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Possible Use of Wading Birds as Beaters by Snail Kites, Boat-Tailed Grackles, and Limpkins

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Possible use of wading birds as beaters by Snail Kites, Boat-tailed Grackles, and Limpkins.—Foraging in single- or mixed-species flocks is common among many bird species, and the advantages of being in these flocks have been the focus of several investigations (reviewed by Moynihan 1962, Bertram 1978). It has been hypothesized that birds occurring in mixed-species flocks gain advantages from (1) reduced predation risk (e.g., Moynihan 1962, Morse 1970), (2) increased foraging efficiency (e.g., Moynihan 1962, Morse 1970), or (3) social learning (e.g., Ward and Zahavi 1973). Here, we report the anomalous occurrence of flocks consisting of species not typically found in the types of aggregations we describe and suggest the possible function of these aggregations with respect to these hypotheses.

Wading birds commonly forage in mixed-species flocks in the tropics (Caldwell 1981), and both White Ibis (*Eudocimus albus*) and Great Egrets (*Casmerodius albus*) are well known to forage in large groups in the Everglades (Kushlan and Bildstein 1992, Bancroft and Sawicki 1995). In contrast, Snail Kites (*Rostrhamus sociabilis*) may roost and nest communally with or without other species (reviewed by Sykes et al. 1995) but are not reported to forage in mixed-species flocks, even though birds often do forage in proximity to conspecifics. Boat-tailed Grackles (*Quiscalus major*) commonly forage in small single-species groups (e.g., 2 or 3) and occasionally forage in mixed-species flocks with other icterid species (G. T. Bancroft, pers. comm.). They will occasionally attempt to pirate apple snails (*Pomacea paludosa*) from Limpkins (*Aramus guarauna*) or Snail Kites (Snyder and Snyder 1969). However, they are not generally known to forage in large mixed-species flocks with wading birds or Snail Kites (G. T. Bancroft, pers. comm.). Limpkins also are not reported to forage, nest, or roost in large groups (D. Bryan, pers. comm.).

Study area and methods.—We intermittently observed foraging flocks of White Ibis, Great Egrets, Boat-tailed Grackles, Snail Kites, and single-species flocks of Limpkins between 30 December 1993 and 30 January 1994 on and adjacent to the Miccosukee Indian Reservation in Water Conservation Area 3A, Broward County, Florida. The study area consisted primarily of wet prairie habitats comprised mostly of spike rush (*Eleocharis* sp.), maidencane (*Panicum* sp.), and sawgrass (*Cladium jamaicense*) interspersed with linear strands of cypress (*Taxodium ascendens*). Water depths in the wet prairie communities at the time of this study were approximately 10–20 cm.

Our observations consisted of locating individual radio-transmittered Snail Kites as part of a larger ongoing study of survival and movements of Snail Kites throughout Florida. For each transmittered bird, we recorded whether or not they were associated with a flock. We defined a flock as a group of individuals in close proximity (i.e., most individuals were $<$ 10 m from their nearest neighbor) and moving in concert (Hutto 1987). The flocks described here were clearly not merely chance aggregations, but rather were maintaining the association by shifting foraging locations in concert. When the wading birds moved, the Snail Kites and Boat-tailed Grackles followed them within a few minutes. Similarly, when part of a Limpkin flock flew to a new location the remainder of the flock followed over a period of several minutes such that they all appeared to end up at the new location.

In addition to radio-transmittered bird locations, we also conducted a count in which we systematically traversed the wet prairies north to south (using a Global Positioning System and the linear strands of cypress to avoid overlap of areas) and recorded the number of individuals of each species for all flocks we observed. This count was conducted on one day (17 January 1994) to avoid the potential for recording the same flock on several occasions. We also used the presence of known individual radio-transmittered kites to maintain the independence of our observations by assuring that each observed flock had been counted

only once. To prevent double counting, we checked each flock encountered for the presence of radio-transmittered kites and did not count any flock in which a previously encountered radio-transmittered bird was present in case the flock had moved (N = 1 flock).

