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Diurnal activity patterns and foraging success of Yellow-Crowned Night-Herons in seasonally flooded wetlands.—The Yellow-crowned Night-Heron (*Nyctanassa violaceus*) has a New World distribution, occurring in a variety of wetland types including marshes, swamps, and lakes (AOU 1983). Although primarily associated with coastal regions and islands, certain populations exploit freshwater wetlands, including the middle Mississippi River and related tributaries (Hancock and Kushlan 1984). Detailed ecological studies of Yellow-crowned Night-Herons are lacking (Riegner 1982), and knowledge of habitat use and feeding strategies is largely restricted to coastal wetlands (Riegner 1982, Watts 1988, Custer and Osborn 1978). Information on Yellow-crowned Night-Heron use of inland freshwater wetlands consists mainly of food habit studies (Price 1946, Sutton 1967, Niethammer and Kaiser 1983). The objectives of the present study were to quantify diurnal activity and feeding patterns of Yellow-crowned Night-Herons and determine (1) the importance of seasonally flooded impoundments as foraging sites, and (2) if foraging differs among age classes and social statuses.

Study site and method.—Data on activity budgets and foraging by adult and immature Yellow-crowned Night-Herons were collected between June and August of 1980 and 1982 in seasonally flooded wetlands on Mingo National Wildlife Refuge (NWR), a 9312-ha hardwood wetland in southeast Missouri (Korte and Fredrickson 1977, Heitmeyer et al. 1989). About 635 ha of seasonally flooded wetlands are managed primarily for waterbirds. Herbaceous annuals comprise the primary vegetation in seasonally flooded wetlands with small, isolated areas of perennial vegetation occurring less frequently. The typical management strategy consists of annual spring or summer drawdowns (2–14 day duration) to promote growth of desirable plant communities adapted to germination and growth on mudflats (Fredrickson and Taylor 1982). The wetlands are flooded sequentially (<30 cm) from early fall through late winter, depending on the date of plant maturation and arrival of migrant waterbirds. Seasonally flooded wetlands, combined with open marsh habitat, constitute about 15% of all habitats in the Mingo Swamp (Heitmeyer et al. 1989).

Activity budgets were determined by instantaneous sampling procedures (Altmann 1974). Data were collected from automobiles or portable blinds, using a 15–40× spotting scope. Because birds were not marked to permit identification of individuals, some birds may have been observed more than once. The possibility of repeat observations is reduced, however, because we conservatively estimated the Yellow-crowned Night-Heron population using seasonally flooded wetlands at 200. Solitary Yellow-crowned Night-Herons and individuals selected randomly from flocks (2–20 individuals) were observed. Activity of the focal individual was recorded at 10-sec intervals using a metronome (Wiens et al. 1970). Nine activity categories were recorded: resting (loafing and sleeping), standing, walking, crouching, maintenance (preening and scratching), food handling, flying, drinking, and aggression. Activity categories were then grouped into foraging (standing, walking, crouching, or handling food) or non-foraging (resting, maintenance, flying, drinking, or aggression). Detailed data on foraging effort (attempts/h), foraging efficiency (captures/total attempts), prey type, and crayfish length (±1 cm) relative to heron bill length (±1 cm) also were recorded when possible. In addition, focal birds were classified as solitary or associated with flocks, based on the presence (flock) or absence (solitary) of at least one other ciconiiform within a 25 m radius.

The proportion of time each bird spent engaged in an activity was determined for each observation period. The data exhibited a non-normal distribution, based on the Shapiro-Wilk (W) statistic, and an angular (2*ARCSIN[SQUAREROOT X]) transformation was performed prior to using parametric statistical analysis (Neter et al. 1985). The Shapiro-Wilk test indicated that foraging effort and foraging efficiency, also expressed in proportions, were approximately normally distributed, and no transformations were required.

The effects of age and flock on mean percent activity were assessed using 1-way ANOVA with two levels of classification. The effects of age, flock, and prey type on foraging activity were assessed using the same procedure. The folded form of the F statistic (F′) was used to test for equality of variance. When variances were unequal, the Cochran and Cox approximation was used to test for differences (SAS 1987). All results, unless otherwise stated, are expressed as weighted means.

