throughout the peninsula (Sykes 1984), in recent years the kite has been restricted to a few large wetlands in southern Florida (Sykes 1983a). Populations declined due to uncontrolled drainage of the Everglades in the mid-1900s, resulting in the loss of habitat and Apple Snails (*Pomacea paludosa*).

Though as few as 25–60 birds may have existed by the 1960s (Sprunt 1945, 1954; Stieglitz & Thompson 1967; Sykes 1979; W. Dineen, personal communication), during the past decade the Florida Snail Kite population has fluctuated between 250–670 individuals (Beissinger 1986; Rodgers et al. 1988). During wet years, the population can increase geometrically owing to long breeding seasons that allow individuals to nest several times (Beissinger 1986; Snyder et al. 1989). During drought, however, recruitment is very low and adult mortality is high, due to starvation, shooting, and accidents, as the population disperses across the state in search of wetlands with snails (Beissinger & Takekawa 1983). During the 1981–82 drought, kite numbers declined from more than 650 (Sykes 1983b) to about 250 surviving birds (Beissinger 1986).

In 1981, we monitored the movement and dispersal of kites during a severe drought (Beissinger & Takekawa 1983). Kites abandoned the larger Everglades marshes as they became dry, moving to the central lakes (Lakes Kissimmee and Tohopekaliga, Osceola County) and the east coast corridor (Palm Beach, Martin, and Broward

counties). The habitats used by kites during drought were quite different from the typical Everglades or lake marshes normally used; kites moved to canals, flooded fields, borrow pits, and small patches of seasonal or permanent marshes. We designated such locations “drought-related” habitats and concluded that while these small wetlands might be marginal kite habitat in wet years, they became important for kite survival during droughts.

By December 1984, kite numbers had recovered to the pre-1981 drought level (Rodgers et al. 1988). Birds were no longer seen in drought-related habitats but had concentrated again in the larger Everglades marshes (unpublished data). However, in winter and spring of 1985, below-normal rainfall produced drought conditions throughout much of southern Florida. While not as severe as the 1981–82 drought (Lin et al. 1984), the 1985 drought produced a similar drying of the primary habitats used by kites.

This paper documents the dispersal of the Florida Snail Kite population during the 1985 drought using data that we gathered primarily through the “Snail Kite Sighting Hotline” at Loxahatchee National Wildlife Refuge. We examine the types and locations of habitats that were critical for the survival of kites during drought, and discuss the difficulty in protecting such wetlands in the face of tremendous development pressures. Other conservation alternatives for mitigating the devastating effect of drought on the Florida Snail Kite population are suggested. Problems in protecting disjunct patches of habitat for migratory or wandering species are discussed.

## Methods

Snail Kite sightings were collected by Takekawa (JET) at Loxahatchee National Wildlife Refuge (NWR) throughout 1985. Sightings were verified by standardized interviews using a broad range of criteria including the appearance and behavior of the bird, habitat, and observer experience (Beissinger & Takekawa 1983), or by a visit to the site. When drought conditions ensued in early 1985 and Snail Kites began to disperse, sighting reports were solicited in March through a news release that went to over 200 addresses, including newspapers, television and radio stations, conservation organizations, and government agencies. Because there were no ongoing field studies during the drought, we verified important sightings by field visits and searched for kites in some drought-related habitats.

Sighting locations were divided into primary, secondary, and drought-related areas (Beissinger & Takekawa 1983). Primary areas were used extensively during the past decade while secondary areas received irregular or

sporadic use. Primary areas included State Water Conservation Area 3A (CA3A) (Dade and Broward counties), State Water Conservation Area 2 (CA2, CA2A, and CA2B) (Broward County), and Lake Okeechobee (Glades, Hendry, Okeechobee, and Palm Beach counties). Secondary areas were Loxahatchee NWR (Palm Beach County), Everglades National Park (NP) (Dade and Monroe counties), and State Water Conservation Area 3B (CA3B) (Dade and Broward counties). Drought-related areas were used during or as a result of dry periods. They included agricultural fields and pastures; major, agricultural, and roadside canals; borrow pits; rivers and lakes; and seasonal and permanent marshes (see Beissinger & Takekawa [1983] for definitions of habitat types). Observer initials are given in parentheses with each verified sighting.

## Results

In total, 299 sightings of Snail Kites were received by our hotline in 1985. A majority (55 percent) were from observers who contributed sightings in 1981–82 (Beissinger & Takekawa 1983). The reliability of sightings was high, with 95 percent verified as Snail Kites. As in 1981–82, over half of the sightings were reported by employees of government agencies, usually trained biologists.

Drought-related sightings of Snail Kites are summarized in Figure 1 and Table 1. Sixty percent of all kite sightings came from drought-related habitats. Kites were found in 35 locations, including lakes, and seasonal and permanent marshes. However, kites also were found in areas heavily influenced by human development, such as canals, borrow pits, agricultural fields, and pastures. Nine, or 26 percent, of these drought-related locations were also used by kites during the 1981–82 drought (Beissinger & Takekawa 1983). At most locations, one to three kites were reported only once (e.g., Table 1, Nos. 1–3, 6–14, 16, 19, 22, 27–29, 32–34). Most kites were found in six locations as evidenced by repeated sightings of numerous birds (Table 1, Nos. 20, 21, 23–25, 30). Three sightings (Table 1, Nos. 1, 16, 22) were the first documentation of kites on those lakes (Sykes 1984). The first kite since 1884 (Sykes 1984) was recorded in Jacksonville, Duval County (Table 1, No. 4).