White Ibis were the most difficult species to count because foraging birds were well concealed in the grass and movements usually were in large groups. Consequently, we had to flush the ibis after counting the kites and grackles in order to estimate flock size. We then made a crude estimate of flock size by actually counting small numbers (e.g., 25) and estimating how many of that group size were within the whole flock. Limpkins also had to be counted after being flushed. However, unlike White Ibises, Limpkins did not flush synchronously but rather flushed in small groups (e.g., 5–20) over a period of several minutes. Consequently, we were able to count the number of Limpkins directly. Great Egrets also occurred in large flocks but were somewhat easier to count than White Ibis or Limpkins because their larger size and erect foraging profile enabled visual observation without having to flush the birds. Boat-tailed Grackles and Snail Kites were relatively easy to count because they perched on small trees adjacent to the foraging ibis. Logistical constraints precluded counting individual or small groups of Boat-tailed Grackles that were not associated with mixed-species flocks. Thus, our summary statistics for this species apply only to birds associated with mixed-species flocks.

We used Pearson's product moment correlation (SAS Inc. 1988) to examine the relationships among group sizes of individual species. Prior to this procedure, we tested for normality of the data for Snail Kites, Boat-tailed Grackles, and combined wading birds (i.e., White Ibis and/or Great Egrets) using a Shipiro-Wilks statistic (SAS inc. 1988) and failed to reject the assumption of normality (at $\alpha = 0.05$) for any of these data. We did not include Little Blue Herons or Tricolored Herons as part of the wading-bird flock size because these species, although sometimes present, often foraged adjacent to the primary flock.

Results.—We observed two primary types of flocks: (1) mixed-species flocks consisting of White Ibises or Great Egrets, in association with Boat-tailed Grackles and Snail Kites, and (2) single-species flocks of Limpkins (Table 1). Although we observed some grackles in proximity to flocks of Limpkins, we did not consider these mixed-species flocks because it was not apparent that the grackles moved in concert with the Limpkins. These were more likely opportunistic aggregations. We did not observe any flocks of White Ibises or Great Egrets during this period without kites and grackles present. Similarly, all radio-transmittered Snail Kites (N = 56 locations of 14 Snail Kites) in this vicinity and located during this period were associated with mixed-species flocks. We did, however, observe several grackles in the area which were not associated with mixed-species flocks. Limpkins were not associated with the other species, except that a few grackles (usually <10) may have been in proximity to Limpkin flocks.

Not all species appeared to maintain actively the mixed-species associations. Rather, White Ibises and Great Egrets appeared to move independently of the kites or grackles and were subsequently followed within a short period of time (usually < 5 min). Wading bird species acted as "core" species of mixed-species flocks with other species as "followers" has previously been reported (e.g., Kushlan 1978, Caldwell 1981).

Our estimates of White Ibis flock size ranged from 50–450 individuals per flock ($\bar{x}$ = 205, SD = 160, N = 6). The flock size of Great Egrets ranged from 90–150 ($\bar{x}$ = 120, SD = 42, N = 2). Numbers of Snail Kites per flock ranged from 4 to 54 ($\bar{x}$ = 21, SD = 18, N = 8). Numbers of grackles per flock ranged from 8–79 ($\bar{x}$ = 31, SD = 23, N = 8). Numbers of Limpkins (not all were in flocks) ranged from 1–116 ($\bar{x}$ = 22, SD = 34, N = 12).

There was a significant correlation between the number of Snail Kites and the number of wading birds (White Ibises and/or Great Egrets)($r = 0.79$, $P = 0.02$). There were weaker

TABLE 1

NUMBER OF SNAIL KITES, BOAT-TAILED GRACKLES, WHITE IBISES, GREAT EGRETS, LIMPKINS, AND OTHER SPECIES COUNTED IN EACH FLOCK OR SOLITARY BIRD ENCOUNTERED ON 17 JANUARY 1994

Snail Kites	Boat-tailed Grackles	White Ibises	Great Egrets	Limpkins	Other[a]
6	27	0	90	0	15
4	8	0	150	0	7
12	19	50	0	0	0
54	79	450	0	0	0
19	43	75	0	0	0
28	31	350	2	0	2
37	11	175	0	0	0
8	28	130	0	0	0
0	0	0	0	2	0
0	0	0	0	23	0
0	0	0	0	17	0
0	7	0	0	116	0
0	3	0	0	57	0
0	0	0	0	1	0
0	0	0	0	2	0
0	0	0	0	7	0
0	4	0	0	34	0
0	0	0	0	1	0
0	0	0	0	2	0
0	0	0	0	3	0

[a] Little Blue Herons and Tricolored Herons.

correlations between numbers of Boat-tailed Grackles and wading birds ($r = 0.64$, $P = 0.08$) and between Snail Kites and Boat-tailed Grackles ($r = 0.66$, $P = 0.07$).