Results.—Adult (N = 34 observation periods) and immature (N = 14 observation periods) Yellow-crowned Night-Herons were observed for 26 h 11 min and 12 h 2 min, respectively. Mean length of observation period/bird was 46.2 ± 4.7 min ([SE], range = 6 to 102) for adults and 51.7 ± 6.6 min (range = 24 to 91) for immatures. Five adults and six immatures were observed by themselves, whereas 26 adults and eight immatures were observed <25 m from other Yellow-crowned Night-Herons.

Activity budgets of adults and immatures were not different (Table 1). Time spent foraging averaged 87.1 ± 0.03% for adults (N = 34) and 81.8 ± 0.07% for immatures (N = 14) when solitary and flocked data were combined (t = 0.68, P = 0.50). When data were separated, based on flocked and solitary birds, activity budgets between age classes remained similar. Adults (N = 5) spent 95.2 ± 0.04% of time foraging compared to 68.5 ± 0.15% for immatures (N = 6) when alone (t = 1.90, P = 0.10). In the presence of other wading birds, adults (N = 26) and immatures (N = 8) averaged 84.8 ± 0.04% and 92.1 ± 0.03% of time foraging (t = 1.29, P = 0.21), respectively.

Food handling was the only activity that differed between age classes, when flocked and solitary birds were compared. Immatures (N = 8, $\bar{x}$ = 8.0 ± 0.03%) spent more time engaged in food handling than adults (N = 26, $\bar{x}$ = 3.0 ± 0.01%) when other Yellow-crowned Night-Herons were present (t = 2.28, P = 0.03). Although not significant (t = 2.28, P = 0.10), solitary adults (N = 5) engaged in food handling ($\bar{x}$ = 6.4 ± 0.03%) more than solitary immatures (N = 6, $\bar{x}$ = 1.2 ± 0.01%).

Adults (N = 34) spent more time engaged in foraging activities ($\bar{x}$ = 87.1 ± 0.03%) than non-foraging activities ($\bar{x}$ = 12.9 ± 0.03%), when all data were combined (t = 15.23, P = 0.0001). More time also was spent foraging ($\bar{x}$ = 95.2 ± 0.04%) compared to non-foraging ($\bar{x}$ = 4.8 ± 0.04%) when adults were alone (N = 5; t = 11.13, P = 0.0001) and in the presence of other wading birds (foraging = 84.8 ± 0.04%, non-foraging = 15.2 ± 0.04%; N = 6; t = 11.51, P = 0.0001).

Immatures (N = 14) allocated more time to foraging ($\bar{x}$ = 81.8 ± 0.07%) than non-foraging activities ($\bar{x}$ = 18.2 ± 0.07%) when all data were combined (t = 5.72, P = 0.0001). When separated into solitary and flocked birds, the amount of time spent in foraging ($\bar{x}$ = 68.2 ± 0.15%) and non-foraging activities ($\bar{x}$ = 31.8 ± 0.14%) was not different when immatures were alone (N = 6; t = 1.50, P = 0.16). However, immatures spent more time foraging ($\bar{x}$ = 92.1 ± 0.03%) than non-foraging ($\bar{x}$ = 17.9 ± 0.03%) when at least one other wading bird was present (N = 8; t = 11.10, P = 0.0001).

Detailed foraging data were collected on 36 Yellow-crowned Night-Herons (22 ad, 14 imm). Foraging effort did not differ between adults ($\bar{x}$ = 12.5 ± 3.7 attempts/h) and immatures ($\bar{x}$ = 18.4 ± 6.1 attempts/h) (t = 0.82, P = 0.42) when solitary and flocked data were combined. Foraging efficiency remained similar between age classes when data were separated into solitary ([ad: N = 4, $\bar{x}$ = 11.3 ± 2.9] [imm: N = 6, $\bar{x}$ = 10.1 ± 6.4], t = 0.17, P = 0.87) and flocked individuals ([ad: N = 15, $\bar{x}$ = 11.5 ± 4.9] [imm: N = 8, $\bar{x}$ =24.7 ± 9.3], t = 1.25, P = 0.24).

