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DENSITY AND HABITAT OF BREEDING SWALLOW-TAILED KITES IN THE LOWER SUWANNEE ECOSYSTEM, FLORIDA

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Abstract.—Historically the Swallow-tailed Kite (*Elanoides forficatus*) bred in the United States in at least 16 eastern states. Currently it is restricted to seven southeastern states, with most of its breeding range in Florida. Breeding Bird Surveys indicate a declining trend for this Neotropical migrant in most of Florida. Using a rapid survey technique at the Lower Suwannee NWR on 25–27 Mar. 1997, we scanned for kites from 16 sampling stations above the forest canopy, using 10× binoculars for 45 min per station. An effective detection distance of 2.4 km provided almost complete coverage of kite habitat (excluding salt marsh) on the refuge (14,620 ha) and in a 1.6-km buffer (13,526 ha). A mobile observation platform, extended to heights of 30–34 m provided an unobstructed view above the forest canopy where foraging bouts, feeding, courtship displays, and other activities by this species occur. This technique was found to be efficient in obtaining an estimate of potential breeding pairs. An estimated 19 breeding pairs were observed, with possibly five additional pairs, a density of at least one pair per 1173–1407 ha. There was no opportunity to search for nests so we were unable to correlate number of active nests with the number of kites observed, and linear nature of study area might concentrate birds, including nonbreeders, so our density of kites may or may not be typical for other areas. The refuge has a mosaic of 11 different habitats (7 forest types, freshwater and salt marshes, open water and urban/suburban) providing much linear edge to the matrix of different plant communities that range in height from less than 1 m to greater than 30 m. Such structure provides quality habitat for Swallow-tailed Kites.

DENSIDAD Y HABITAT REPRODUCTIVO DE *ELANOIDES FORFICATUS* EN LA PARTE INFERIOR DEL ECOSISTEMA SUWANEE, FLORIDA

Sinopsis.—Históricamente, el milano *Elanoides forficatus* se reprodujo en 16 estados de los E.U.A. Al presente el ave ésta restringida a siete estados de la parte sureste, con la mayoría del área reproductiva encontrándose en Florida. Los censos reproductivos indican una reducción de éste migratorio neotropical en gran parte de Florida. Del 25–27 de marzo de 1997, utilizando una técnica de censado rápido, tratamos de localizer milanos desde 16

estaciones de muestreos en el Refugio Nacional de Vida Silvestre de Suwanne. El censo se hizo sobre el docel del bosque utilizando binoculares 10× y dedicando 45 minutos/estación. Una distancia efectiva de hasta 2.4 km facilitó una cobertura completa del habitat del milano (excluyendo anegados salados) en el refugio (14,620 ha) y de 1.6 km de zona de amortiguamiento (13,526 ha). Plataformas movibles de observación, con altura extendible de 30–34 m permitieron observer, sobre el docel del bosque y sin obstrucción, patrones de forrajeo, alimentación y patrones de cortejo de las aves. La técnica fue eficiente para obtener estimados del número potencial de parejas reproductoras. Se estimaron 19 parejas reproductoras con la posibilidad de cinco adicionales y una densidad de un par de milanos por cada 1173–1407 ha. No hubo la oportunidad de buscar nidos, por lo que no pudo correlacionarse el número de nidos con el número de las aves observadas. El refugio tiene un mosaico de 11 habitats diferentes habilitando mucho borde lineal para la matris de diferentes comunidades de plantas que varían en altura desde 1 a más de 30 m. Este tipo de estructura proves de habitat adecuado para el milano estudiado.

Prior to 1880, the Swallow-tailed Kite (*Elanoides forficatus*) bred in the United States in at least 16 eastern states from coastal South Carolina, across the northern Gulf of Mexico to east-central Texas, northward through much of the Mississippi Valley and its tributaries to northwestern Minnesota and southern Wisconsin, and up the Ohio River to southwestern Ohio (Robertson 1988, Cely and Sorrow 1990). The species is currently restricted to parts of seven southeastern states, representing only 15% of the historic range, with most birds breeding in Florida (Meyer 1995).

Although there have been no range-wide systematic surveys of Swallow-tailed Kites, based on sightings, Breeding Bird Atlas results, and available habitat, there are an estimated 480–750 pairs breeding in Florida and 800–1150 pairs in the United States (Meyer 1995). At the end of the breeding season, the U.S. population probably is 3200–4600 individuals. There is no evidence of any population changes since a low point in the 1940s (Meyer and Collopy 1996), and there has not been much reoccupation or expansion into the former range (Robertson 1988, Cely and Sorrow 1990, Meyer and Collopy 1995, Meyer 1995), except for perhaps limited reoccupation of historical range in coastal South Carolina (Cely and Sorrow 1990) and recent colonization in the Upper Florida Keys (Robertson and Woolfenden 1992; W. B. Robertson, Jr., pers. comm.). Swallow-tailed Kites have not experienced the marked increases recently exhibited by the White-tailed Kite (*Elanus leucurus*), the Mississippi Kite (*Ictinia mississippiensis*) (Meyer and Collopy 1996), and the Snail Kite (*Rostrhamus sociabilis*) (Sykes et al. 1995, Bennetts and Kitchens 1997).

