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RESEARCH ARTICLE

New ecological information for the Black Tinamou (*Tinamus osgoodi hershkovitzi*)

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ABSTRACT

The Black Tinamou (*Tinamus osgoodi*) is a rare and endangered bird with two geographically disjunct subspecies. Very little pertinent information exists due to its secretive habits and cryptic coloration. Observations from a one-year study at Alto Fragua Indi Wasi National Park in southern Colombia have provided new ecological information for *T. o. hershkovitzi*. This subspecies vocalizes mostly between March and April, suggesting that the breeding season occurs during the first half of the year. Detections by camera traps indicate that this tinamou is more active in late morning, a pattern also found in other lowland tinamous. The subspecies was found in the entire study area, but more commonly at middle altitudes (1,400–1,600 m). We estimated a density of 13.47 birds km^{-2}, which is relatively high compared with the abundance of other tinamous of similar size. Despite the locally observed high density of this subspecies of Black Tinamou, high rates of logging and hunting in the area make this population vulnerable to rapid decline in the future.

Keywords: Tinamidae, vocal activity, circadian pattern, density, conservation

Nueva información ecológica del *Tinamus osgoodi hershkovitzi*

RESUMEN

Tinamus osgoodi es un ave rara y en peligro de extinción, con dos subespecies aisladas. Existe muy poca información relevante de la especie debido a sus hábitos sigilosos y a su coloración críptica. Las observaciones obtenidas durante un año de estudio en el Parque Nacional Alto fragua Indi-Wasi en el sur de Colombia han brindado información ecológica nueva para *T. o. hershkovitzi*. Esta forma vocaliza mayormente entre marzo y abril, sugiriendo que la estación reproductiva debe ser durante la primera mitad del año. Las Camaras Trampa indicaron que este tinámido es más activo al final de la mañana, un patrón encontrado en otros tinámidos de tierras bajas. Esta forma se encontró en toda el área de estudio, pero con más frecuencia a altitudes intermedias (1400 – 1600 m). Estimamos una densidad de 13.47 aves/km^2, que es relativamente alta en comparación con la abundancia de otros tinámidos de tamaño similar. A pesar de la alta densidad de la especie observada localmente, en el área se registran altas tasas de deforestación y de caza de la especie, lo que hace que esta población sea vulnerable a una rápida disminución en el futuro.

Palabras clave: actividad vocal, conservación, densidad, patrón circadiano, Tinamidae

INTRODUCTION

The Black Tinamou (*Tinamus osgoodi*) inhabits humid forest in the foothills of the eastern Andes, where epiphytes, tree ferns, bromeliads, and mosses are abundant. The majority of observations suggest that this species may require tall primary forest, as do most of its congeners (Cabot 1992, Lancaster 1964a, Schelsky 2004). Due to a terrestrial lifestyle and limited flight capacity, tinamous are considered strictly sedentary and likely do not perform any kind of migration (Cabot 1992), although some tinamous undertake short movements when climatic conditions demand, e.g., when flooding occurs in the Amazon or when cold fronts arrive in the mountains at higher latitudes (Cabot 1992). The almost complete absence of information relating to the Black Tinamou is due to its narrow distribution and the general challenge of studying tinamous: their secretive habits and cryptic coloration make observations in the field difficult (Brennan 2004). However, the incorporation of modern technology in the form of camera traps is particularly suitable

