NESTING BIOLOGY OF THE CALIFORNIA BLACK RAIL IN SOUTHWESTERN ARIZONA

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The nesting requirements and reproductive biology of the California Black Rail (*Laterallus jamaicensis coturniculus*) are poorly known. The main reasons for this are that Black Rails inhabit dense marshes and their small size and secretive nature have made them difficult birds to study (Todd 1977). Additionally, inland breeding populations are sparsely distributed, relatively inaccessible, and declining (Snider 1969, Rosenberg et al. 1991, Evens et al. 1991). As a result, California and Arizona list the California Black Rail as threatened and endangered, respectively (California Department of Fish and Game 1988, Arizona Game and Fish Department 1988). Information on reproduction is essential to management and protection of this threatened subspecies.

Most of the information on nesting by California Black Rails is from clutches of eggs collected in the late 1800s and early 1900s in coastal habitat (Bent 1926). Egg dates for 29 nests range from 12 March to 23 May. The average clutch size for 31 egg sets in museum collections is 6.1 ± 1.4 (standard deviation), ranging from 3 to 8 (Wilbur 1974). Nests are "deeply cupped and placed on damp ground or elevated in vegetation" (Wilbur 1974). Heaton (1937b) stated that Black Rail chicks hatch one at a time, and both Heaton (1937a) and Huey (1916) concluded that adults readily abandon their nests. Further information on Black Rail nesting habitat, nest success, incubation period, brood survival, renesting and double-clutching potential, and reproductive behavior is lacking. Our study summarizes information obtained from five California Black Rail nests that we monitored along the lower Colorado River 27 km northeast of Yuma, Arizona, and relates this information to the ecology and management of this subspecies.

STUDY AREA AND METHODS

We monitored California Black Rail nests as a part of a general life history study of the species conducted at Mittry Lake Wildlife Management Area, Yuma County, Arizona, from March 1987 to December 1988. We studied Black Rails in 15.5 hectares in the northeast corner of the management area (south Yuma Proving Ground Slough), an old oxbow of the Colorado River. The slough's water level varies by no more than 7 cm annually. The marsh is recharged by a feeder canal from Imperial Dam that releases 10-15 cubic feet per second and seepage from the Gila Gravity Canal of about 3-4 cubic feet per second (Earl Burnett, U.S. Bureau of Reclamation, Yuma Projects Office, pers. comm.). Historically, several wildfires have burned the study area, most recently in November 1979. Most of the emergent vegetation was burned during the last fire but has since grown back (Todd 1980). The area received local scouring and slight flooding in

1983. Most emergent plants recovered in 1984–85, but an open channel still remained along the western edge of the study area.

Southern cattail (*Typha domingensis*) is the dominant emergent, encompassing 65% of the study area, with three-square bulrush (*Scirpus americanus*), California bulrush (*S. californicus*), and inland saltgrass (*Distichlis stricta*) distributed along the shoreline. The marsh is bordered by a desert upland with scattered stands of honey and screwbean mesquites (*Prosopis juliflora* and *P. pubescens*) and sections of arrowweed (*Tessaria sericea*), seepwillow (*Baccharis glutinosa*), and saltcedar (*Tamarix chinensis*) extending into the wetland.

We trapped Black Rails by using a modified version of a drop-door trap used by Zembal and Massey (1983) to catch Light-footed Clapper Rails (*Rallus longirostris levipes*). Traps were placed along drift fences constructed by stapling surveyor's stakes to 1-m-tall lengths of 1.8-cm-mesh black plastic bird netting. Drift fences were placed perpendicular to zones of shallow water where Black Rails vocalized or were known to occur, and the base of the fence was covered with mud or vegetation so that rails could not find their way around the fence. Birds encountering the drift fences were channeled into traps placed along the fencing.

We sexed Black Rails by plumage color (Russell 1966, Eddleman and Flores unpubl. data). Males had uniformly colored dark gray throats and ventral plumage, whereas females had light gray to dull white throats and medium to pale gray ventral plumage.