Causes for decline of the species are believed to be shooting, habitat loss, and habitat degradation (Robertson 1988, Meyer 1995, Meyer and Collopy 1996). Breeding Bird Surveys indicate local reductions of this Neotropical migrant in parts of Florida. The species is limited by low reproductive potential resulting from delayed breeding, small brood size ($n = 2$), low nesting success and productivity, and failure to renest following failure (Meyer and Collopy 1996). Strong fidelity to nest and roost sites promotes social behavior and efficient foraging, thus enhancing productivity and survival. However, these behaviors concentrate nesting ac-

tivity and discourage colonization of vacant habitat, thus increasing the species' vulnerability to disturbance (Meyer and Collopy 1996).

We conducted a rapid systematic survey of Swallow-tailed Kites on the Lower Suwannee National Wildlife Refuge (NWR) and adjacent areas to determine distribution and abundance of potential breeding pairs and to identify habitat associations of the core areas. This study was a Partnership Project between the Biological Resources Division of U.S. Geological Survey and the Refuge Division of the U.S. Fish and Wildlife Service, Southeastern Region, Atlanta, Georgia, in cooperation with the Lower Suwannee NWR, Chiefland, Florida.

STUDY AREA AND METHODS

The Lower Suwannee NWR, Dixie and Levy counties, Florida, was the focal area. We included some adjacent lands in a 1.6-km buffer around the refuge boundary. The Suwannee River flows southward through the eastern part of the refuge for 32 km before emptying into the Gulf of Mexico.

Kites were counted from a mobile observation platform (aerial manlift, model AMZ131XT; Fig. 1) at heights of 30–34 m above ground, affording an unobstructed view across the forest canopy (Fig. 2). A similar technique has been used in South Carolina (Cely and Sorrow 1990). From the raised aerial manlift, two observers using 10× binoculars continually scanned 360° at 16 predetermined survey stations (Fig. 3) for 45 min per station, recording locations, numbers, behaviors (e.g., pair flights, agonistic behavior, vocalizations), and movements of Swallow-tailed Kites. Cost (discount rate of US $4000 for 3 d; regular cost being US $6000) of the equipment rental necessitated conducting the survey throughout the day, 0830 to 1830 h EST and left no time to replicate counts at the survey stations. A circle with a radius of 2.4–3.2 km (distance estimated from aerial photos) was covered at each observation point. Approximately 95% of the refuge and adjacent private lands, excluding salt marsh (not used for nesting by kites), were surveyed in this manner. Kite locations were plotted on false-color infrared aerial vertical positive prints (flown 21 Jan. and 6 Mar. 1994, scale of 1:40,000), U.S. Geological Survey, National Aerial Photography Program, enlarged to 1:24,000. Features across the landscape could be seen from the observation platform, and these were located on the aerial photos, enabling us to plot locations of kites. Also, we were often able to check locations of these birds from two or more stations to further collaborate the birds' locations. From the plotted locations of two to three kites observed together, the estimate of the number of pairs was derived. The birds tended to stay in the vicinity of the core sites during the 45-min count period and often much longer, as some were also observed in the same area from adjacent observation points. The kite survey was conducted 25–27 Mar. 1997. Late March was chosen because kites in this region of Florida are then in the process of establishing/re-establishing their territories and tend to spend much time in a core area around the nest site (Meyer 1995). For convenience, we chose