The occurrence of kite sightings was temporally related to the drying of CA3A (Fig. 2). When the southern marshes dried in March and April, kite sightings in drought-related habitats increased, peaking in June. After the marshes reflooded in August, the number of kite sightings in drought-related habitats declined and remained at lower levels through the fall as dispersed birds began returning to primary habitats. A negative trend between the monthly minimum water level in CA3A and the number of kite sightings in drought-

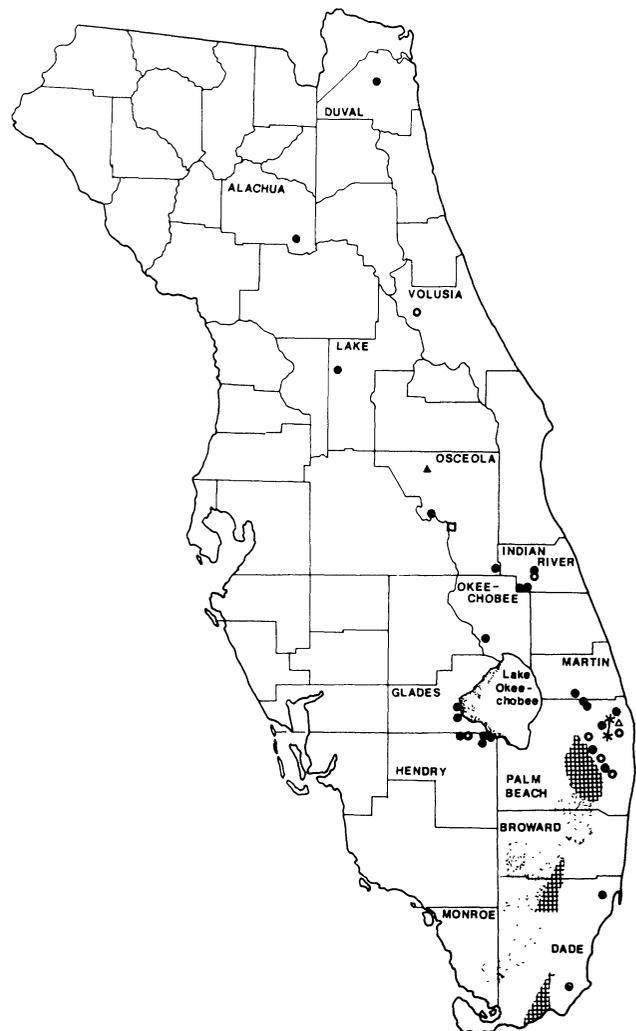


Figure 1. Locations of Snail Kite habitats in Florida. Primary areas are stippled. Secondary areas are crosshatched. Solid dots indicate drought-related habitats used in 1985. Open dots are drought-related habitats used in 1985 and during the 1981–82 drought (Beissinger & Takekawa 1983). Special symbols represent the following drought-related habitats: Lake Tohopekaliga (solid triangle), Lake Kissimmee (open square), the roost site (open triangle), and the West Palm Beach Water Catchment Area and associated wetlands (asterisks connected by a line show the borders of this site).

related habitats (Spearman  $r = -0.478$ ,  $P = 0.06$ ) further substantiates this scenario.

A major kite roost, associated with a large wading bird rookery, was discovered in northeast Palm Beach County during the height of the drought (Table 1, No. 25, and Fig. 3). A peak of 372 Snail Kites was surveyed there on 12 June, the largest roost ever encountered in Florida (Sykes 1985; J. A. Rodgers, personal communication). This roost was in willow (*Salix caroliniana*) and Brazilian pepper (*Schinus terebinthifolius*) on sev-

**Table 1.** Drought-related locations of Snail Kite sightings in Florida in 1985 outside of primary and secondary areas. Habitat types are defined in Beissinger & Takekawa (1983). The location of each sighting appears in the appendix by the numbers listed below. Asterisks indicate locations also used by Kites during the 1981–82 drought (Beissinger & Takekawa 1983).