We glued 2- g radio transmitters (Model SOPB-1038-LD, Wildlife Materials, Inc., Carbondale, IL) to the backs of captured Black Rails with cyanoacrylic glue in combination with eyelash cement (Stenzel 1982). We located the tagged Black Rails from three fixed telemetry stations (two travel trailers and one plywood shed), each equipped with a dual 12-element null-peak Yagi antenna system placed on a mast projecting through the roof. Azimuths were determined from a needle fastened to the mast, which pointed to a compass rose on a table around the mast. Azimuths were taken from each station on three beacon transmitters at the beginning of each tracking session. The average deviation between measured and surveyed azimuths at each station was used to calibrate the compass rose prior to each tracking session. Bird locations were determined by plotting near-simultaneous azimuths obtained from telemetered birds by two assistants at different stations communicating via two-way radios. Tracking was conducted so that each daylight and crepuscular hour of the day was monitored for an equal amount of time during each week. Points where otherwise active birds generated radio signals of steady strength for long periods were where we searched for nests.

We searched for nests by locating incubating telemetered birds with a hand-held antenna, then looking in clumps of vegetation for the nest. In three cases, scolding adults indicated when nests were nearby. Information recorded on nests included location, description, habitat type, clutch size, fate, and hatching date. Incubation shifts were monitored by means of an automatic activity recorder with a Telonics TDP-2 data processor (Telonics, Inc., Mesa, AZ) connected to our telemetry system. The antennas were locked in position pointing in the general direction of the selected bird when the activity recorder was used. The radio receiver was connected to the data processor, allowing peak signal amplitude and pulse interval to be recorded on a Rustrak strip-chart recorder. Movement of birds resulted in a variable signal amplitude and a wavy line on the chart paper, whereas stationary birds yielded a relatively straight line. All other data on nesting were recorded opportunistically. Data are expressed as means plus or minus standard deviations. Clutch sizes and water depth at nest sites and random sites were compared by means of Mann-Whitney *U* tests (Zar 1984).

RESULTS

We found five nests during nine nest searches, the first Black Rail nests described from Arizona. One pair was found incubating in one nest (both adults had been fitted with transmitters), two nests were located because telemetered males were incubating, one nest was located because a telemetered female was incubating, and one nest was found incidentally. Nests were found on 19 April, 17 June, 9 July, 13 July, and 23 July 1988, with the first suggestion of incubation by a telemetered bird on 30 March 1988. The latter nest was not located, however. Incubation began and hatching occurred at the five nests that were located on 18 April and 5 May, 14 June and 2 July, 25 June and 15 July, an unknown date and 21 July, and unknown date and 23 July, respectively. Clutch size averaged 4.8 ± 1.5, ranging from 3 to 7. While we were handling her, one female laid an egg, which weighed 9 g, or 29% of her body weight.

Nests varied in distance from upland habitat but were consistently placed over shallow water (Table 1). All nests were elevated above the mud substrate in clumps of vegetation (three in California bulrush, one in southern cattail, and one in three-square bulrush) and consisted of a well-defined bowl with a canopy and ramp. Four nests were constructed primarily of southern cattail, one of spikerush (*Eleocharis* sp.) Water depth at nest sites averaged 1.2 ± 1.2 cm and approached being significantly less

Table 1 Characteristics of Five California Black Rail Nests at Mittry Lake Wildlife Management Area and of two Eastern Black Rail Nests

	This study		
Measurement (cm)	Mean ± S.D.[a]	Range	Eastern Black Rails
Inside diameter	7.4 ± 0.6	7–8	8.3[b]
Outside diameter	12.6 ± 1.5	11–15	11.4[b]
Bowl depth	4.4 ± 1.7	3–7	6.4[b]
Height above substrate	6.4 ± 3.4	2–11	2.5[c]
Water depth at nest site	1.2 ± 1.2	0–3	—

[a]S.D., standard deviation.
[b]One nest; E. W. Nelson in Bent (1926).
[c]One nest; Harlow (1913).

than the average water depth at 272 randomly selected sites ($\bar{x}$ = 5.7 ± 7.7 cm; Mann-Whitney *U* test, *U* = 374.0, *P* = 0.07).