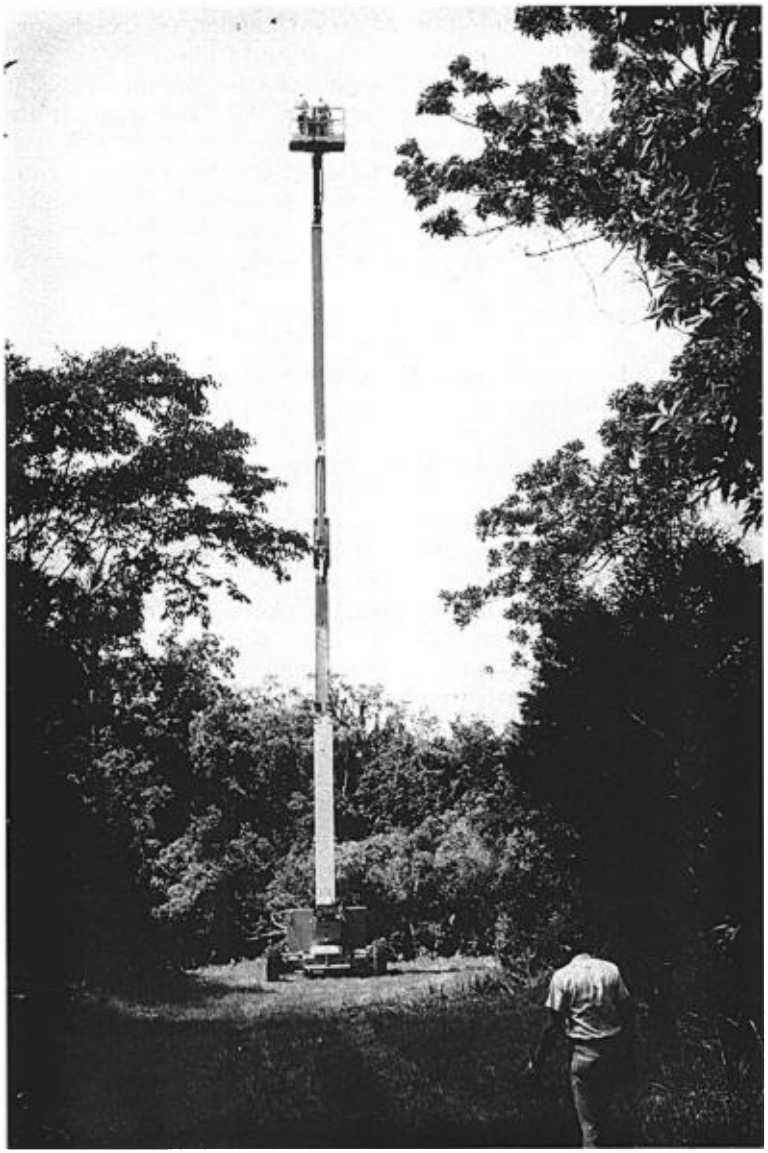

FIGURE 1. Observers counting Swallow-tailed Kites above the forest canopy from a mobile observation platform 30+ meters above ground at survey station number 3, Lower Suwannee NWR, Levy County, Florida, 25 Mar. 1997.

FIGURE 2. Southern hydric hardwood and bottomland forest with a taller emergent stand of pines in the center background. Such small emergent stands are favored nesting sites for Swallow-tailed Kites.

as the core area for each pair a circle with a radius of 0.8 km (= 203 ha) around the site where the pair were recorded during the observation period. The extensive road system within the study area provided access with the heavy equipment [the aerial manlift weighs 21,637 kg in addition to the weight of the lowboy (a low flat-bed heavy equipment trailer) and tractor-trailer]. Thus, the 16 kite survey stations had to be placed along roads that would accommodate the weight and provide space to maneuver this heavy equipment.

Eleven habitats or land cover types were selected for this study. These habitats are adapted from the *Florida land use, cover and forms classification system* (Florida Department of Transportation [DOT] 1985) and *Land use/land cover mapping project classification manual* (Suwannee River Water Management District [WMD] 1997) with the modifications explained in Appendix 1. The habitats were: (1) URBAN/SUBURBAN (included all development); (2) MIXED HARDWOOD/PINE (dominant species included Chapman oak (*Quercus chapmanii*), live oak (*Q. virginiana*), sand-live oak (*Q. geminata*), myrtle oak (*Q. myrtifolia*), yaupon (*Ilex vomitoria*), American holly (*I. opaca*), redbay (*Persea borbonia*), sweetbay (*Magnolia virginiana*), southern magnolia (*M. grandiflora*), red maple (*Acer rubrum*), sweetgum (*Liquidambar styraciflua*), hickories (*Carya* spp.), cabbage palm (*Sabal palmetto*), and southern red cedar (*Juniperus silicicola*), with slash pine (*Pinus elliotti*), longleaf pine (*P. palustris*), and loblolly pine (*P. taeda*) as minor associates); (3) PINE PLANTATION