No.	County	Habitat	Dates	No. of Kites
1	Alachua	Cross Creek, Lochloosa Lake	19 April	1
2	Dade	Main canal	early summer	1
3	Dade	Main canal	11 June	1
4	Duval	Borrow pit	26 April–1 May	1
5	Glades	Agricultural canal	5 June, 13 Aug.	1
6	Glades	Pasture, agricultural canal	13 Aug.	3
7	Hendry	Agricultural canal	19 March	2
8*	Hendry	Agricultural canal	12 June	1
9	Hendry	Agricultural canal	20 June	2
10	Hendry	Permanent marsh	3 July	1
11	Hendry	Agricultural canal	23 July	1
12	Indian River	Roadside canal	6 May	1
13	Indian River	Permanent marsh	14 May	1
14*	Indian River	Permanent marsh	11 June	2
15	Indian River	Roadside canal	9 Dec.	1
16	Lake	Lake Harris	25 July–7 Aug.	1
17	Martin	Roadside canal, seasonal marsh	13 July	1
18	Okeechobee	Kissimmee River, permanent marsh	24 Dec.	1
19	Osceola	Roadside canal	24 June	1
20*	Osceola	Lake Kissimmee	17 Feb.–early Dec.	1–35
21*	Osceola	Lake Tohopekaliga	15 May–early Dec.	1–17
22	Osceola	Lake Hatchineha	9 Nov.	1
23	Palm Beach	West Palm Beach Water Catchment Area	28 Feb.–6 Nov.	1–13
24*	Palm Beach	Roadside canal, permanent marsh	15 Feb.–18 Dec.	1–15
25	Palm Beach	Borrow pit, marsh	29 March–25 Nov.	1–372
26	Palm Beach	Major canal, marsh	21 April–24 July	1–2
27	Palm Beach	Seasonal marsh	21 June	1
28	Palm Beach	Seasonal marsh	14 July	2
29	Palm Beach	Seasonal marsh	1 June	1
30	Palm Beach	Permanent marsh	14 May–7 Dec.	1–35
31*	Palm Beach	Urban canal	10 March	4
32*	Palm Beach	Agricultural field	5 May	1
33	Palm Beach	Agricultural canal	18 Oct.	1
34*	Palm Beach	Agricultural canal	4 Nov.	1
35*	Volusia	Permanent marsh	mid-June–mid-Aug., 25 Nov.	1

eral spoil islands in an old borrow pit located along the eastern edge of the West Palm Beach Water Catchment Area (WCA), a 32 km<sup>2</sup> wetland composed of tree islands, wet prairies, and sloughs. It is owned and managed by the City of West Palm Beach as a storage facility for drinking water. Locations of foraging areas used by roosting kites were not readily apparent. Most of the kites entered the roost from the direction of the WCA and surrounding wetlands, but observations of kites within the WCA were limited because it is closed to public access. As summer rains replenished primary areas, kites gradually left; numbers at the roost declined to 305 by late June, 70 on 29 July, and approximately 30 through August. A small number of kites remained following the drought and 13 were seen in late November.

Although few kites nested in 1985, this roost site was one of the two areas where nests were found. A single nest was discovered in a Brazilian pepper tree on a spoil island. The male parent was a seven-year-old bird banded in Conservation Area 3A or Lake Okeechobee. One chick appeared to have fledged from the nest. This

is the first documented nesting in this vicinity since the 1920s (Sykes 1984).

Kites also nested on Lake Kissimmee. Resightings in 1985 of two birds seen there in 1983 (a male banded in 1979 in CA3A and its offspring banded on Lake Kissimmee in 1983) may indicate that a stable population is forming. Four nests were found and three produced six fledglings while one nest collapsed in cattails (*Typha* sp.). Based on findings in previous years (Snyder et al. 1989), there undoubtedly were more nesting attempts since as many as 35 kites were seen. Although Snail Kites were not reported nesting on Lake Tohopekaliga in 1985, they were seen during the breeding season in areas used for nesting in 1981–82 (Beissinger & Takekawa 1983).

While most birds moved to the central lakes and wetlands in northeast Palm Beach County, some used alternative habitats. For example, a 30 ha impoundment in Wellington (Table 1, No. 30, and Fig. 3) supported up to 35 kites throughout the summer. This impoundment was formerly agricultural land that had become over-

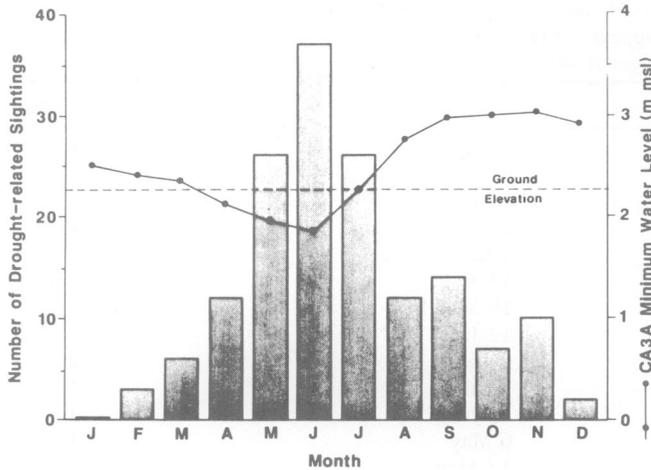


Figure 2. The number of sightings of Snail Kites in drought-related habitats in 1985 reported to the "Snail Kite Sighting Hotline" in relation to month, and superimposed on minimum water depth in State Water Conservation Area 3A (CA3A), the primary location used by kites before dispersal.

grown until 1981, when the Acme Improvement District began managing it for on-site filtering of water before it is pumped into Loxahatchee NWR. Almost all kites seen here were brown-plumaged birds (females or subadults); included was a two-year-old banded kite that had fledged in CA3A. Although snails were abundant, as judged by the preponderance of egg clusters and the ease with which kites caught snails by still-hunting (Beissinger 1983), twice kites were observed feeding on stinkpot (*Sternotherus odoratus*) or mud turtles (*Kinosternon subrubrum*). The intensive use by kites of this small pond may make it one of the highest recorded densities of foraging kites/ha supported over a sustained period (Beissinger 1983).

