

control better home ranges than others, at least with respect to available nest sites. These possibilities need not be mutually exclusive, nor can they be distinguished with our data.

Nest sites have been suggested as a limiting resource in some hole-nesting and colonial species (Lack 1968, Welty 1975, Brown 1975), but the possibility that they also may be limiting in tree-nesting species has received scant attention (Balda 1970). In Monteverde the number of isolated trees is limited. Most of these are too greatly disturbed by the strong prevailing winds to be suitable nest sites for Brown Jays. Our results do not demonstrate that nest sites are a limiting resource, because they do not show that some birds are excluded from good nest sites. They do demonstrate, however, that Brown Jays make complex decisions in choosing nest sites, and they suggest a quantitative method for testing the hypothesis that nest sites may be a limiting resource in tree-nesting species.

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Age Differences in Foraging Black-necked Stilts in Texas

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Seabirds exhibit delayed maturity in that most species do not begin breeding until they are 3 yr or older (Lack 1967). One reason often given for delayed breeding is that young have difficulty mastering foraging techniques and learning foraging areas (Lack 1968). Orians (1969) first noted age differences in the foraging ability of Brown Pelicans (*Pelecanus occidentalis*): young had lower diving success than adults. Similarly, Recher and Recher (1969) found age-related success differences in Little Blue Herons (*Florida caerulea*). The authors in both studies concluded that the inefficiency of juveniles was an adequate explanation for the deferment of reproduction. Since that time, age-related differences in foraging success or abilities have been found in all seabirds examined, including Olivaceous Cormorants (*Phalacrocorax olivaceus*) (Morrison et al. 1978), Royal Terns (*Sterna maxima*) (Buckley and Buckley 1974), Glaucous-winged Gulls (*Larus glaucescens*) (Barash et al. 1975, Searcy 1978), and Herring Gulls (*L. argentatus*) (Verbeek 1977a, b; Ingolfsson and Estrella 1978). Among shorebirds, the foraging behavior

TABLE 1. Foraging behavior of Black-necked Stilts in Texas at different times of day (August 1979).

	<i>n</i> ^a	Adult	Young	Test value ^b	<i>P</i> ^c
<i>Time:</i>					
0700					
Percent age composition	43 (5)	91	9	16.33	0.001
Percent of each age engaged in feeding	43 (5)	100	100	—	—
\bar{x} time interval (s) ^d	40	1.4 ± 0.7	1.5 ± 0.8	180	NS
\bar{x} number items/10 s	40	9.1 ± 2.7	7.1 ± 1.8	54	0.001
\bar{x} number steps/item ^e	40	1.1 ± 0.4	1.9 ± 1.2	33	0.001
\bar{x} s feeding/10 s	40	7.4 ± 3.1	7.9 ± 3.1	179	NS
0800					
Percent age composition	22 (7)	38	62	4.16	0.01
Percent of each age engaged in feeding	22 (4)	50	90	—	—
0900					
Percent age composition	21 (4)	29	71	11.26	0.001
Percent of each age engaged in feeding	21 (4)	42	90	—	—
1300					
Percent age composition	20 (4)	51	49	0.10	NS
Percent of each age engaged in feeding	20 (4)	13	46	—	—
\bar{x} time interval	40	9.6 ± 6.0	14.3 ± 4.0	110	0.01
1900					
Percent age composition	34 (5)	53	47	0.24	NS
Percent of each age engaged in feeding	34 (5)	100	100	—	—
\bar{x} time interval	40	11.5 ± 17.0	10.4 ± 8.0	148	NS
\bar{x} time feeding/10 s	40	2.3 ± 0.9	6.7 ± 4.0	12	0.001

^a For percent data, I give the \bar{x} number of birds present for the number of samples shown in parentheses. For other data, I give the number of individuals sampled.

^b χ^2 Goodness of Fit test used on raw data for age composition. Mann-Whitney *U*-test used for all other data (Siegel 1956).

^c NS = not significant.

^d Refers to the time between successful obtainment of food items.