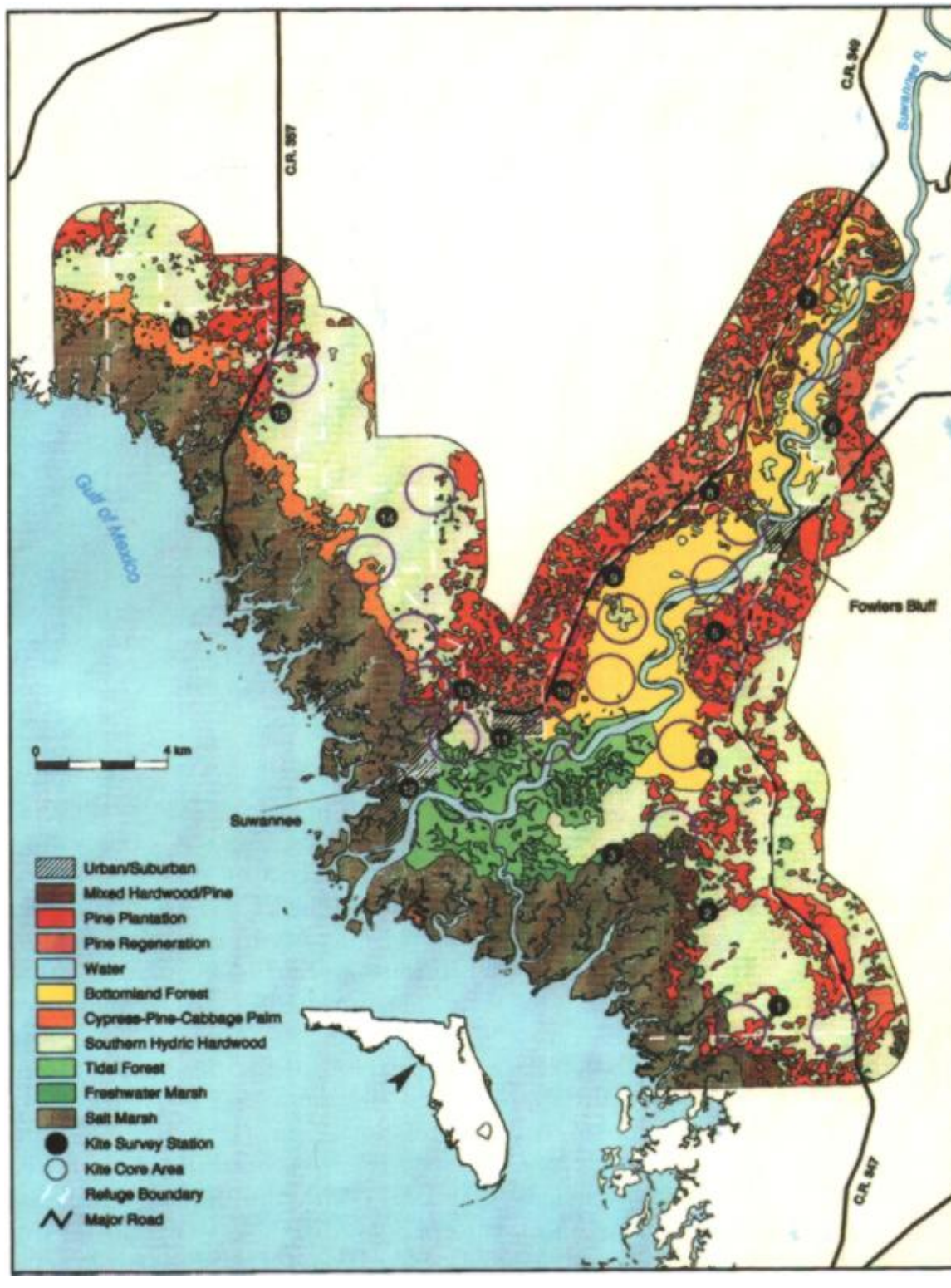

FIGURE 3. Lower Suwannee ecosystem study area, Dixie and Levy Counties, Florida. Study area includes the Lower Suwannee National Wildlife Refuge and a 1.6-km buffer zone around the refuge boundary. Sixteen Swallow-tailed Kite survey stations and 19 core areas are shown in relation to habitat and other physical features.

