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RESEARCH AND CONSERVATION OF FOREST-DEPENDENT TINAMOU SPECIES IN AMAZONIA PERU

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Resumen. – Investigación y conservación de los tinamúes amazónicos en Perú. – La investigación y la conservación en Sudamérica han crecido mucho durante las últimas décadas. Sin embargo, pocas investigaciones se han enfocado en los tinamúes (Familia: Tinamidae) y menos en las especies amazónicas. A consecuencia, no entendemos bien su estado de conservación, historia natural, ni uso del hábitat. En este estudio, proveo información sobre la comunidad de tinamúes de un bosque húmedo de la estación biológica de Cocha Cashu en el Parque Nacional del Manu en Perú. En ese bosque, se encuentran nueve especies de tinamúes y cuatro tipos de hábitat. Destaco aquellas especies que pueden ser más susceptibles a la pérdida de hábitat y fragmentación y discuto las necesidades específicas de investigaciones futuras en los tinamúes amazónicos.

Abstract. – Research and conservation in the Neotropics has grown significantly in recent decades, but few studies have focused on tinamous (Order: Tinamiformes), and even fewer on forest-dependent tinamou species. Consequently, their status, natural history, and habitat use remain little understood. Here I provide information regarding the tinamou community in a lowland forest at Cocha Cashu Biological Station, Manu National Park, Peru, where nine tinamou species occur among four dominant habitat types. I highlight species that may be susceptible to habitat loss and fragmentation and discuss specific needs for future research in Amazonian tinamous. *Accepted 30 December 2003.*

Key words: Tinamous, conservation, Amazonia, Neotropics, habitat selection, *Crypturellus*, *Tinamus.*

INTRODUCTION

Tinamous are a diverse and ancient family of terrestrial birds found only in the Neotropics, inhabiting a diverse array of habitats. Forest dwelling tinamous are typically large bodied, ranging in weight from 200 to 2000 g and their diet consists mainly of fruits, invertebrates, and occasionally small vertebrates with varying degrees of dietary specialization (Cabot 1992).

Because of their relatively large size, potentially small populations, and terrestrial habits, forest-dwelling tinamous may be especially vulnerable to habitat loss and alteration (Willis 1974, Terborgh & Winter 1980, Karr 1982, Gaston & Blackburn 1995). Little is known of the ecology of tinamous, with basic life history information (i.e., clutch size, egg color) absent for 40% of tinamou species. Here, I provide information on the tinamou community in a lowland forest in southeastern Peru and place it in the context of conservation by highlighting aspects of tinamou life histories that can affect species susceptibility to extirpation in compromised landscapes and suggest topics for continued research.

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TABLE 1. Species occurring at Cocha Cashu and their known attributes. Data are not necessarily from populations at this site.

Species	Range of masses (g)[a]	Clutch size[b]	Maximumand minimum elevation[c]	Habitats[d]
Tinamus tao	1325–2080	2–9	L–1900	F1, F4
Tinamus major	795–1210	3–6	L–1000	F1, F2, F15?
Tinamus guttatus	623–800	5–6	L–850	F1
Crypturellus cinereus	430–615	2	L–700	F2, F3, F15
Crypturellus soui	165–268	1–4(2)	L–1500	F1E, F15, F3
Crypturellus undulatus	462–660	4–5	L–900	F3, F8, F7, F15
Crypturellus atrocapillus	unknown	unknown	L–900	F1E, F15
Crypturellus variegatus	345–423	1	L–900	F1
Crypturellus bartletti	227–325	1	L–500	F2, F1

[a]Mass ranges are from Davies (2002) and all subspecies were pooled where applicable except for *C. bartletti* which are reported in Schelsky (2003).
[b]Clutch size ranges are from Davies (2002) except for *C. bartletti* which is reported in Schelsky (2003).
[c]Maximum elevation is reported in meters and taken directly from Parker *et al.* (1996): L = lowlands.
[d]Habitats from Parker *et al.* (1996): F1 – tropical lowland evergreen forest, F2 – flooded tropical evergreen forest, F3 – river-edge forest, F4 – montane evergreen forest, F7 – tropical deciduous forest, F8 – gallery forest, F15 – secondary forest, and E – edge (used as a modifier to particular habitats).

STUDY AREA AND METHODS

The study area is the Cocha Cashu Biological Station in Manu National Park, Peru (11°51'S, 71°19'W, elevation ~400 m) which lies between the boundary of tropical and subtropical moist forest, has a mean annual temperature of 23–24°C (range 7–33°C) and average annual rainfall of ~2000 mm (Terborgh 1983). Meandering of the Manu River creates a complex mosaic of habitats that can be classified as successional forest, mature floodplain forest, high ground (*terra firme*) forest intermixed with large, dense bamboo stands, swamps, and an oxbow lake (Terborgh 1983, Salo *et al.* 1986, Terborgh & Petren 1991). The intact landscapes around Cocha Cashu contain nine species of tinamou ranging in size from 165 to 2080 g with diverse clutch sizes (1–9) and habitats, documented from across their ranges (Table 1).

I reviewed data from tinamou surveys conducted at Cocha Cashu Biological Station taken from studies of the avian communities in three plots of four dominant habitat types: 1) late succession (80 ha) (Robinson & Terborgh 1997), 2) mature floodplain (97 ha) (Terborgh *et al.* 1990), and 3) upland (*terra firme*) (76 ha) intermixed with bamboo (12 ha) (Robinson & Terborgh unpubl.). Early morning and late evening surveys were conducted in 1982–1985 to record singing birds, and were completed almost every day from September through November, the months when the birds were presumably breeding. Survey routes were 1.5–2 km long and were walked in 2–4 h in the morning and 1–2 h in the evening. Locations of singing birds were mapped by estimating the distance and angle from a known location on the marked trails, paying special attention to counter-singing individuals. I used spot map data for nine species of tinamou to estimate the number of individuals in each habitat. I used both clus-

TABLE 2. Densities* of tinamou species listed by habitat type at Cocha Cashu Biological Station.

