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NESTING BIOLOGY, HOME RANGE, AND HABITAT USE OF THE BROWN WOOD RAIL (*ARAMIDES WOLFI*) IN NORTHWEST ECUADOR

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ABSTRACT.—The Brown Wood Rail (*Aramides wolfi*) is a globally threatened, poorly known species endemic to the Chocó rain forests of South America. We provide a first report on the species' nesting biology, home range, and habitat use. Nests (n = 16) were open cups ~2 m above ground and were more common in secondary forest than expected by chance. Median clutch size was four eggs, incubation lasted >19 days, the precocial young departed the nest within 24 hrs of hatching, and 66% of nests successfully produced young. At least two adults participated in parental care and pair bonds appear to be maintained year-round. The home range of an adult radio-tracked for 7 months was 13.5 ha in secondary and selectively-logged forest contiguous to primary forest. This easily overlooked species may be more resilient to moderate levels of habitat degradation than previously suspected, but extensive deforestation throughout its range justifies its current status as 'Vulnerable to Extinction'. *Received 24 February 2010. Accepted 28 July 2010.*

Twenty species of Rallidae have become extinct since 1600, and 33 of the remaining 133 extant species (24%) are currently globally threatened (Taylor 1996). Cryptic habits complicate adequate assessment of conservation requirements for many of these species (BirdLife International 2000). For example, population size, conservation status and, in some cases, even geographic distribution of the six species of Wood Rail that comprise the South American genus *Aramides* are currently unclear (Taylor 1996).

Aramides Wood Rails are relatively large, primarily terrestrial birds that favor more wooded environments than many other rails (Ridgely and Greenfield 2001). Four members of the genus are thought to be globally threatened (Taylor 1996), including the Brown Wood Rail (*Aramides wolfi*). This species is distributed at lower elevations along the western slope of the Andes in Colombia, Ecuador, and perhaps Peru (BirdLife International 2000). It is recorded from streams and swampy areas inside humid forest and secondary woodlands (Ridgely and Greenfield 2001). The Brown Wood Rail is reclusive, hard to observe, and vocalizes infrequently; its basic biology remains poorly known. Widespread habitat destruction within its range (Sierra 1996, Conservation International 2001) and its apparent absence from many localities (Ridgely and Greenfield 2001), have caused it to be considered 'Vulnerable to Extinction' globally (BirdLife International 2000) and 'Endangered' in Ecuador (Hilgert 2002). We provide the first detailed report of the basic biology, including nest site selection, nesting biology, and habitat use of the Brown Wood Rail.

METHODS

Field work was conducted at Bilsa Biological Station (79° 45′ W, 0° 22′ N, 330–730 m elevation), a 3,500-ha private reserve operated by Fundación Jatun Sacha within the 70,000-ha Mache-Chindul Ecological Reserve in Esmeraldas Province, Ecuador. Bilsa is approximately two-thirds undisturbed humid rain forest and one-third secondary forests (extensively logged with 10–20 years of regeneration) or selectively-logged forests (high-graded 10–20 years ago). The surrounding area contains patches of primary, selectively logged, and secondary forests interspersed among areas used for cacao (*Theobroma cacao*) cultivation, grazing livestock, and other agricultural uses.

We conducted systematic surveys for Brown Wood Rail nests throughout Bilsa from January 2007 to January 2009. We monitored activity at nests from blinds using 10× binoculars to record status and behaviors, and recorded nest location and elevation using hand-held global positioning system (GPS) units. We quantified habitat characteristics around all but one nest by measuring canopy height, canopy openness (with a spherical densiometer), and number of trees with diameter at breast height (DBH) between 10 and 50 cm in

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10-m diameter circular plots and >50 cm in 20-m diameter circular plots. We compared these data to equivalent measurements from 87 points at 200-m intervals along 17.5 km of trails in Bilsa that we used to survey for *Aramides* nests. We classified these 87 points as being in primary, altered, or secondary forest based on visual inspection and knowledge of land use history, and used a discriminant analysis to build a predictive model of group membership based on habitat characteristics. This model correctly assigned 85% of the 87 training points as primary (n = 41), selectively-logged (n = 23) or secondary (n = 23) forest. The two discriminant analysis functions were significant (Function 1, Wilks' Lambda = 0.280, $P < 0.001$; Function 2, Wilks' Lambda = 0.866, $P = 0.008$) and were subsequently used to classify the type of forest where Brown Wood Rail nests were found.