Discussion.—Reduced predation risk was unlikely to have caused the formation of these flocks because the risk of predation for adult herons and Snail Kites is relatively low (Caldwell 1981, Sykes et al. 1995). In addition, the primary predator of adult Snail Kites is probably the Great-horned Owl (*Bubo virginianus*)(Sykes et al. 1995), which would not have been a major threat during diurnal feeding. Social learning is also unlikely to have caused the formation of these flocks because herons frequently return to the same general area for feeding, making the need for social information unnecessary (Caldwell 1981). Additionally, the primary prey of the kites, grackles, and Limpkins during this period was apple snails, whereas adult apple snails would have been unlikely to have been anything more than an occasional food item for the "core" wading bird species (P. Frederick, pers. comm.). Consequently, there would have been little advantage for birds feeding on apple snails to gain information on the foraging location of birds feeding on other prey. Our observations were, however, consistent with the hypothesis of increased foraging efficiency (although not through social learning).

Based on hundreds of hours of field observations of Snail Kites in Florida, it was apparent that food intake by these birds in mixed-species flocks was extremely high. Unfortunately, these flocks persisted for only 4–5 weeks and had dissipated before we had an opportunity

to measure food intake rates directly. However, casual observations of foraging birds (≈ 12–16 h over the study period) indicated that Snail Kites often took less than one minute of flight time to capture a snail, considerably shorter than times previously reported (e.g., reviewed by Sykes et al. 1995). We have no such experience with which to compare Boat-tailed Grackles or Limpkins; however, both appeared to be capturing apple snails with little difficulty.

One strategy of mixed-species group foraging that has been previously reported, particularly in association with Ciconiiformes, is the use of beaters (e.g., Courser and Dinsmore 1975, Kushlan 1978, Russell 1978). In this strategy, individuals of a group flush prey as a result of their activity, which then enhances the opportunities for other individuals (Rand 1954). Snail Kites and Boat-tailed Grackles were mostly foraging among the wading birds rather than merely in their vicinity. They also actively followed the foraging flocks of wading birds. This suggests some advantage associated with the wading birds themselves, rather than just mutual attraction to areas of high prey density. We suggest that the kites and grackles were using the wading birds as beaters. During this time we observed that the physical disturbance from our air boat in the water sometimes revealed live floating apple snails. We checked several snails to confirm that they were alive and their visible presence would usually be short lived, as they dropped in the water column very shortly after the disturbance. We believe that the shallow water in combination with disturbance of the substrate from the foraging wading bird flocks provided a short burst of availability of apple snails, which was the primary prey for the three species (Snail Kites, Boat-tailed Grackles, and Limpkins) not typically found in foraging flocks.

This potential explanation still leaves unanswered why Limpkins were in single-species flocks. Unlike Snail Kites and Boat-tailed Grackles, Limpkins have long legs and often wade while foraging (Snyder and Snyder 1969). Thus, if "beating" offers an advantage to foraging in flocks, Limpkins are capable of forming their own single-species flocks, and unlike kites or grackles, would not need to rely on other species to disturb the substrate.

We can only speculate about why the use of beaters would have been used at this place and time, and not otherwise a common foraging strategy; although this behavior has been observed on a few occasions in other areas (e.g., Everglades National Park and Big Cypress National Preserve) since our original observations (M. Wilson, S. MacDonald, S. Dayhoff, pers. comm.; pers. obs.). Each time these flocks have been observed their dissipation has coincided with the time that Snail Kites, Boat-tailed Grackles, and Limpkins usually begin breeding in this area (January-February) (Sykes et al. 1995, pers. obs.). Consequently, the restricted mobility associated with breeding may have precluded persistence of these flocks. Water levels in these areas also were lower than those typically used, at least by nesting Snail Kites (Sykes et al. 1995), and sufficient water would have been unlikely to persist for the duration of breeding if nests had been initiated in the areas where these flocks formed.

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