(planted in rows, mainly slash pine >10 yr old); (4) PINE REGENERATION (pine plantation, mainly slash pine ≤10 yr old); (5) OPEN WATER (included rivers, streams, waterways, lakes, ponds, etc.); (6) BOTTOMLAND FOREST (dominants included blackgum (*Nyssa biflora*), water tupelo (*N. aquatica*), bald cypress (*Taxodium distichum*), black titi (*Cliftonia monophylla*), titi (*Cyrilla racemiflora*), red maple, box elder (*Acer negundo*), river birch (*Betula nigra*), water oak (*Q. nigra*), sweetgum, coastal plain willow (*Salix caroliniana*), water hickory (*Carya aquatica*), redbay, sweetbay, Carolina ash (*Fraxinus caroliniana*), swamp ash (*F. pauciflora*), and common buttonbush (*Cephalanthus occidentalis*), with associated species of slash pine, loblolly pine, and short-leaf pine (*P. echinata*); (7) CYPRESS-PINE-CABBAGE PALM (included pure or mixed stands of pond cypress (*Taxodium ascendens*) or bald cypress, slash pine, pond pine (*P. serotina*), and cabbage palm, with associates being blackgum, water tupelo, black titi, swamp cottonwood (*Populus heterophylla*), red maple, American elm (*Ulmus americana*), pumpkin ash (*F. profunda*), Carolina ash, overcup oak (*Q. lyrata*), and water hickory); (8) SOUTHERN HYDRIC HARDWOODS (included mixed wetland forest communities in which neither hardwoods nor cypress clearly dominate the canopy or hardwood forest growing on low, flat hydric sites dominated by cabbage palm, red maple, live oak, water oak, laurel oak (*Q. hemisphaerica*), southern red cedar, and ironwood (*Bumelia lycioides*), or cut over wetlands in which not all vegetation has been removed); (9) TIDAL FOREST (wetland forest, inland of the salt marsh, which is affected by tidal flow at the mouth of the Suwannee River and dissected by freshwater marshes. It is dominated by bald cypress and various wetland hardwoods and similar to BOTTOMLAND FOREST); (10) FRESHWATER MARSH (dominants included sawgrass (*Cladium jamaicensis*), cattail (*Typha domingensis, T. latifolia, T. angustifolia*), arrowhead (*Sagittaria* spp.), maidencane (*Panicum hemitomon*), common buttonbush, cordgrass (*Spartina bakeri*), bulrush (*Scirpus* spp.), needlerush (*Juncus effusus*), common reed (*Phragmites communis, P. australus*), and arrowroot (*Thalia geniculata*); and (11) SALT MARSH (dominants included salt marsh cordgrasses (*Spartina alterniflora, S. patens, S. cynosuroides*), black needlerush (*J. roemerianus*), seashore saltgrass (*Distichlis spicata*), saltwort (*Batis maritima*), glassworts (*Salicornia* spp.), seaside daisy (*Borrichia frutescens*), and groundsel bush (*Baccharis halimifolia*). We used the exact Wilcoxon rank-sum test (Lehmann 1975) to test for differences in the percentage of each habitat type between core and random areas.

Vegetative cover and map of the Lower Suwannee NWR and surrounding areas (Fig. 3) were photo-interpreted as part of a regional project by the Suwannee River Water Management District. Habitat types and land uses were interpreted from false-color infrared, vertical, aerial positives at a scale of 1:40,000 taken on 21 Jan. and 6 Mar. 1994. Sixteen quarter-quadrangle positives were used to cover the four USGS 7.5-min quadrangles covering the refuge. These photos were scanned at a resolution of 24 microns, with a ground resolution of 4 ft per pixel. Images were reg-

istered using georeferencing procedures in Imagegraph's ImageStation analysis software package. Images were registered and projected to the State Plane East (feet) coordinate system with a ±6 root-mean-square-error (RMS). This process used ground control points obtained with a Global Positioning System (GPS) receiver. A total of 16 points were collected for each quad, with a final mapping accuracy meeting USGS 1:24,000 standards. Planimetric mapping of habitat types and land uses were performed by digitizing vegetation and land use boundaries from enlarged, infrared image printouts. Digitized vector data were converted into an ARC/INFO format. ARC/INFO was used to edit the resulting coverages and to add habitat and land use of the numerical classification system of the Florida land use, cover and forms classification system (Florida DOT 1985). Areal statistics summarizing the total coverage of each habitat type were then derived and a plot of the refuge and surrounding area were created utilizing ARC/INFO software. Twenty random circles, each with a radius of 0.8 km, were selected in a manner similar to the process previously outlined with a few adjustments. ARC/INFO GIS software was used to randomly select 40 points. A visual analysis was performed in order not to overlap with the previously delineated 19 core areas. The 40 points were overlaid with the core areas and 20 points selected that did not overlap the core areas nor contain more than 15% salt marsh. These 20 points were then buffered by 0.8 km to create the random circles and intersected with 1994 land cover data to obtain the habitat types within each.

RESULTS

A total of 59 Swallow-tailed Kites was observed (Table 1). This represents an estimated potential 19 breeding pairs at 19 core sites and possibly up to 24 breeding pairs. Kites were seen at 12 of the 16 survey stations, and eight potential pairs were seen from more than one station. Duplication of individuals was avoided by plotting their locations on aerial photographs. One or two extra, nonbreeding adults are present at most nest sites (Meyer 1995). We saw at least 16 pairs that had a third bird within their core area during the period of the survey. We treated each such group of three as a pair unit.