Foraging efficiency (captures/attempts) of adults (N = 4, $\bar{x}$ = 75.0%) did not differ from

TABLE 1
DIURNAL ACTIVITY PATTERNS (PERCENTAGE OF TOTAL OBSERVATIONS) OF ADULT AND IMMATURE YELLOW-CROWNED NIGHT-HERONS ON MINGO NWR

Behavior[a]	Adult	Immature
Foraging		
Stand	63.9	54.9
Walk	13.7	15.4
Crouch	5.8	6.4
Handle food	3.7	5.1
Non-foraging		
Maintenance	3.1	5.8
Rest	8.3	12.3
Fly	0.9	0.6
Drink	0.3	0.2
Aggression	<0.1	0.0

[a] Behaviors were not different between age classes ($P > 0.10$).

that of immatures (N = 5, $\bar{x} = 71.3 \pm 0.08\%$) when individuals foraged by themselves, but adults were more efficient (N = 14, $\bar{x} = 73.3 \pm 0.07\%$) than immatures (N = 8, $\bar{x} = 51.1 \pm 0.08\%$) when ≥ 1 conspecific was present ($t = 1.93$, $P = 0.06$). Adults also had a higher foraging efficiency (N = 14, $\bar{x} = 80.7 \pm 0.05\%$) than immatures (N = 9, $\bar{x} = 56.5 \pm 0.07\%$) when other species of herons were present ($t = 2.96$, $P = 0.007$). The overall foraging efficiency (solitary and flocked birds) of adults (N = 21, $\bar{x} = 77.1 \pm 0.07\%$) was significantly ($t = 1.97$, $P = 0.06$) higher than that of immatures (N = 13, $\bar{x} = 58.9 \pm 0.06\%$).

Prey types captured by Yellow-crowned Night-Herons included burrowing crayfish (*Procambarus* sp.), fish, tadpoles (*Rana* sp.), and one snake (Table 2). Relative crayfish length to heron bill length was significantly ($t = 2.12$, $P = 0.04$) greater for adults (N = 21, $\bar{x} = 1.15 \pm 0.07$) than for immatures (N = 12, $\bar{x} = 0.88 \pm 0.12$). When analyses were conducted on weighted means, tadpoles constituted a greater proportion of known prey taken by immatures than adults, whereas crayfish, fish, and snakes comprised similar proportions of known prey captured by adults and immatures.

Discussion.—Adult and immature Yellow-crowned Night-Herons spent similar amounts of time in foraging and non-foraging activities. Activity of immature Yellow-crowned Night-Herons was influenced by the presence of other herons. Solitary immatures spent an equivalent amount of time engaged in foraging and non-foraging activities, whereas foraging occurred more than non-foraging activities in the presence of other herons. An aggregation of herons may indicate a quality foraging site where prey densities or predictability of prey is great. Immatures in flocks may have foraged more than solitary immatures because they were in areas where prey densities were high. Also, foraging is, in part, a learned behavior (Kushlan 1981), and immatures in flocks may have been foraging at higher levels because they were learning from nearby conspecifics.

In contrast, adult Yellow-crowned Night-Herons performed foraging activities more than non-foraging activities regardless of flock size. Adult herons are more efficient at foraging and sometimes exhibit territoriality, particularly when prey are uniformly distributed (Kaiser 1982). Black-crowned Night-Herons (*N. nycticorax*) appear to use feeding sites repeatedly,

TABLE 2

WEIGHTED MEANS ($\bar{x}$ ± SE) OF KNOWN PREY ITEMS (PERCENT) CAPTURED BY ADULT AND IMMATURE YELLOW-CROWNED NIGHT-HERONS ON MINGO NWR[a]

	Crayfish		Fish		Snake		Tadpole	
Age class	$\bar{x}$	(± SE)	$\bar{x}$	(± SE)	$\bar{x}$	(± SE)	$\bar{x}$	(± SE)
Adult[b]	76.7^{A}	10.8	23.3^{A}	10.7	0.0^{A}	0.0	0.0^{A}	0.0
Immature[c]	58.3^{A}	14.9	11.1^{A}	6.6	4.2^{A}	4.1	26.4^{B}	10.6

[a] Prey items sharing a letter between age classes did not differ ($P > 0.05$). Comparison by 1-way ANOVA with 2 levels of classification.

[b] N = 15.

[c] N = 12.

and individuals chase or evict conspecifics that land near them (Custer and Osborn 1978). This type of social behavior, combined with increased foraging efficiency, may permit exploitation of feeding sites by adult night-herons under any social condition.