Species	Upland forest "*terra firme*"	Bamboo	Mature floodplain	Late succession
Tinamus tao	6	3	2	—
Tinamus major	8	2	17	14
Tinamus guttatus	—[1]	5	—	—
Crypturellus cinereus	12	10	5	16
Crypturellus soui	19	15	4	6
Crypturellus undulatus	—	—	10	40
Crypturellus atrocapillus	—	2.5	—	—
Crypturellus variegatus	6	—	2	—
Crypturellus bartletti	3	—	26	8

*Densities are reported as number of individuals per 100 ha.
[1]— Not recorded.

ters of points and counter-singing events to distinguish between individuals, because counter-singing in tinamous can be between both territorial same-sex individuals and duetting pairs (pers. observ.). The density of individuals was reported as the number of individuals per 100 ha.

RESULTS

Tinamou communities differed considerably among the well defined habitat patches of Cocha Cashu (Table 2). The dominant species in the upland forest were *Tinamus tao*, *T. major*, *Crypturellus cinereus*, and *C. soui* whereas *C. bartletti* and *T. major* were most common in the floodplain. *Crypturellus undulatus* was widespread and abundant in late successional forest and *Crypturellus cinereus* was fairly common in all habitats, but was extremely patchy within habitat patches, which suggests that it may respond to finer-scale features within patches such as tree-fall gaps or swamps. *Crypturellus variegatus* and *C. atrocapillus* occurred in low densities with *Crypturellus variegatus* being patchily distributed in both mature floodplain and upland forests avoiding bamboo, whereas *C. atrocapillus* and *T. guttatus* were only found in bamboo.

DISCUSSION

Given the increasing anthropogenic impacts upon Amazonian forests, it is crucial to assess how these impacts will affect the different tinamou species within the context of their autecology. Moreover, understanding each species' natural history allows for determining which management actions, if any, are feasible to mitigate these anthropogenic impacts.

At Cocha Cashu, no tinamou was rare in their preferred habitat, although some of the larger tinamou species, such as *T. Tao* and *T. guttatus*, occurred in lower population densities, but were more common than other similarly sized non-tinamou bird species (Robinson & Terborgh 1997). Moreover, *C. bartletti* was one of the most abundant species in the mature floodplain surpassing most other birds, including small- and large-bodied passerines (Terborgh *et al.* 1990). Although the spot map data from these studies are informative, the population density estimates are better used as relative measures of abundance than actual population densities. Terborgh *et al.* (1990) acknowledge that their estimates for tinamous were likely suspect lacking information on territoriality and mating systems.

The tinamou community at Cocha Cashu shows a high degree of segregation among habitats, suggesting the importance of maintaining habitat heterogeneity within anthropogenically impacted forests. Species dependent on river-created habitats, such as *C. undulatus* and *C. cinereus*, and on dense undergrowth typical of secondary forest, such as *C. soui*, are better adapted to patchy landscapes but require the maintenance of natural disturbance regimes, or mimicry of these regimes via management. Conversely, the species dependent upon bamboo, *T. guttatus* and *C. atrocapillus*, may be especially vulnerable because bamboo forests are patchily distributed and subject to large die-offs without rapid regeneration, thus requiring planning to maintain these specific habitats within the landscape in sufficient quantities (Kratter 1997).

Frugivores in tropical forests are dependent upon resources that are patchily distributed in space and time and therefore may make them sensitive to certain land uses and conversions (Sherman & Eason 1998). Little is known about the diets of forest tinamous or their level of dependence on infrequently occurring food resources. Research is needed to determine dietary preferences of forest tinamous and how these ephemeral resources vary spatially and temporally.

There is little information on dispersal of forest tinamous. However, observational information and my research on tinamous of Cocha Cashu suggest that forest tinamous can and do disperse. *C. undulatus* disperses between forested areas and is capable of crossing more than 500 m of open water (Remsen & Parker 1983, Schelsky pers. observ.), whereas *C. bartletti* dispersed at least one kilometer through unoccupied habitat, but was not documented crossing large natural barriers such as rivers or lakes (Schelsky 2003). Although *C. bartletti* did not avoid forest edges, it was never observed in small anthropogenic clearings suggesting that even small-scale forest clearings may serve as barriers. Given the diversity of forest tinamou species and associated differences in their natural history it is apparent that the observed differences in habitat preferences also relate to dispersal ability and are an important topic for future research.

The lack of data on populations and reproductive ecology of forest tinamous calls for well executed, methodologically sound estimations of population densities (Thompson *et al.* 1998, MacKenzie & Kendall 2002), survival and reproduction. These data are critical not only for understanding population dynamics, but for assessing the extent and impact of human exploitation upon populations of forest tinamous. Hunting was not a major threat to tinamou populations at Cocha Cashu. However, in areas with a greater level of human exploitation, hunting may be a threat, particularly to the larger bodied species (Vickers 1991).

Research into tinamou ecology within protected areas, such as Cocha Cashu, are informative and essential for understanding the basic ecology and community organization of forest dwelling tinamous. In addition, placing much needed data of forest tinamou communities and life histories into the context of the continued loss and fragmentation of tropical forests is imperative for the perseverance of forest dwelling tinamous.

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