## Discussion

### The Kite Sighting Program

The sighting program was designed to monitor the dispersal of Snail Kites during drought and supplement ongoing field studies (Beissinger & Takekawa 1983). In 1985, however, it was the only tool available to monitor the population, except for the annual survey in December (Rodgers et al. 1988). Data collected by the sighting program undoubtedly were biased toward areas frequented by people. But in spite of the limitations of our sighting program, the tremendous amount of information gathered with limited effort and minimal expense easily justified its implementation.

The effectiveness of any sighting program depends on observer accuracy, standardized verification procedures, and good publicity. Multiple criteria for verifica-

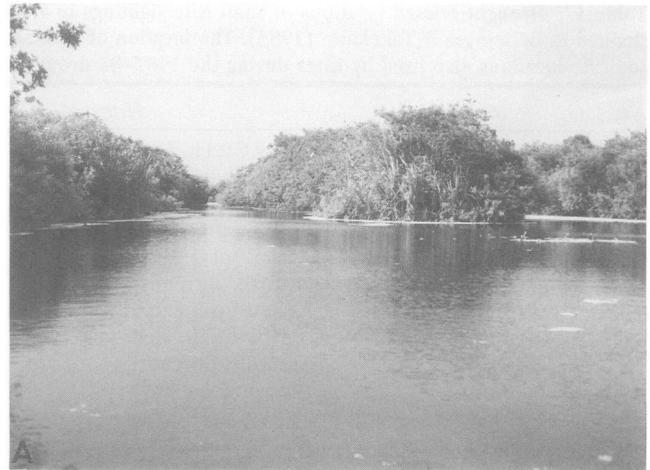


Figure 3. A. The roost site adjacent to the West Palm Beach Water Catchment Area, Palm Beach Co. (Table 3, No. 22), where a nest was also found. Up to 372 Snail Kites roosted in the willow (*Salix caroliniana*) and Brazilian pepper (*Schinus terebinthifolius*) tree islands. B. The Wellington pond (Table 3, No. 30), a 30 ha impoundment for on-site water treatment where up to 35 Snail Kites survived the drought. Both habitats are threatened by development (see Discussion).

tion are essential (Beissinger & Takekawa 1983). Publicity efforts should target potential observers. For our program, these included employees of governmental agencies and local birders such as those in local Audubon chapters. Increased longevity greatly enhances the value of a sighting program: over half of the kite sightings in 1985 were from observers who had previously contributed sightings (Beissinger & Takekawa 1983). The continuity provided by these experienced observers and the change of the common name from Everglade Kite (sometimes confused with American Swallow-Tailed Kite [*Elanoides forficatus*]) to Snail Kite helped to greatly reduce misidentification problems in 1985 (5

percent) compared to 1981–82 (16 percent, Beissinger & Takekawa 1983). Finally, crediting published sightings to each observer may act as positive reinforcement to sustain observer participation.

### The Pattern of Kite Dispersal During Drought

In 1985, 60 percent of the kite sightings were reported from drought-related habitats (Table 1). When rainfall reflooded primary habitats in late summer, the frequency of kite sightings increased in these areas (Fig. 2) and declined in drought-related habitats (Table 1). The 1985 drought, like the 1981–82 drought (Beissinger 1986), resulted in minimal recruitment, high adult mortality, and a 39 percent population decline (Rodgers et al. 1988).

The pattern of kite dispersal during the 1985 drought was very similar to that of the 1981–82 drought (Beissinger & Takekawa 1983), except many more kites moved to the east coast corridor and sightings were concentrated in Palm Beach County. Significant numbers of birds moved to the WCA and nearby marshes. These habitats represent a large part of the remnants of the original Loxahatchee Slough, a system of marshes, ponds, and hammocks that comprised the northeastern arm of the Everglades. One large roost (Fig. 3) adjacent to the WCA included more than half of the known pre-drought kite population.

There may be several reasons why east coast corridor wetlands are so heavily used by kites during droughts. This area has the highest rainfall in southern Florida (Thomas 1974) and kites might expect to find some wet areas here when most others are dry. Also the marshes of the Loxahatchee Slough exhibit a striking ability to hold water, even during severe drought. Water retention may be enhanced in these marshes because the soils are very fine-grained and less permeable than in Everglades marshes, where water-absorbing peat soils dominate (Davis 1946). In addition, there are more undeveloped wetlands interspersed with other natural habitats (e.g., pine flatwoods) in northern Palm Beach and southern Martin Counties than farther south (Dade and Broward counties).

Some drought-related habitats may permit more sustained use by kites than others. Our data indicate that the less disturbed marshes of the WCA and Loxahatchee Slough more reliably supported kites than some man-made habitats like canals, artificial impoundments, or flooded farm fields. For example, a canal (Table 1, No. 31) and flooded farm field (Table 1, No. 32) were used extensively by several kites in 1981–82, but received little use in 1985. Prior to 1985, the canal was dredged and the farm field was drained, eliminating previously abundant snail populations. Kites reappeared at both sites in 1985 but did not remain.