Foraging effort (attempts/time), foraging efficiency (captures/attempts), and proportion of total time allocated to food handling were similar between solitary adults and immatures. Foraging effort also was similar when adults and immatures foraged in flocks, but adults foraged more efficiently, whereas immatures spent a greater proportion of total time engaged in food handling. These results indicate that immatures foraging in flocks are capturing fewer prey and spending more total time handling food than adults. This suggests that handling time per food item is likely greater for immatures foraging in a flock. The presence of other herons may displace immatures from favorable foraging areas or cause more inexperienced immatures to make foraging attempts prematurely before prey becomes inaccessible because of territorial boundaries.

Although Yellow-crowned Night-Herons are considered to be dietary specialists on crustaceans (Palmer 1962, Hancock and Kushlan 1984), the species and genera of prey vary among regions (Niethammer and Kaiser 1982, Watts 1988). Microhabitat conditions, including water depth, surface substrate, and vegetation, are important in determining the abundance, diversity, and distribution of prey (Willard 1977, Watts 1988). Habitat conditions favorable for tadpoles, as well as fish and crayfish, exist in seasonally flooded impoundments on Mingo NWR. During drawdown, these impoundments provide highly profitable prey complexes that are highly correlated to total wading bird use within portions of the Mississippi River basin (Reid 1989).

In our study, immatures had a more diverse diet than adults. Burrowing crayfish represented the primary prey captured by adults whereas tadpoles dominated the diet of immatures. Although crayfish contributed to the diet of both age classes, adults captured larger crayfish. Use of tadpoles by immatures may occur because this prey type is more readily available, smaller, and represents less dangerous prey for inexperienced birds, or is found within the same microhabitats as crayfish. In contrast, adults may pursue larger prey (i.e., crayfish and fish) because they forage more efficiently.

In conclusion, seasonally flooded emergent wetlands represent important foraging sites for Yellow-crowned Night-Herons. Foraging efficiency appears to differ between age classes, however, depending on social conditions. In the presence of other herons, immatures forage with lower efficiency. As a result, wetland managers interested in providing optimum foraging opportunities for herons of different ages should sequentially discharge water at slow rates from impoundments comprising a wetland complex. Such a strategy will maximize the availability of shallowly flooded habitat over a longer time period, permitting greater dispersal of herons. Increasing dispersal may increase the foraging efficiency of immatures.

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Mate switching and mate choice in female Northern Mockingbirds: facultative monogamy. — Northern Mockingbirds (*Mimus polyglottos*) usually are considered monogamous (Laskey 1962, Ford 1983), and some pairs remain together for as long as eight years (Breitwisch, pers. comm.). However, several reports indicate that individual mockingbirds may breed opportunistically in a number of different mating combinations. The most commonly reported deviations from monogamy involve bigamous males that mated simultaneously with two females in adjacent territories, often following the disappearance of a neighboring male resident (Laskey 1941, Logan and Rulli 1981, Breitwisch et al. 1986, Derrickson 1989). Sequential polyandry, in which a female repeatedly paired alternately with two neighboring males within the breeding season, has also been observed (Fulk et al. 1987). I report here a number of instances indicating that female mockingbirds switch mates more often than initially expected for a "monogamous" species. Further, female choice is suggested by the variety of circumstances associated with mate switching.

In the breeding seasons of 1989 and 1990, I observed several instances of females switching mates in a residential population of mockingbirds in Guilford County, North Carolina. From 1 March–1 July, mating status and nesting success were determined by three to four visits per week to each of approximately 25 territories inhabited by mated birds. Eight to 10 territories inhabited by unmated males were visited biweekly. Each visit lasted from 5–10 min, and the status and behavior of each bird was noted. Instances of females switching mates fall into the following three groupings: (1) switches that followed the disappearance of the female's original mate, (2) switches in which a female resided in the territory of one male for a period with no indication of nest building or copulation, and then left his space to breed with a second male in a different territory, and (3) true re-matings involving banded females that nested with one male, left the territory in which he continued to reside, moved into the territory of and renested with a second banded male. The numbers below refer to these groupings.

(1) Female BkOBk switched mates both within and between seasons. From spring 1988–spring 1990 she successfully fledged young with at least three different banded males. Each switch followed the disappearance of the male residing in her territory, a pattern common when males disappear. However, this female appeared to be exercising female choice with each re-mating. In no case did a male move into her territory (common when females are widowed). Rather, each time she moved into the territory of her new mate. In early March 1989, she was seen in the territories of four different males. By late March, she remained with one male, with whom she successfully fledged young in 1989 and 1990.