The density of potential breeding Swallow-tailed Kites within the study area (refuge + buffer) was approximately one pair for 1173–1407 ha (salt marsh excluded). At least 14 core areas were 75% or more within the refuge for a density of one pair per 1044 ha.

The core areas tended to be clumped (Fig. 3). Each of fifteen core areas was <2 km from another core area, and 12 were ≤1 km from another, while 10 were ≤1 km from the Suwannee River. All core areas were in mesic to hydric forested habitats, but at least six bordered along the edge of the extensive salt marsh, four overlapped the Suwannee River, and three extended into urban/suburban areas.

The study area, consisting of the Lower Suwannee NWR and the buffer zone around the refuge boundary, contains a total of 34,889 ha (includ-

TABLE 1. Swallow-tailed Kite survey at Lower Suwannee NWR and adjacent areas, Dixie and Levy Counties, Florida, 25–27 Mar. 1997.

Station number	Number observed	Estimated pairs[a]
1	6	2
2	0	0
3	3	1
4	5	2
5[b]	3	2
6	3	1
7	0	0
8	3	1
9	5	2
10	6	1–3
11	10	2–4
12	0	0
13	4	1–2
14	5	2
15	6	2
16	0	0
Total	59	19–24

[a] Behavior of kites at stations 10, 11, and 13 indicated possibly more pairs present than the lower conservative number.

[b] Although only three kites were observed at station 5, behavior of the birds and distances apart lead us to conclude there were two pairs.

TABLE 2. Habitats of the lower Suwannee ecosystem. Dixie and Levy Counties, Florida.

Habitat	Area (ha)					
	Lower Suwannee NWR		1.6 km buffer[a]		Study area	
	Amount	%	Amount	%	Amount	%
Urban/Suburban	15	<0.1	351	3	366	1
Mixed Hardwood/Pine	597	3	280	2	877	3
Pine Plantation (>10 yr)	2079	10	3807	26	5886	17
Pine Regeneration (≤10 yr)	421	2	1523	11	1944	6
Open Water (ponds, creeks)[b]	504	3	86	<0.1	590	2
Bottomland Forest	2709	13	432	3	3141	9
Cypress-Pine-Cabbage Palm	1093	5	412	3	1505	4
Southern Hydric Hardwood	5125	25	6455	45	11,580	33
Tidal Forest	1406	7	88	<0.1	1494	4
Freshwater Marsh	671	3	92	<0.1	763	2
Salt Marsh	5836	29	907	6	6743	19
Total	20,456	100	14,433	100	34,889	100

[a] Buffer consists of private lands, owned mainly by large wood products companies, around boundary of the refuge.

[b] Excludes waters of the Suwannee River and Gulf of Mexico.

TABLE 3. Habitats within 19 Swallow-tailed Kite core areas compared to 20 random areas, lower Suwannee ecosystem, Florida.

Core area	Habitat (ha)[a]											
	Urban/ suburban		Mixed hardwood/pine		Pine plantation		Pine regeneration		Open water		Bottomland forest	
	Amt.	%	Amt.	%	Amt.	%	Amt.	%	Amt.	%	Amt.	%
1					42	21						
2			13	6	63	31			1	1		
3			70	35	11	5						
4					142	70			2	1	2	1
5					13	6					173	86
6					137	67	3	1	1	1		
7	2	1			13	6			43	21	102	51
8			17	8	4	2			34	17	108	53
9	5	2	16	8	21	10			17	8	117	58
10											159	78
11					136	67			3	1	1	1
12											203	100
13	28	14					5	2	26	13	35	17
14	23	11	1	1	3	1			1	1	1	1
15					7	3						
16			2	1	58	29			2	1	1	1
17					10	5						
18												
19					31	15						
Total	58	2	119	3	691	18	8	<0.5	130	4	902	23
Mean ± SE All areas:												
Core	3 ± 1.9		6 ± 3.8		36 ± 11.3		0.4 ± 0.3		7 ± 3.0		48 ± 16.3	
Random	3 ± 2.2		3 ± 2.0		35 ± 9.0		10 ± 5.4		9 ± 3.1		17 ± 7.2	
Frequency of Occurrence All areas (%):												
Core	21		32		79		11		53		59	
Random	20		10		75		35		65		35	

[a] Amount of habitat rounded to nearest whole hectare.

TABLE 3. Extended.