The incubation period recorded for three nests was 17 to 20 days, beginning with the first day of incubation as indicated by the activity recorded by the birds' transmitters and ending with the hatching date as confirmed by nest visits. Both sexes incubated the eggs. Two females spent 43.0 to 47.0% of their time during the day incubating, whereas one male spent 47.2% of his time incubating (Table 2). One female exhibited an unusual incubation pattern in that she sat only one or two very long incubation shifts during the daylight hours, whereas the other two sat 7-10 shifts of much shorter duration. No other bird was detected near her nest, so we assumed she had lost her mate or her mate did not assist in incubation. Black Rails aggressively defended three nests by giving scolding vocalizations (Reynard 1974:753), raising their wings, and attempting to charge us.

All clutches hatched successfully, and we found no evidence of partial clutch predation, egg abandonment, or egg infertility. Newly hatched broods were observed in two of the nests; both times the broods and parents left the nest within 24 hours after the clutches hatched completely. One female was recaptured with an egg in her oviduct 18 days after her clutch hatched, suggesting that Black Rails lay second or replacement clutches. One telemetered male seemed to be incubating in April, but we could not find his nest. He was found incubating another nest in July.

DISCUSSION

The timing of Black Rail nesting we observed was similar to that of previous studies (Huey 1916, Wilbur 1974), but extended further into the summer. The shorter nesting season in tidal marshes in California may reflect selection against nesting during the high summer tides of June and July, a selective pressure absent on the lower Colorado River. Alternatively, this apparent difference may be an artifact of the paucity of information on Black Rail nesting.

Nest-site selection by Black Rails at Mittry Lake was strongly influenced by water depth, and Black Rails are known to nest in water shallower than do other species of rails (Fredrickson and Reid 1986). We found no nests over water deeper than 2.5 cm. Nests of California Black Rails in southwestern Arizona resembled Black Rail nests from other locations. The measurements of the nests were similar to those recorded for Eastern Black Rails (*L. j. jamaicensis*) (Table 1), and their construction was typical of rallid nests in having a ramp, canopy, and well-defined nest bowl (Ripley 1977). At Mittry Lake Black Rails typically used dead southern cattail for nesting material, even though other emergents such as California bulrush and three-square bulrush were the dominant species at most nest sites.

The average clutch size of 4.8 ± 1.5 observed at Mittry Lake does not differ significantly from the 6.1 ± 1.4 for 31 California Black Rail clutches in museum collections (Wilbur 1974; Mann-Whitney *U* test, *U* = 56.0, *P* = 0.09) but is less than the 8 ± 1.4 recorded for 21 nests of Eastern Black Rails (Clark 1884, Bent 1926, Stone 1937) ($\bar{x}$ = 8.0 ± 1.4; Mann-Whitney

U test, $U = 23.0$, $P = 0.003$). The smaller clutch size noted in this study may have been an artifact of the late dates on which most nests were found. Three of the five nests were found in July and may have been renesting or second nesting attempts. In other rallids clutch size in later nests tends to be smaller (Fredrickson 1970). We observed that a Black Rail can lay an egg that is almost 30% of her body weight. Therefore, Black Rails may lay clutches weighing almost 200% of their body weight. Although little information exists on the time required to lay a clutch of eggs, one eastern individual laid 6 eggs in 6 to 8 days (Wayne 1905), implying that a tremendous energy demand on female Black Rails during the nesting season. The participation of both sexes in incubation follows the general pattern of rallids (Ripley 1977), although we observed one exception to this pattern with one female (Table 2).