### The Current Status of Drought-related Habitats: What Is "Critical" Habitat?

Unfortunately, the emergency habitats used most frequently by kites for survival during droughts, seasonal and permanent wetlands of Palm Beach and surrounding counties, are under extremely intensive development pressure. Already, numerous drought-related habitats identified in 1981–82 (Beissinger & Takekawa 1983) and in 1985 are threatened by imminent development proposals; these include most of the marshes around the WCA. Even where proposals provide for marsh retention, hydrology would be significantly altered.

For example, the kite roost and associated marshes adjacent to the WCA (Table 1, No. 25, and Fig. 3) are located only 300 m from Palm Beach County's new resource recovery facility (landfill and incinerator). Although efforts are being made to buffer the roost site from human disturbance, storm water will be discharged into the surrounding marshes. An important foraging area along the Florida Turnpike east of the WCA (Table 1, No. 24) would be severely influenced by an interchange planned for the site. Furthermore, a housing development has been proposed on land west of the WCA (Table 1, No. 27). Although the proposal provides for preservation of most of the high-quality wetlands on the site, it would also line them with houses and result in storm water releases into the marshes. The potential impact on kites of such development around the WCA is difficult to assess.

The Wellington pond (Table 1, No. 30, and Fig. 3), another important survival habitat for kites during the drought, also has been proposed for further development. If approved, the pond would be reduced in size by one-half; the remainder would be drained and developed.

When critical habitat was determined in 1977, the role of drought-related habitats was not known. Critical habitat for the Snail Kite includes portions of the large wetland tracts that kites use extensively for nesting, but does not include any of the refuge sites used by kites during drought (U.S. Fish and Wildlife Service 1986). Thus, conservation efforts have succeeded in identifying only part of the habitat that is critical to kite survival.

### The Importance of Drought-related Habitats as Emergency Habitats

Population growth may be limited by that resource which is shortest in supply. Prior to the creation of the Conservation Areas and rewatering of the Everglades in the 1960s, suitable habitat and favorable snail densities for nesting probably limited kite population size. But with the recent improvement in nesting habitat and the increasing development of east coast corridor wetlands, drought-related habitats may become the limiting factor

that ultimately determines Snail Kite population size in Florida.

In the past 15 years, kite populations have literally risen and fallen with Everglades water levels (Sykes 1983b; Rodgers et al. 1988). Many of the life history traits of this bird in Florida are adaptations to or results of highly unpredictable water levels and fluctuating snail populations (Beissinger 1986, 1987; Beissinger & Snyder 1987). Because drought will always occur in Florida, kite numbers will continue to fluctuate cyclically in phase with Everglades water levels.

Cyclic drought occurs in Florida at intervals of 5–7 years, and both the frequency and severity of drought conditions have increased during the past 50 years (Beissinger 1986). Due to the increasing water demands of urban areas and agriculture in this rapidly growing state, the water table is likely to continue falling. Future droughts may be expected to occur more frequently and last longer. Because of lag effects the following year, drought-related habitats are likely to be intensively used by kites for two of every five or six years. Our data also show that kites return to specific drought-related habitats in succeeding droughts (Table 1, and Beissinger & Takekawa 1983), further heightening the importance of these areas as emergency habitats for survival. This scenario — cyclic drought, a falling water table, and fewer drought-related habitats in the east coast corridor — paints a bleak prognosis for the Snail Kite in Florida. If the Snail Kite is to survive, we believe that as many drought-related habitats as possible must be preserved and protected from alterations in hydrology.

#### **Endangered Species and Habitat Protection: The Problems of Uncertainty, Cumulative Effects, and Compromise**

The protection of many threatened and endangered species is closely dependent upon the preservation of habitat. Despite the legislative mechanisms available for protecting endangered species (the Endangered Species Act [ESA]) and wetlands (Fish and Wildlife Coordination Act; Section 10 of the Rivers and Harbors Act of 1899; and Section 404 of the Clean Water Act), absolute protection has not been readily achieved. During federal evaluation of projects involving endangered species (Section 7 consultations), it is extremely difficult to obtain a jeopardy verdict that would save a habitat by completely halting a project (Drabelle 1985); instead the decision often involves compromise between the scope of the project and the welfare of the endangered species (Yaffee 1982).

The difficulty of obtaining a jeopardy decision may be, at least in part, the intent of the ESA (Yaffee 1982), but it is also inherent in the consultation process. First, uncertainty results from a significant limitation on biological knowledge related to specific management decisions (Leitzell 1986) so that Section 7 consultations

must often be based on insufficient information. With kites, we frequently do not know if a small, isolated wetland was or would be used during droughts. Second, the process of evaluating projects on a case-by-case basis, as wetlands are usually proposed for development, makes it difficult to assess the cumulative effects of many small projects in a region over time. For example, a single development project in Palm Beach County may not jeopardize the Snail Kite, but it may do so when combined with other projects in this region over several years. Finally, compromises that allow partial development of small habitats — for example, the proposal for the Wellington pond (Table 1, No. 30) — may reduce them to a size too small to sustain use. In the case of wetlands, even if they are retained, they may be altered or degraded by changes in water flow, level, or hydroperiod, reducing their suitability or even eliminating their availability during drought.