Habitat (ha)[a]										
Cypress-pine-cabbage palm		Southern hydric hardwood		Tidal forest		Freshwater marsh		Salt marsh		Area total
Amt.	%	Amt.	%	Amt.	%	Amt.	%	Amt.	%	
		161	79							203
		94	46			8	4	24	12	203
		122	60							203
21	10	36	18							203
		17	8							203
12	6	50	25							203
		43	21							203
		40	20							203
		26	13			1	1			203
		44	22							203
5	2	58	29							203
										203
				89	44	20	10			203
5	2	98	48	24	12	32	16	15	7	203
52	26	116	58			15	7	13	6	203
16	8	48	24			12	5	64	31	203
		193	95							203
50	25	143	71			3	1	7	3	203
7	3	165	82							203
168	4	1,454	38	113	3	91	2	123	3	3,857
9 ± 3.7		76 ± 13.5		6 ± 4.9		5 ± 2.0		7 ± 3.6		
5 ± 2.9		96 ± 13.4		18 ± 10.1		7 ± 2.4		1 ± 0.4		
42		89		11		37		26		
35		90		25		50		10		

TABLE 4. Summary statistics of the percentage of each habitat type per circle. An exact Wilcoxon rank-sum test was used to test for differences between core (n = 19) and random (n = 20) areas.

Habitat type	Core		Random		
	Mean	SD	Mean	SD	P
Urban/Suburban	1.50	3.96	1.58	4.82	0.8430
Mixed Hardwood/Pine	3.09	8.11	1.35	4.34	0.1830
Pine Plantation	17.92	24.20	17.27	19.78	0.8834
Pine Regeneration	0.21	0.64	4.75	12.00	0.0467
Open Water	3.37	6.47	4.58	6.83	0.3073
Bottomland Forest	23.39	34.95	8.23	15.77	0.1474
Cypress/Pine/Cabbage Palm	4.36	7.92	2.46	6.40	0.4224
Southern Hydric Hardwood	37.70	28.95	47.44	29.02	0.2732
Tidal Forest	2.93	10.27	8.67	20.74	0.2816
Freshwater Marsh	2.36	4.39	3.45	5.35	0.4284
Salt Marsh	3.19	7.63	0.22	0.88	0.1052

ing salt marsh; refuge 20,456 or 59% and buffer 14,433 or 41%). The dominant habitats (Table 2) are southern hydric hardwood (33%), salt marsh (19%), and pine plantation (17%). Within the refuge, salt marsh (29%), southern hydric hardwood (25%), bottomland forest (13%) and pine plantation (10%) comprise the largest amount of habitat, while in the buffer, southern hydric hardwood (45%), pine plantation (26%) and pine regeneration (11%) have the most.

The frequency with which habitats occurred within core nesting areas is summarized in Table 3. Southern hydric hardwood, present in 89% of the core areas, was the major habitat within these sites, with a mean of 76 ha per area (37%). This was followed by bottomland forest, present in 59% of all the areas, with a mean of 48 ha per core area (24%). Pine plantation, present in 79% of all the areas, had a mean of 36 ha per core area (18%). The remaining eight habitats each had a mean area of $\leq$9 ha within each core circle, but the frequency of occurrence within the areas was relatively high for open water (53%), cypress-pine-cabbage palm (42%), freshwater marsh (37%), mixed hardwood/pine (32%), salt marsh (26%).

Means and standard deviations of the percentage of each habitat type are given in Table 4, separately for core (n = 19) and random (n = 20) areas. There were no significant differences (exact Wilcoxon rank-sum test) between percentages of habitats in core and random areas, except for Pine Regeneration which is a minor component within lower Suwannee ecosystem and may represent a Type I error.

DISCUSSION

We found the rapid survey technique (3 d in our case) using the aerial manlift to be an efficient method of obtaining an estimate of the number of pairs of potential breeding Swallow-tailed Kites over a large area

(34,889 ha in this study). This was possible for the following reasons: kites are gregarious, vocal, and frequently engage in agonistic and courtship behaviors from the time of their arrival on the breeding grounds (Snyder 1974, Meyer and Collopy 1995). Arrival dates are fairly consistent for a given locality (Meyer 1995). Arrival times of the kites in the region of the lower Suwannee River are generally mid-March. Prospective nesting sites are marked by conspicuous activity, often by three or more birds, before nest building begins (Meyer and Collopy 1995). During such time the pairs tend to remain for long periods each day in what we call a core area that is generally around the nest site. Thus, using the equipment described, we had an unobstructed view across the forest canopy, enabling us to count kites and make an estimate of the number of pairs.

We caution that we did not have the opportunity to ground truth for nests so we are unable to correlate the number of active nests with the number of kites observed. Furthermore, the linear nature of the habitat at the Lower Suwannee NWR might concentrate birds, including nonbreeders, so our density of kites may or may not be typical for other areas. The next step is for someone to determine the number of nesting pairs in relation to the number of kites observed using the survey technique herein described so as to determine the reliability of the population estimate obtained.