From past accounts by oologists (Huey 1916, Heaton 1937a), we expected that Black Rails would readily abandon their nests, but no nests were abandoned during our study. Perhaps the collection of all or part of the clutch or disturbance of nesting birds early in incubation explains the abandonment of nests found in the past. Some previous reports suggest that Black Rails defend the nest site weakly (Huey 1916, Heaton 1937b). We found that some Black Rails were strongly aggressive in nest defense. Their behavior around the nest closely resembled that of the Galapagos Rail (*Laterallus spilonotus*), which also raises its wings and charges intruders near the nest (Franklin et al. 1979). We did not actively seek nests until our monitoring indicated incubation was well underway (at least 10-14 days), so nest defense may become stronger as incubation advances.

The high nest success was similar to that observed in many temperate rallids (Zimmerman 1977, Bateman 1977). The absence of predation on the nests reflected the lack of predation on Black Rails at Mittry Lake in general. No telemetered birds were lost to predation during the study and we think that this was due to the high density of the vegetation they inhabited.

Table 2 Incubation Patterns of Three California Black Rails at Mittry Lake Wildlife Management Area, April–July 1988[a]

	Sex		
	Male	Female	Female[b]
No. of days observed	3	4	4
No. of recesses per day	7.7 ± 0.5	9.0 ± 0.7	2.8 ± 0.4
No. of incubation shifts per day	7.2 ± 1.9	8.0 ± 0.7	1.8 ± 0.4
Length of shift (minutes)	48.6 ± 44.8	47.5 ± 43.4	256.3 ± 172.6
Percentage of time on nest	47.2 ± 6.8	43.0 ± 2.2	47.0 ± 4.4

[a]Data presented are means ± standard deviations except for number of days observed.
[b]Incubated alone.

The Black Rail broods we observed behaved like those observed by Heaton (1937b), with the parents and brood leaving the nest soon after all the eggs hatched. Chicks remained in the nest until all eggs hatched, but we could not determine exactly how long they stayed between hatching and the time they left with their parents. Adults and the brood remained in the general area of the nest and frequently returned to the nest site to roost for the evening.

MANAGEMENT IMPLICATIONS

The relatively large clutch size, long breeding season, and apparent low predation of California Black Rails in southwestern Arizona suggest this species has a high reproductive potential. The requirement for shallow water at suitable nest sites, however, limits this potential by restricting Black Rails to the shallower parts of marshes. Being placed over shallow water also makes Black Rail nests vulnerable to water-level fluctuations. Ingersoll (1909) reported finding at least 30 Black Rail eggs that had floated out of nests after high tides in a salt marsh near San Diego, California. The weekly and daily fluctuations in water flow on the Colorado River thus preclude Black Rails from nesting in most wetlands connecting to the river. The only sites where Black Rails occur on the lower Colorado River are where water levels are controlled by limiting inflow and/or outflow (such as Mittry Lake) or at seeps (Evens et al. 1991).

Enhancement of existing and potential nesting habitat at inland sites would be possible with structures to maintain or manipulate water levels (Fredrickson and Reid 1986). Potential sites for manipulation of habitat are available on several state and federal wildlife refuges in southern California and along the Colorado River (Eddleman et al. 1988). Acquisition of water rights where needed and inclusion of Black Rails as a management priority are needed before management programs can proceed. Then, improvement of existing water-control structures by maintenance of dikes and addition of reliable pumping capability could provide the tools for management of Black Rail habitat. Water could be added or removed as needed to maintain moist soil or shallow water for Black Rail nesting, with particular attention paid to minimizing water level changes during the March-July nesting period. Additional wetland management areas might be created in existing croplands adjacent to the river or near other water sources.

Additionally, the preservation of hydrologic regimes at existing nesting habitat such as seeps adjacent to canals or in isolated settings such as the Bill Williams River (Rosenberg et al. 1991) is needed to maintain small inland populations of Black Rails, which may be most subject to random extinction (Evens et al. 1991). Practices such as concrete lining of canals presumably disrupt or eliminate the seepage that provides shallow water needed for nesting habitat of Black Rails.

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