^e Refers to the mean number of steps between successful obtainment of food items.

of Ruddy Turnstones (*Arenaria interpres*) was examined by Groves (1978), who found that the foraging and success rates of adults and juveniles differed, although the frequencies of success were similar. She did not find age-related differences in the percentage of birds foraging over different times of the day. Juvenile Ruddy Turnstones do not breed (Stout 1967). In general, efficiency increases with age, although the components of foraging behavior responsible for these differences are not always clear. In all of the above studies, the age of first reproduction is delayed beyond the first year.

In this report, I examine age-related foraging behavior in Black-necked Stilts (*Himantopus mexicanus*) in Texas during August. At this time, the young are distinguishable from the adults (Stout 1967). Black-necked Stilts are capable of breeding when they are 1 yr old, as Hamilton (pers. comm.) has observed them breeding at that age on his study site in California. At present, the percentage of 1-yr-olds that breed is unknown. Although Hamilton (1975) examined the breeding biology and behavior of stilts, he did not specifically examine age-related foraging. Stilts feed by pecking insects, fish, and small crustaceans from the surface of shallow-water areas (Bent 1929, Hamilton 1975).

I examined the foraging behavior of Black-necked Stilts on Santa Ana National Wildlife Refuge, Texas from 18–20 August 1979. Observations were made at Cattail Pond, a marsh with feeding spots ranging from wet mud with small shallow pools to water several centimeters deep. I observed at various times of the day, from 0630 to 2030, to elucidate daily variations in foraging behavior.

Young of the year were identified by their lighter and browner backs and head plumage as compared to the jet black pattern of adults (Stout 1967). In general, the dorsal head and back feathers of the young were duller, browner, and less iridescent than those of adults, and the tips of the feathers in these regions tended to be buffy or dull grey. The legs of the young were pale pink as compared to the bright red legs of adults. Birds that were not distinguishable because of plumage pattern (dull females or young males) or light conditions were not included in the foraging samples.

Several measures of foraging behavior were noted, including flock composition, percent of birds foraging by age, aggressive interactions, amount of time spent foraging, time interval between obtaining food, and the number of items obtained in 10-s intervals. Flock composition and the percentage of birds

foraging were determined by censusing every 10 min during the observation period. I compared the behavior of young adults at different times of the day and the foraging behavior of young in different foraging situations (in flocks, near flocks, and solitary). Insufficient numbers of adults fed solitarily to allow me to make similar comparisons for adults.

Flock composition varied during the day, with adults making up most of the flock early in the morning, young making up most of the flock during the late morning and early afternoon, and an equal percentage of adults and young present in the early evening (Table 1). Significant age differences in flock composition occurred during the day except for the evening hours.

The stilts did not feed continuously. In the early morning (0700), all birds fed during all 10-min sample periods, whereas by 0800 the percentage of young that were feeding dropped to 90% and that of adults dropped to 50% (Table 1). This difference continued during the 0900 samples. Low sample sizes necessitated lumping the samples from 0800 to 1000: the young foraged during significantly more of the time samples than did adults (Sign test, $P < 0.004$; Siegel 1956). By early evening, age differences in the percentage of birds engaged in feeding again disappeared, as all birds foraged.

Stilts picked up small invertebrates from the water's surface, and their swallowing motions were conspicuous. The time interval between successfully obtaining food items was used as a measure of foraging rate. An ANOVA indicated significant differences in feeding rates by time of day ($F = 47.1$; $df = 2, 114$; $P < 0.001$) and age ($F = 6.29$; $df = 2, 114$; $P < 0.01$), but not age-time interaction ($F = 1.9$). The adults had significantly shorter inter-food intervals at 1300 but not at 0700 and 1900 (see Table 1).

I examined other foraging parameters from 0700 to 0900 and from 1700 to 1900. The number of items eaten during 10-s foraging intervals was significantly greater in adults (Table 1). Young stilts also took significantly more steps between obtaining food items than did adults (see Table 1).

Feeding stilts often spent some foraging time with their heads raised rather than peering at the water searching for insects. During the 0700–0900 samples, but not the 1700–1900 samples, adults and young spent the same percentage of foraging time actually searching the water's surface. During the evening samples, adults spent less time searching than did young.