In coastal South Carolina (Francis Marion National Forest), there were an estimated 80 pairs in 165,000 ha (Cely and Sorrow 1990) or a mean of 2073 ha per pair. The estimated density of kites on the Lower Suwannee ecosystem (19–24 pairs; salt marsh excluded) was 1173–1407 ha per pair. Given that kites are highly social and relatively non-defensive and their nests are clumped into "neighborhoods" and because habitats within the bigger landscapes are so heterogeneous and vary so much in their distribution, density estimates may range widely between localities (K. D. Meyer, pers. comm.). The study area (Fig. 3), the Lower Suwannee NWR in particular, consists of a complex mosaic of 11 habitat types. Heights of the vegetation range from $\geq$1 m in the freshwater marshes up to approximately 36 m in a few small areas of the more mature forest. The structure of the forest canopy across the landscape is highly variable in height with lone emergent trees and scattered emergent domes of taller pines, cypress, or water tupelo providing an unevenness to the canopy in a region of otherwise flat topography. Such structure of plant communities provides quality habitat for Swallow-tailed Kites (Meyer 1995, Meyer and Collopy 1996). Hence, the Lower Suwannee NWR is a very important breeding area for this Neotropical migrant.

Foraging bouts by adults, particularly after nestlings do not require much brooding, may encompass large areas (Robertson 1988; W. B. Robertson, Jr., pers. comm.), and, in our case, the kites may well have ranged the whole study area and beyond. Three breeding radio-tagged adult Swallow-tailed Kites in southern Florida had estimated range sizes of 30.8, 117.1, and 10.6 km^2 with maximum distances traveled of 5.8, 26.5, and 4.1 km, respectively (Meyer and Collopy 1995). Straight-line distances to

key foraging sites maxed at about 20 km (Cely and Sorrow 1990, Meyer and Collopy 1995). This was only where ranges were linear, so distances traveled vary depending on size, shape, and distance foraging sites are in relation to nest sites.

The lack of significant differences in the percentages of habitats between core and random areas may be due to the level of resolution used for habitats across the landscape in this study. Thus, a finer tuned method of habitat measurement or addition of other parameters will be required to determine differences between core and random sites.

The survey technique herein described might prove to be valuable for surveying all the southern coastal floodplain habitats where Swallow-tailed Kites are suspected or known to be present, or if accuracy can be verified by corroborative methods.

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APPENDIX. Land cover types (habitats) used in this study were modified from *Florida land use, cover and forms classification system* (FLUCFCS) (Florida Dept. Transportation 1985) and *Land use/land cover mapping project classification manual* (Suwannee River Water Management District 1997).

Habitats (this study)	Code	FLUCFCS description[a]
Urban/suburban	1130	Low density residential, mixed
	1140	Ranchettes, fixed (>5 ac/du)
	1150	Ranchettes, mobile
	1160	Ranch, mixed
	1210	Medium density residential (2–5 du/ac)
	1230	Medium density residential/mixed
	1400	Commercial and services
	1756	Maintenance yards
	1810	Swimming beach
	1840	Marinas and fishing camps
	1860	Community recreation facilities
	1923	Inactive developed land, non-forested
	1924	Inactive developed land, forested
	2110	Improved pasture
	7410	Rural land in transition without positive indications of intended activity
	8330	Water supply plants
	8350	Solid waste disposal
Mixed hardwood/pine	3290	Other shrubs and bushes
	4140	Pine-mesic oak
	4250	Temperate hardwood
	4320	Oak scrub
	4340	Hardwood-conifer mix
	4390	Maritime hammock
Pine plantation (>10 yr old)	4410	Pine plantation
Pine regeneration (≤10 yr old)	4430	Forest regeneration
Open water	5100	Streams and waterways
	5120	Embayments not opening directly into the Gulf of Mexico
	5230	Lakes 10–100 acres
	5240	Lakes <10 acres, dominant features
	5340	Reservoirs <10 acres, dominant features
	5410	Embayments opening directly into the Gulf of Mexico

APPENDIX. Continued.

Habitats this study	Code	FLUCFCS included description[a]
Bottomland forest	6130	Gum swamp
	6140	Shrub swamp
	6150	Bottomland hardwood
	6170	Mixed wetland hardwoods
Cypress-pine-cabbage palm	6210	Cypress
	6220	Wet flatwoods
	6240	Cypress-pine-cabbage palm
Southern hydric hardwood	6300	Wetland mixed forest
	6310	Hydric hammock
	6600	Cutover wetlands
Tidal forest	6320	New tidal forest
Freshwater marsh	6410	Freshwater marshes
	6430	Wet prairie
	6440	Emergent aquatic vegetation
Salt marsh	3220	Coastal shrub
	6420	Salt marshes
	6510	Salt barrens
	6530	Inland shores

[a] ac = acre; du = dwelling unit.