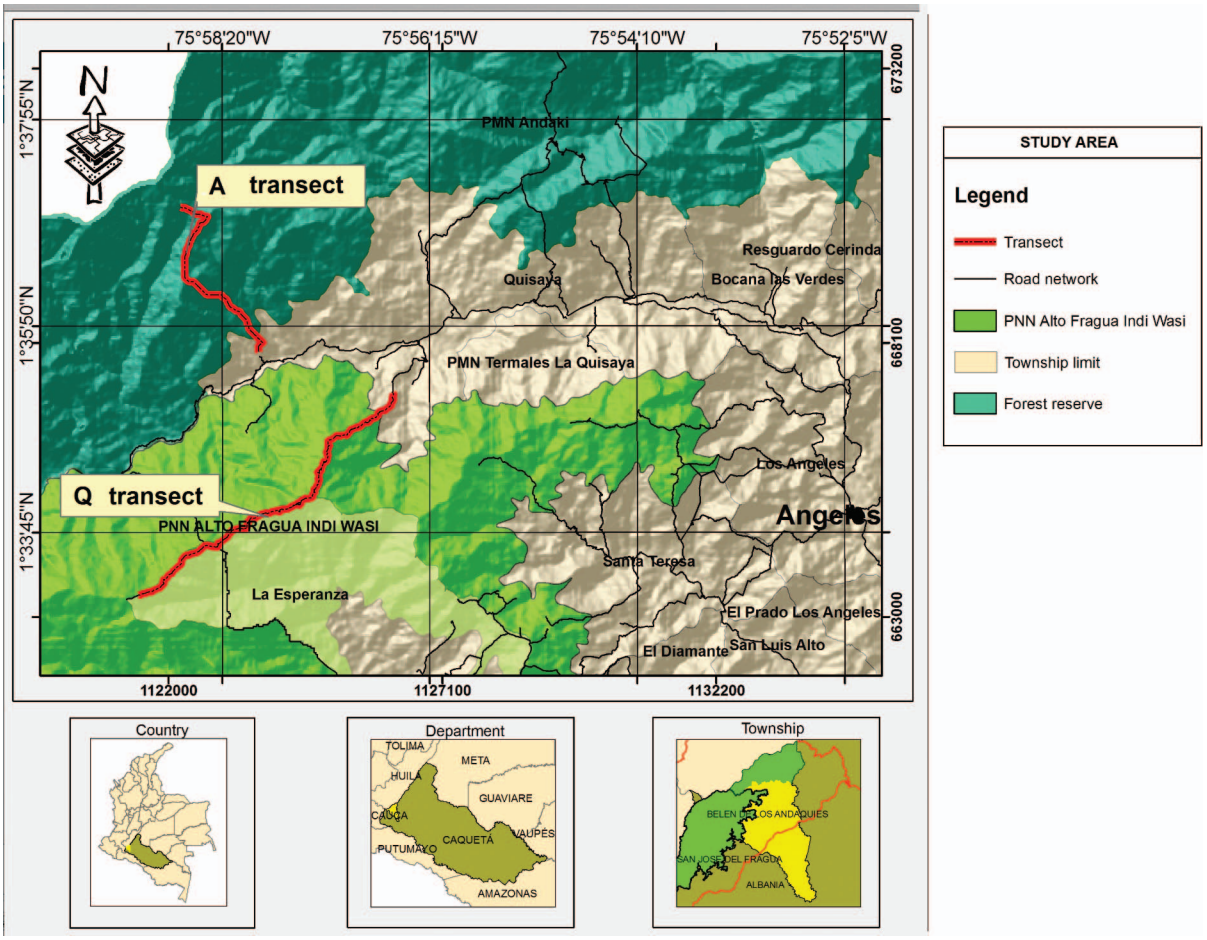

FIGURE 1. Map of the study area in Caquetá Department, Colombia, showing the locations of the two transects that we used to census *Tinamus osgoodi hershkovitzi*.

for studying moderately sized fauna with elusive behavior, such as tinamous (Kuhnen et al. 2012, Rowcliffe et al. 2014).

The Black Tinamou is a polytypic species with 2 recognized subspecies, *T. o. osgoodi* and *T. o. hershkovitzi*, and 1 unassigned population in Antioquia, Colombia (Cuervo et al. 2008). A recent acoustic, climatic, and geographical analysis suggests that the 2 subspecies might deserve to be treated as different species (Negret and Laverde-R. 2015). The subspecies are isolated by more than 1,000 km, occupy slightly different elevational ranges, have different vocalizations, and possess differences in plumage that were noticed decades ago (Conover 1949, Traylor 1952, Blake 1953, Negret and Laverde-R. 2015). The nominal form, *T. o. osgoodi*, is distributed in southern Peru and northern Bolivia (Cabot 1992, Vriesendorp et al. 2004). *T. o. hershkovitzi* is considered very rare in southern Colombia, but new localities have been reported recently in northern Ecuador (Pitman et al. 2002, Brinkhuisen and Córdova Saeteros 2011).

Because of their relatively large size, potentially small populations, and terrestrial habits, forest-dwelling tinamous may be especially vulnerable to habitat loss and alteration (Schelsky 2004). Basic ecological information and estimates of population densities are needed to reassess the current status of the rare Black Tinamou in its distributional range (Birdlife International 2014). Here, we describe daily and vocal activity patterns and elevational range, and provide an estimate of population density from a one-year study in Alto Fragua Indi Wasi National Park in southern Colombia.

METHODS

Study Area

Fieldwork was carried out in the foothills of the eastern Andes of Colombia in the upper Amazon Basin, Caquetá Department, in Alto Fragua Indi Wasi National Park (Figure 1). This park is bordered on the west by Serrania de los Churumbelos National Park, and on the north by Cueva de los Guacharos National Park. Our study area was near the northern limit of Alto Fragua Indi Wasi National Park. Annual precipitation at the two closest meteorological stations (San José de Fragua and El Mono) ranges between 3,400 and 4,400 mm; the dry season starts

TABLE 1. Density estimates (birds km^{-2}) and 95% confidence intervals of Black Tinamous (*Tinamus osgoodi hershkovitzi*) in Alto Fragua Indi Wasi National Park, Caquetá Department, Colombia, based on different model functions implemented in the 'Rdistance' package in R. The best-fitting function based on Akaike's Information Criterion (AIC) values is highlighted in bold font. ESW is the effective strip width for each estimated distance function.