Some stilts fed in dense flocks (inter-bird distances of 15–100 cm); some fed near these flocks (but not in them), while others fed solitarily (more than 30 m from conspecifics). In general, adults fed in dense flocks or in small groups but seldom fed solitarily at Santa Ana Refuge during the study period. I compared the number of items obtained in 10-s intervals for young stilts in these three situations. The mean number (\pm SD) of items located varied: in group = 8.3 ± 2.6 , near to group = 4.9 ± 2.0 , solitary = 3.3 ± 1.6 . Subjecting the data to an ANOVA indicated significant differences in feeding rates ($F = 36.6$; $df = 2, 57$; $P < 0.001$). Birds foraging in groups obtained significantly more food items than those feeding nearby (Mann-Whitney $U = 36$, $n = 40$, $P < 0.001$), and those feeding near dense flocks obtained more food items than young that fed solitarily ($U = 84$, $n = 40$, $P < 0.01$). The food items appeared to be the same size in relationship to their bills.

Aggression was infrequent during most of the day but occurred with some regularity in the early morning when most birds fed vigorously. Feeding birds sometimes flew at intruders that approached. For ten 10-min sample periods between 0700 and 0900, aggression rates (number of interactions \cdot bird⁻¹ \cdot 10 min⁻¹) varied from 0 to 0.47 ($\bar{x} = 0.21 \pm 0.14$). These chases normally occurred when an intruder flew and landed within a meter or two of a foraging adult. Only three of 39 chases observed were performed by young stilts. No aggression was observed between 0900 and 1600, when few birds fed and feeding stilts were scattered; some aggression occurred in the early evening when more birds were actively engaged in feeding.

Little information exists on age-related differences in foraging behavior in shorebirds (see Pitelka 1979, Groves 1978 for references). This is understandable, because in many shorebirds it is difficult to distinguish the age classes (Stout 1967). In late summer, however, Black-necked Stilt young are distinguishable. In the present study, age-related differences in foraging behavior existed with respect to some parameters, but not others: (1) adults had lower inter-food time intervals during the middle of the day but not in the early morning or early afternoon; (2) adults obtained more food items/10 s in the early morning than did young; (3) young spent more time feeding/10 s in the early evening but not in the early morning; (4) a higher proportion of adults fed in the very early morning, a higher proportion of young fed in the late morning to late afternoon, and equal numbers fed in the late evening; and (5) young stilts took more steps between the localizing of items and thus expended more energy in searching for food.

Taken altogether, these data suggest that age differences in stilt foraging do exist under some conditions. For all ages, foraging rates were higher in the morning compared to later in the day. Significantly more adults foraged when feeding rates were higher. Higher capture rates might have been a result of food availability, light conditions, or motivation. By 0900 in Texas, the glare on the water might make foraging difficult. Furthermore, insects might have already emerged or otherwise disappeared later in

the day, thus making food less abundant. Presumably, stilts are hungrier early in the morning after a long night than they might be later in the day. This is supported by the high percentage of time spent foraging during the early morning hours by both adults and young.

Young stilts had longer inter-food intervals than adults at 1300 but not at 0700 and 1900. Furthermore, more young fed at 1300, when they were more successful than adults. These results suggest a temporal partitioning by adults and young, but this hypothesis bears further testing.

Young stilts feeding in flocks had higher foraging rates than solitary feeders. Perhaps the movement of the group stirs up insects, making food generally more available to flock members. The occurrence of foraging flocks (dense flocks as well as loose groups) might reflect food conditions (every bird goes to the place with the most food) or a tendency to group in order to facilitate stirring up food. Few adults fed completely solitarily, suggesting that they learn that group feeding is more efficient.

The age-related differences in foraging behavior observed have implications for the classical notion that age-related foraging differences result in deferred maturity. Ruddy Turnstones, where some age-related foraging differences exist (Groves 1978), exhibit delayed reproduction (Stout 1967). Some Black-necked Stilts are known to breed when 1 yr old, yet the young are significantly less successful than adults with respect to some, but not all, foraging parameters. This suggests that age-related foraging differences alone are not sufficient to explain deferment of breeding in birds (particularly seabirds and shorebirds) as Orians (1969), Recher and Recher (1969), and others have suggested. Lack's (1967, 1968) original hypothesis was developed for birds that feed on patchily distributed (in time and space) food resources. Furthermore, Lack did not conclude that age-related foraging differences were sufficient to account for delayed maturity.

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