#### **Cyclic Drought and Snail Kite Conservation: Mitigating Drought-Induced Crashes**

A goal for the recovery of the Snail Kite has been described as “the number of kites that have a 95% probability of surviving 3–4 successive drought years of no reproduction and high mortality, while remaining reproductively viable” (U.S. Fish and Wildlife Service 1986). To achieve this goal, we recommend that as many drought-related habitats as is feasible, particularly the central lakes (Lakes Kissimmee and Tohopekaliga) and east coast corridor wetlands in Palm Beach and surrounding counties, be considered for inclusion as “critical habitat” for the Snail Kite.

Critics of critical habitat have suggested that not only is the registration process unruly, but the designation may not provide any more protection than is already accorded by the requirements of the ESA (Sidle 1987). However, drought-related habitats may not be protected as easily by the provisions of the ESA because they have not all been clearly identified, are typically suboptimal kite habitat, and may not be occupied by kites except for periods of several months during drought. Also, because these wetlands are small tracts scattered in suburban areas (Fig. 3), they may receive less agency attention and be less aesthetically appealing to the public for preservation compared to the larger Everglades areas.

Conservation action, however, will not succeed if it is taken only at the federal level. Local, state, and federal planners and biologists must work together aggressively to identify potential drought-related habitats, their suitability for kite use, and the mechanisms for protection (i.e., habitat identification in land use plans and stronger zoning). All habitats important to kites should be considered, including manmade habitats such as canals. Development projects that would alter hydrology through

changes in water levels, flow management, or the creation of new drainage outlets should be closely scrutinized. Whenever possible, projects should be evaluated on a regional or ecosystem basis to allow the determination of cumulative effects.

Sustaining the Loxahatchee Slough mosaic of wetlands is vital to insure that some wetlands will remain saturated during drought. Large wetland tracts in Florida typically have a higher surface to volume ratio than smaller tracts. Combined with consumption of these water supplies for human uses, they are extremely vulnerable to drying, as demonstrated by the regular drying of the Conservation Areas. Presently in the Loxahatchee Slough system, water losses are mostly due to evapotranspiration (D. Worth, personal communication); few drainage outlets exist, because development has been limited in this region. However, increases in drainage outlets created by development act to lower water levels and lead to more rapid drying during droughts. Therefore, protection of not only the WCA but also of other Loxahatchee Slough wetlands from additional development and changes in hydrology may be critical for the survival of Snail Kites and for the functioning of the entire wetland ecosystem.

Water requirements of people and obligate wetland wildlife species can be compatible, as illustrated by the WCA, which stores drinking water for the City of West Palm Beach. A large portion of the WCA wetlands was not usable for kites during the 1981–82 drought because it dried in early spring. Following the drought, water management guidelines were altered to prevent similar drying (A. Trefry, personal communication). Consequently, the WCA stayed wet throughout 1985, providing an important oasis for kites in conjunction with the adjacent marshes and ponds. We urge that the WCA be declared a kite sanctuary by the City of West Palm Beach to identify its importance to kites. Such protection would also complement a controversial court decision in 1981 that closed this area to motorized vehicles (primarily airboats) to protect water quality.

Another land use practice that provides survival habitat for obligate wetland species during droughts is on-site water treatment. Small marshes, for example the Wellington pond (Table 1, No. 30), are created to filter water before discharging it into larger wetland tracts. If an area consistently produced snails and could be kept flooded during drought, it would help to mitigate the devastating mortality to Snail Kites caused by drought. Such impoundments, however, will require active management to maintain healthy marsh conditions. Flooding wetlands during drought with water that has been used for other purposes might be tried on a larger scale with one of the smaller Everglades management units, like the Rotenberger Tract or the Holey Lands (Hendry and Palm Beach counties). These sites could be used for

on-site treatment of water from the Everglades Agricultural Area, a potential source of large volumes of water during drought, and they are located immediately north of CA3A, the major source of dispersing kites.

### Coattails and Conclusions

The protection of smaller isolated wetlands will benefit many other species besides the Snail Kite. The effects of drought on kite populations reflect the problems that cyclic drought poses for other large, mobile, wetland-dependent species. This includes birds with disjunct habitat requirements like the endangered Wood Stork (*Mycteria americana*) and species of special concern such as the Florida Sandhill Crane (*Grus canadensis pratensis*), Limpkin (*Aramus guarauna*), and several species of herons and egrets (Kale 1978). Most of these species have more flexible diet requirements than the Snail Kite, but nonetheless are dependent upon flooded wetlands. Finally, protection of these small, suburban wetlands would ensure that some open space and landscape diversity remained in the rapidly urbanizing ecosystem of southern Florida, where development is marching westward over the natural matrix of habitats from the East coast to the diked borders of the Everglades and beyond.

Just as “possession is nine-tenths of the law,” consistent occupancy of a habitat facilitates protecting sites in single-species conservation plans. Protecting a few habitats critical to survival may be accomplished for relatively sedentary species — for example, Red-Cockaded Woodpeckers (*Picoides borealis*) or timber wolves (*Canis lupus*). Habitat conservation for migrant or wandering species, however, can be problematic because these species may use widely disjunct habitat patches. For migrants that concentrate on staging or wintering sites — for example, shorebirds, Whooping Cranes (*Grus americana*), or Bald Eagles (*Haliaeetus leucocephalus*) — it may be possible to identify specific areas of consistent use and protect them as a network (Myers et al. 1987). But the pattern of movement may be too diffuse to concentrate protection in just a few sites for songbirds that migrate to the neotropics (Keast & Morton 1980), or wandering species with disjunct daily habitat needs like California Condors (*Gymnogyps californianus*) and Wood Storks, which nest and forage in widely separated sites (Snyder 1986; Kushlan 1986), or Snail Kites. Adequate habitat protection for such species must target many scattered sites to form a natural landscape matrix.