Model	Abundance estimate	95% CI	ESW	AIC
Uniform	**13.47**	**11.41–17.30**	**8.98**	**52.93**
Half-normal	13.39	11.10–17.26	9.03	54.58
Negative exponential	12.72	11.27–16.72	9.51	54.87
Gamma	15.24	12.94–19.24	7.94	56.14
Hazard-rate	17.36	16.09–28.03	6.97	57.42

in early December and continues up to February, and the rainy season starts in March and lasts to the end of June (Parques Nacionales Naturales de Colombia 2005). The area is dominated by primary forest with a canopy height of ~20 m. The flora is a mixture of Andean and Amazonian plants, and the understory is full of palms and epiphytes. The landscape is characterized by steep hills; landslides are common, and access to some areas is difficult, especially during the rainy season.

Population Density

We did censuses along two transects (A and Q; Figure 1) from January to December, 2012, between 06:30 and 16:00, following recommendations given by Peres (1999) and Buckland et al. (2001). Transect A was 3.8 km long and ranged between 800 and 1,600 m in elevation; transect Q was 5.4 km long and its elevational range was 800–1,550 m. During censuses, we annotated visual records with estimates of the perpendicular distance to the transect and elevation (Marshall et al. 2008). We truncated visual records at 10 m because beyond this distance, in a montane forest, records did not meet some of the assumptions needed for density estimation (Peres 1999, Buckland et al. 2001). The sum of the total transect length of all censuses (214 km) was used to estimate population density using the 'Rdistance' (McDonald 2012) package in R (R Development Core Team 2013). We explored the distance functions implemented in 'Rdistance' to find the best fit to our data using AIC values. Additionally, we searched the literature for density information published for other species of tinamou to compare with our results, and to get a general idea of how common other tinamous are in relation to their size.

Elevational Range

Based on the elevation data for records obtained during censuses (visual and aural), in conjunction with anecdotal observations made outside formal censuses, we plotted the elevational range of *T. o. hershkovitzi* in our study area. Additionally, we searched for all records in the literature and databases for this subspecies to obtain a broad idea of its altitudinal distribution (see details in Negret and Laverde-R. 2015).

Annual Pattern of Vocalizations

During censuses, the number of individuals singing each month was recorded. We used these records to plot and describe the annual pattern of vocalizations of the Black Tinamou.

Daily Activity

Three camera traps, each separated by 1 km, were set up along transect A from August, 2012, to April, 2013, to measure the circadian pattern of the Black Tinamou. All records were grouped by hour to make a daily activity pattern graph in Oriana (Kovach Computing Services 2011). When individuals repeatedly triggered cameras without leaving the field of view, only the time of the initial trigger was counted as a record. Finally, we assumed that the trap rate at a given time of day would be proportional to the level of activity in the population at that time (Rowcliffe et al. 2014).

RESULTS

Population Density

We obtained a total of 22 visual records during all censuses. Estimated density was 13.47 birds km^{-2} (95% CI: 11.4–17.3 birds km^{-2}) using the uniform likelihood function, which had the lowest AIC value (AIC = 52.93; Table 1). Our density estimate, compared with those of other tinamous of similar size, was somewhat greater, but approximated the ranges provided in the literature (Table 2).

Elevational Range

We observed *T. o. hershkovitzi* across the entire elevational range of both study transects, but the subspecies was much more common between 1,400 and 1,500 m (Figure 2). Our lowest observation was at 800 m, and the highest was at ~1,600 m, but within the region the subspecies has been observed up to 2,100 m in Guacharos National Park (Hilty and Brown 1986).

Annual Pattern of Vocalizations

We obtained a total of 20 records of individuals vocalizing during all censuses. There seemed to be a peak in vocal activity between March and April, when 5 and 7 birds were singing, respectively. Vocal activity decreased in other months, with one or no individuals vocalizing from July to December (Figure 3).

Daily Activity

The Black Tinamou was especially active around midday. Camera traps obtained 22 records in total: 9 records (41%)

TABLE 2. Weights and density estimates reported for different tinamou species. Estimates in Schelsky (2004) and Lancaster (1964b) are based on the spot-mapping method, while those in Sao-Bernardo (2004) are based on the line-transect method. The density variation column shows the 95% CI for *T. o. hershkovitzi* and *T. solitarius*, and the range in different areas for all other species.