We captured three adult Brown Wood Rails in mist nets between March 2007 and January 2009, and took morphological measurements and applied three colored leg bands. We applied a lightweight radio transmitter (model PD-2; Holohil Systems, Carp, ON, Canada) using a Rappole harness (Rappole and Tipton 1991) to a breeding individual of unknown gender captured on 12 March 2008. The 3.8-g radio weighed <1% of the bird's total body mass. We tracked the individual using a TR4 receiver and a RA-2AK ''H'' antenna (Telonics, Mesa, AZ, USA) until the radio battery failed in November 2008. We suspended radio-tracking during nesting to minimize disturbance. We obtained locations of the bird at 30-min intervals during each radio-tracking session and recorded UTM coordinates using a handheld GPS unit. We plotted these coordinates using the Animal Movement extension in ArcView GIS 3.2 (ESRI 2006) and describe home ranges as minimum convex polygons (MCP's) (Mohr 1947), and 95 and 50% fixed kernel isopleths using least-squares cross validation (Worton 1989, Seaman and Powell 1996). Means ± SD are provided for all measurements.

RESULTS

We found nine active nests and seven additional nests that had evidence of recent activity but which were not active when discovered. Nests were found in February (n = 3), March (n = 10), and April (n = 3). Median clutch size was four eggs (mean = 3.7 ± 0.7, range = 2–4). Eggs were oval in shape and cream-colored with brown spotting at the ends; dimensions of one were 4.7 × 3.5 cm (Fig. 1A). At least two adults shared incubation duties with replacement triggered by sharp, cracking vocalizations by the arriving adult. At most only a single adult was banded at any given nest, and we could not confirm whether more than two birds incubated. Maximum incubation period observed was 19 days, which should be considered the minimum for this species because all active nests had full clutches with discovered.

Two of nine active Wood Rail nests were apparently depredated, one was abandoned, and six successfully fledged four young each. Hatching was synchronous (on the same day) and young left the nest within 24 hrs of hatching. Chicks hatched with eyes open and were brooded almost continuously until departing the nest; we observed no feeding while the chicks were still in the nest. Chick plumage was dark brown with light brown longitudinal streaking and highly cryptic (Fig. 1B), similar to that described for other Rallidae. At least two adults continued to care for the young for up to 10 days of age. Young chicks stayed together and were twice observed among the roots of a palm (*Iriartea deltoidea*) with stilt roots but were cryptic, moved rapidly, and difficult to observe.

Nests were open cups atop stumps of fallen trees (n = 5 cases; mean tree DBH = 31.1 ± 16.2 cm, mean tree height = 1.5 ± 0.6 m), at the intersection of multiple trunks and/or lianas (n = 3 cases; DBH = 5.03 ± 1.0 cm, height = 4.1 ± 2.9 m), or in understory shrubs (n = 8 cases; DBH = 6.6 ± 3.6 cm, height = 2.8 ± 1.4 m). Average nest height was 1.8 ± 0.5 m (range = 1.2–2.6) above the ground. Nests were constructed primarily of large, dead leaves (e.g., Araceae, Cecropiaceae, Piperaceae, and ferns) and a few small pieces of dried vine, and were relatively bulky (exterior dimensions: 26.8 ± 8.3 × 28.2 ± 6.0 × 12.3 ± 4.0 cm; interior dimensions: 12.0 ± 1.7 × 20.0 ± 2.6 × 3.8 ± 1.0 cm). The interior was lined with a mixture of live and dead, smaller leaves (primarily Melastomataceae). Nests were constructed beneath leaves and ferns in low light environments, making them relatively cryptic despite their large size (Fig. 1C).