### Acknowledgments

This work was supported by the U.S. Fish and Wildlife Service and the National Zoological Park. Beissinger was

supported by a National Science Foundation postdoctoral fellowship in environmental biology during the preparation of this manuscript. We wish to express special thanks to Joyce M. Kleen, James A. Rodgers, Jr., and Anne Cox for their support in collecting and compiling data. We are grateful to the following observers who helped with key discoveries: Ken and Carol Snyder, Ellie Van Os, Betty and Ernest Wargo, Mikel Hulon, Mike Zaffke, and Ken and Cynthia Peacock. Our appreciation also goes to Oron L. Bass, Jr., and the staff at Loxahatchee NWR. Herbert W. Kale, II, James A. Rodgers, Jr., Noel F. R. Snyder, Arnold Banner, Ellie Van Os, Mike Bentzien, and two anonymous reviewers graciously reviewed and improved this paper. We are indebted to many observers who reported Snail Kite sightings to our hotline.

## Appendix

Locations (followed by observers' initials<sup>1</sup> in parentheses) (see Acknowledgments for a key to observers) for drought-related sightings (Table 1): 1. SW end of Lochloosa Lake on Cross Creek (LH); 2. Miami near NW 95th St and 14th Ave intersection (DH); 3. N of Everglades National Park and C-111 canal, W of US 1 (AS); 4. Jacksonville along SR 115, N of US 1 junction (PP, MD); 5. 1.6 km W of Moore Haven at US 27 and SR 78 intersection (PAQ, TC); 6. Between SR 78 and Lake Okeechobee levee, halfway between Moore Haven and Okeetontee (TC); 7. E of Clewiston along US 27 (LA); 8. 11.2 km W of Clewiston at intersection of US 27 and SR 80 (HQ, JQ); 9. On US 27 1.9 km W of Clewiston (RM1); 10. 3.2 km SW of Clewiston (DFQ); 11. On SR 80 1 km W of US 27 (PAQ, DGB); 12. Florida Turnpike 1.6 km E of the Radubough Rd overpass (PWS); 13. W of CR 512, 1.2 km N of SR 60 (JAR, AW1); 14. N of SR 60 and W of CR 512, 1.2 km N of SR 60 (JAR, AW1); 15. Turnpike at mile marker 131.2 (PAQ); 16. W side of Lake Harris at Helena Run (CB); 17. W of Tequesta on S side of SR 710 3.2 km NW of SR 706 intersection (TR); 18. Near Platts Bluff on the Kissimmee River at Pool E, 22 km N of Lake Okeechobee (LP); 19. Turnpike just S of SR 60 (PWS); 20. Lake Kissimmee marshes (BW, EW, MH, VW, JAR, BK, PM, LG, BC, MB, GZ, GT); 21. Lake Tohopekaliga marshes (GW, MH, JAR); 22. Lake Hatchineha at S end of C-37 canal (MB); 23. West Palm Beach Water Catchment Area in the N 3.2 km and in S central marshes (AC, PW, JET, TC, DA, SA, JS, EVO, AB); 24. North Palm Beach along the Florida Turnpike, from just N of SR 702 S 0.8 km to the M canal (BSN, HWK, TR, WD, SM, PAQ, JC, DS, RH, BF, LDB, WVM); 25. Just E of the West Palm Beach Water Catchment Area and 0.8 km N of SR 702 (JET, JMK, EVO, KS, CS, JFS, PM, DP, RF, TR); 26. SW and NW corners of the PGA National development along the C-18 canal (TP, MCB, EVO); 27. W of the West Palm Beach Water Catchment Area and 0.5 km N of the M canal (JET, EVO, AB); 28. NW of Palm Beach Gardens on SR 710 1.6 km SE of SR 711 intersection (KS); 29. 1.6 km E of SR 710 on SR 706 (WVM); 30. Wellington 0.8 km SW of the Palm Beach Polo Grounds and 2.9 km NE of Loxahatchee N.W.R. (CP, KP, JET, RD, PWS, BH, JH, BF, EVO, JMK, JFS, CL, KS, HW, AW2, WVM); 31. 3 km portion of the M-1 canal in Royal Palm Beach, parallel to 130th

Ave N and 40th St, 3.5 km NW of the intersection of US 441 and SR 704 (RH); 32. Whitworth Farms E of US 441 and 2.5 km S of intersection with SR 804 (JW); 33. 1.6 km W of US 441 and 3.2 km S of Lantana Rd (RM2); 34. 3.2 km W of US 441 between Lake Worth and Lantana, W of Homeland entrance (BSN); 35. Lake Woodruff N.W.R. in marsh impoundments W of Spring Garden Lake (LR, NC).