Nests were found in forest areas where elevation averaged 551 ± 31 m asl (range = 448–587), canopy height averaged 15.2 ± 6.5 m, densiometer measures of canopy openness averaged 14.1 ± 6.9%, and there were 3.13 ± 2.1

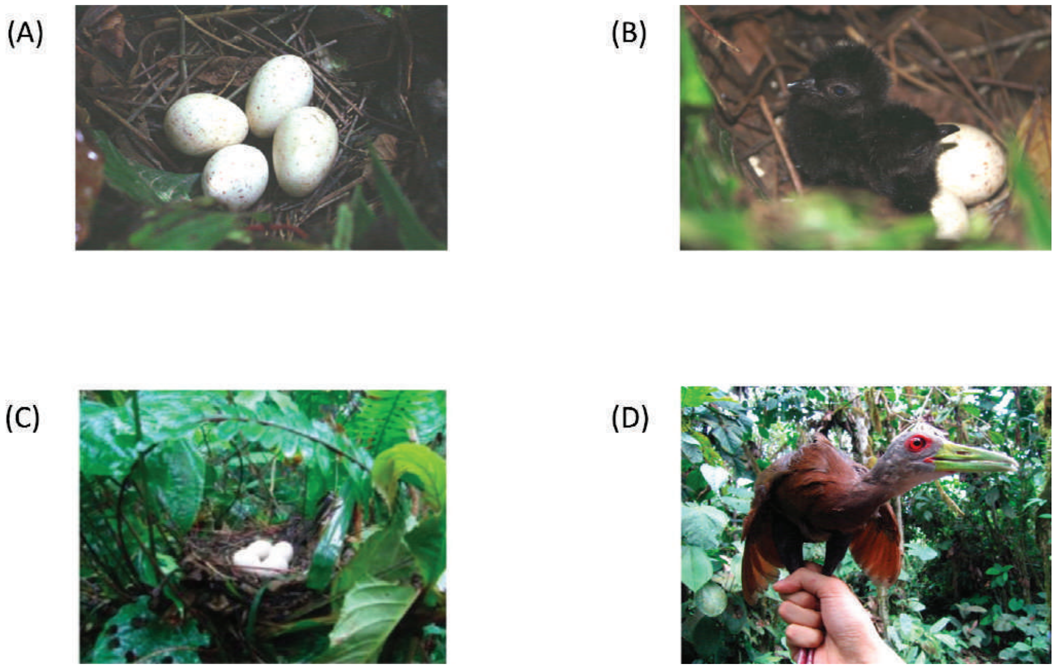

FIG. 1. Brown Wood Rail in Bilsa Biological Station, northwest Ecuador. (A) Interior of a nest with the average clutch size of four eggs. (B) Two recently-hatched chicks with two eggs about to hatch. (C) A nest 1.6 m agl on top of a tree stump with vegetation temporarily pulled back for purposes of the photograph. (D) Adult. (Photographs A–C by N. El Ksabi; photograph D by L. Carrasco).

trees with DBH between 10 and 50 cm, and 0.44 $\pm$ 0.9 trees with DBH $>$ 50 cm. Eleven nests were in secondary forest, four in selectively-logged forest, and one in primary forest. Comparison of nest site to habitat availability in the Bilsa area (based on 87 sampled points) revealed Brown Wood Rails used secondary forests as nesting sites in a larger proportion than this habitat is available in the area we sampled ($\chi^2_2 = 13.74$, $P = 0.001$).

Morphological measurements for three individuals of unknown gender were: mass (506.7 $\pm$ 61.1 g), tarsus (73.9 $\pm$ 1.0 mm), wing chord (175.8 $\pm$ 1.8 mm), tail length (52.4 $\pm$ 1.7 mm), beak depth (16.5 $\pm$ 3.3 mm), beak width (8.9 $\pm$ 0.9 mm), culmen from the distal edge of the nare (29.4 $\pm$ 1.8 mm), and exposed culmen (55.6 $\pm$ 4.1 mm). The eye ring and the iris were intensely bright red in all individuals (Fig. 1D).

We conducted 24 radio-tracking sessions and obtained 150 independent locations of a radio-marked bird of unknown gender between 12 March and 9 October 2008. This individual used a clearly defined territory whose overall MCP home range size was 13.5 ha; 95 and 50% kernel home range sizes were 9.0 and 0.9 ha, respectively. The radio-equipped individual was active throughout the day and at night was observed roosting 5 m above the forest floor in a ~7-m tall Melastomataceae tree, suggesting a diurnal pattern of activity. We opportunistically observed adults eating tadpoles from small puddles (10 cm^2) in muddy trails and small streams on five separate occasions.

The radio-marked bird was seen and/or heard with at least one other adult throughout the radio-tracking period. We recorded three distinct types of vocalizations: (1) a sharp, crackling vocalization audible at short distances used when nesting, heard when adults replace each other incubating or when adults called recently-hatched young; (2) a low frequency call audible for long distances used by adults of the same pair, perhaps to establish territoriality; and (3) a loud crackling call also audible over long distances which corresponds to the ''kyow'' of Ridgely and Greenfield (2001).

DISCUSSION

This is the first published account of the nesting biology and home range for any member of the

Aramides Wood Rails, a poorly known neotropical genus with several globally threatened members. Breeding of Brown Wood Rails coincided with peak rainfall and, although the clutch size of four eggs is relatively small compared to other Rallidae (Taylor 1996), nesting success was relatively high (66%). However, post-hatching mortality of young may also be high; at least one adult that successfully hatched young re-nested 14 days later, suggesting the young had been depredated.

At least two adults contributed to incubation, brooding, and post-hatching care. We also observed and/or heard a second individual accompanying a radio-marked bird throughout the 7-month tracking period. We did not observe more than two adults together at any time. These preliminary data suggest Brown Wood Rails may form long-term, socially monogamous pair bonds.

The home range size of 9.0–13.5 ha (95% kernel and MCP, respectively) for Brown Wood Rails is intermediate relative to other terrestrial rain forest species. Home range of the Chestnut Wood Quail (*Odontophorus hyperythrus,* 275 g) in the Colombian Andes was 5.2 ha (Franco et al. 2006) and home range of the Chowchilla (*Orthonyx spaldingii,* 150 g) in the Australian Wet Tropics was <2 ha (Jansen 1999). In contrast, the Banded Ground Cuckoo (*Neomorphus radiolosus*, 433 g) we tracked for a similar time period in Bilsa had a home range of ~50 ha (Karubian and Carrasco 2008). Movements of the radio-marked Brown Wood Rail suggest a clearly demarcated territory, and regular observations of footprints in the established core home range of this individual after the completion of radio-tracking suggest year-round residency.

Brown Wood Rails in our study area appeared to exhibit a preference for secondary and selectively-logged forests. The entire home range of the radio-marked individual was restricted to secondary and selectively-logged forest, and a disproportionately high number of nests (15 of 16) we discovered were in secondary or selectively-logged forest. In contrast, the Banded Ground Cuckoo we tracked in the same general area of Bilsa restricted nesting and movements almost exclusively to primary forest (Karubian et al. 2007, Karubian and Carrasco 2008). Some *Aramides* species have been reported in drier habitats such as deciduous woodlands (Taylor 1996; R. S. Ridgely, pers. comm.), but the Brown Wood Rail may depend upon year-round availability of water: the study area was humid premontane rain forest averaging ~3 m of rain per year (J. Karubian, unpubl. data). All foraging observations were of tadpoles in standing puddles or along creeks, and the individual we tracked was often in close proximity to water or muddy areas.

Brown Wood Rails are cryptic, difficult to observe, unlikely to be captured by passive mist netting, and do not reliably respond to playback making censuses using traditional methods unreliable. Local population size can be estimated with home range data with the caveat these data are only from a lone individual tracked for 7 months. Assuming that Bilsa contains 1,500 ha of suitable habitat (e.g., secondary and selectively-logged forest; Jatun Sacha Foundation, unpubl. data) and that the species forms socially monogamous pairs with territories 10–15 ha in size, Bilsa could possibly support 100–150 pairs. Interviews with local residents and our own observations suggest this species is relatively common when suitable forest occurs outside the boundaries of Bilsa. We observed four old nests (not included in the analyses) and footprints in fragments of secondary forest and cacao plantations outside Bilsa (but <500 m from continuous forest). Our preliminary conclusion is that population size of this species in the 70,000-ha Mache-Chindul Reserve may be several hundred pairs.

Bilsa and surrounding areas where Brown Wood Rail presence was inferred or confirmed consist of a mosaic of habitat types in which secondary forests are often contiguous to primary forest. Brown Wood Rails may persist in and even prefer secondary forests, but more extensive land clearing that increases isolation of forest fragments is likely to adversely affect this species. Our findings suggest Brown Wood Rails may be relatively resilient to intermediate levels of habitat degradation encountered in our study area, but we consider its' current status as 'Vulnerable to Extinction' to be justified given the continued and widespread deforestation occurring throughout its range.

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