## Literature Cited

- Beissinger, S. R. 1983. Hunting behavior, prey selection, and energetics of Snail Kites in Guyana: consumer choice by a specialist. *Auk* **100**:84–92.
- Beissinger, S. R. 1986. Demography, environmental uncertainty, and the evolution of mate desertion in the Snail Kite. *Ecology* **67**:1445–1459.
- Beissinger, S. R. 1987. Anisogamy overcome: female strategies in Snail Kites. *American Naturalist* **129**:486–500.
- Beissinger, S. R. 1988. The Snail Kite. Pages 148–165 in R. S. Palmer, editor. *Handbook of North American birds*. Volume IV. Yale University Press, New Haven, Connecticut.
- Beissinger, S. R., and N. F. R. Snyder. 1987. Mate desertion in the Snail Kite. *Animal Behaviour* **35**:477–487.
- Beissinger, S. R., and J. E. Takekawa. 1983. Habitat use by and dispersal of Snail Kites in Florida during drought conditions. *Florida Field Naturalist* **11**:89–106.
- Bent, A. C. 1937. Life histories of North American birds of prey. Part 1. United States National Museum Bulletin **167**:70–78.
- Davis, J. H., Jr. 1946. The peat deposits of Florida. *Geological Bulletin No. 30*, Florida Geological Survey, Tallahassee, Florida.
- Drabelle, D. 1985. The endangered species program. Pages 72–91 in A. S. Eno and R. L. Di Silvestro, editors. *Audubon Wildlife Report*. National Audubon Society, New York.
- Kale, H. W., II, editor. 1978. *Rare and endangered biota of Florida*. University Presses of Florida, Gainesville, Florida.
- Keast, A., and E. S. Morton, editors. 1980. *Migrant birds in the neotropics: ecology, distribution and conservation*. Smithsonian Institution Press, Washington, D.C.
- Kushlan, J. A. 1986. Responses of wading birds to seasonally fluctuating water levels: strategies and their limits. *Colonial Waterbirds* **9**:155–162.
- Leitzell, T. L. 1986. Species protection and management decisions in an uncertain world. Pages 243–254 in B. G. Norton, editor. *The preservation of species: the value of biological diversity*. Princeton University Press, Princeton, New Jersey.
- Lin, S., J. Lane, and J. Marban. 1984. Meteorological and hydrological analysis of the 1980–82 drought. Technical Publications 84-7, South Florida Water Management District, West Palm Beach, Florida.
- Myers, J. P., R. I. Morrison, P. Z. Antas, B. A. Harrington, T. E. Lovejoy, M. Sallaberry, S. E. Senner, and A. Tarak. 1987. Con-

<sup>1</sup>The names of observers are available from the author.

- servation strategy for migratory species. *American Scientist* 75:19–26.
- Rodgers, J. A., Jr., S. T. Schwikert, and A. S. Wenner. 1988. Status of the Snail Kite in Florida: 1981–1985. *American Birds* 42:30–35.
- Sidle, J. G. 1987. Critical habitat designation: is it prudent? *Environmental Management* 11:429–437.
- Snyder, N. F. R. 1986. California condor recovery program. Pages 56–71 in S. E. Sanner, C. M. White, and J. R. Parrish, editors. *Raptor conservation in the next 50 years*. Raptor Research Report No. 5.
- Snyder, N. F. R., S. R. Beissinger, and R. E. Chandler. 1989. Reproduction and demography of the Florida Everglade (Snail) Kite. *Condor* 91:300–316.
- Sprunt, A., Jr. 1945. The phantom of the marshes. *Audubon Magazine* 47:15–22.
- Sprunt, A., Jr. 1954. *Florida bird life*. Coward-McCann, New York.
- Stieglitz, W. O., and R. L. Thompson. 1967. Status and life history of the Everglade kite in the United States. *Special Science Report — Wildlife Number 109*, United States Department of the Interior, Bureau of Sport Fisheries and Wildlife, Washington, D.C.
- Sykes, P. W., Jr. 1979. Status of the Everglade Kite in Florida — 1968–1978. *Wilson Bulletin* 91:495–511.
- Sykes, P. W., Jr. 1983a. Snail Kite use of the freshwater marshes of South Florida. *Florida Field Naturalist* 11:73–87.
- Sykes, P. W., Jr. 1983b. Recent population trend of the Snail Kite in Florida and its relationship to water levels. *Journal of Field Ornithology* 54:237–246.
- Sykes, P. W., Jr. 1984. The range of the Snail Kite and its history in Florida. *Bulletin of the Florida State Museum, Biological Sciences* 29:211–264.
- Sykes, P. W., Jr. 1985. Evening roosts of the Snail Kite in Florida. *Wilson Bulletin* 97:57–70.
- Thomas, T. M. 1974. A detailed analysis of climatological and hydrological records of South Florida with reference to man's influence upon ecosystem evolution. Pages 82–122 in P. J. Gleason, editor. *Environments of South Florida: past and present*. Memoir 2, Miami Geological Society, Miami, Florida.
- U.S. Fish and Wildlife Service. 1986. Everglade Snail Kite (*Rostrhamus sociabilis plumbeus* Ridgeway) revised recovery plan. U.S. Fish and Wildlife Service, Atlanta, Georgia.
- Yaffee, S. L. 1982. *Prohibitive policy: implementing the Federal Endangered Species Act*. M.I.T. Press, Cambridge, Massachusetts.