Species	Weight (g) *	Density **	Density variation	Source
Tinamus tao	1,565	3.6	2–6	Schelsky (2004)
T. solitarius	1,284	1.2	1–2	Sao-Bernardo (2004)
T. o. hershkovitzi	1,285	13.5	11–17	This study
T. major	960	10.2	2–17	Schelsky (2004)
T. guttatus	638	5.0	N/A	Schelsky (2004)
Crypturellus boucardi	436	N/A	5–9	Lancaster (1964b)

* Mean weight from Dunning (2008).
** Birds km^{-2}.

were between 11:00 and 13:00. Twelve records (55%) were registered in the morning, while 10 (45%) were captured in the afternoon. The 95% confidence interval showed an activity tendency of the species toward late morning (Figure 4). A Rayleigh test showed that daily records were grouped and had a distribution different from uniformity ($P < 0.001$). The mean hour of sightings was 11:00.

Anecdotal Observations

Hunting in the region is common, mainly for local consumption, but some animals hunted are sold in nearby villages. Due to its preference for steep hills with difficult access, the Black Tinamou is not heavily hunted in the area; however, the hunting of some individuals was reported during the study period. The presence of seeds of Fabaceae (*Inga* sp. and *Inga* cf. *edulis*), Urticaceae (*Pourouma* cf. *bicolor*), and Ericaceae in the gizzard of one individual, and several observations of Black Tinamous taking fruits from the forest floor, revealed a mostly frugivorous diet.

DISCUSSION

The Black Tinamou has been considered rare, but recently was reported as fairly common at mid-elevations in northern Ecuador (1,000–1,350 m) and Peru (1,400–1,650 m), although estimations of density were not provided (Pitman et al. 2002, Vriesendorp et al. 2004). The density estimate in our study area (13 birds km^{-2}; Table 1) appears to be high compared with the densities of other members of the genus *Tinamus* of similar size to the Black Tinamou, but within the density ranges of some other tinamous (Schelsky 2004). For example, the Solitary Tinamou (*T. solitarius*) is very rare (1.2 birds km^{-2}; Table 2) in a protected area in São Paulo, Brazil (Sao-Bernardo 2004), and the Grey Tinamou (*T. tao*) is not very abundant

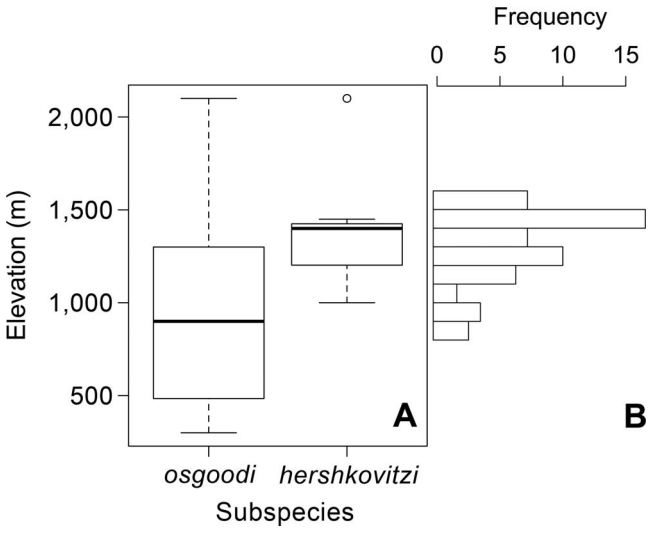

FIGURE 2. Histogram of the elevational records obtained during censuses and from anecdotal observations of *Tinamus o. hershkovitzi* in Alto Fragua Indi Wasi National Park, Caquetá Department, Colombia, compared with the range of *T. o. osgoodi*. Boxplot data from Negret and Laverde-R. (2015, figure 4).

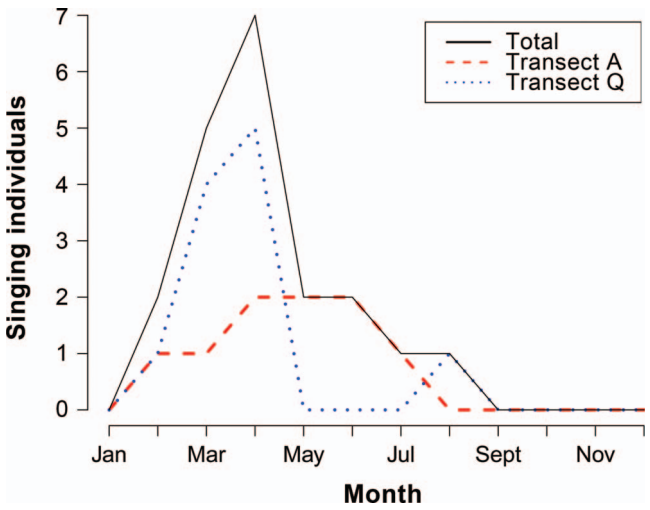

FIGURE 3. Number of Black Tinamous vocalizing each month during censuses conducted in Alto Fragua Indi Wasi National Park, Caquetá Department, Colombia, from January to December, 2012. See Figure 1 for transect locations.

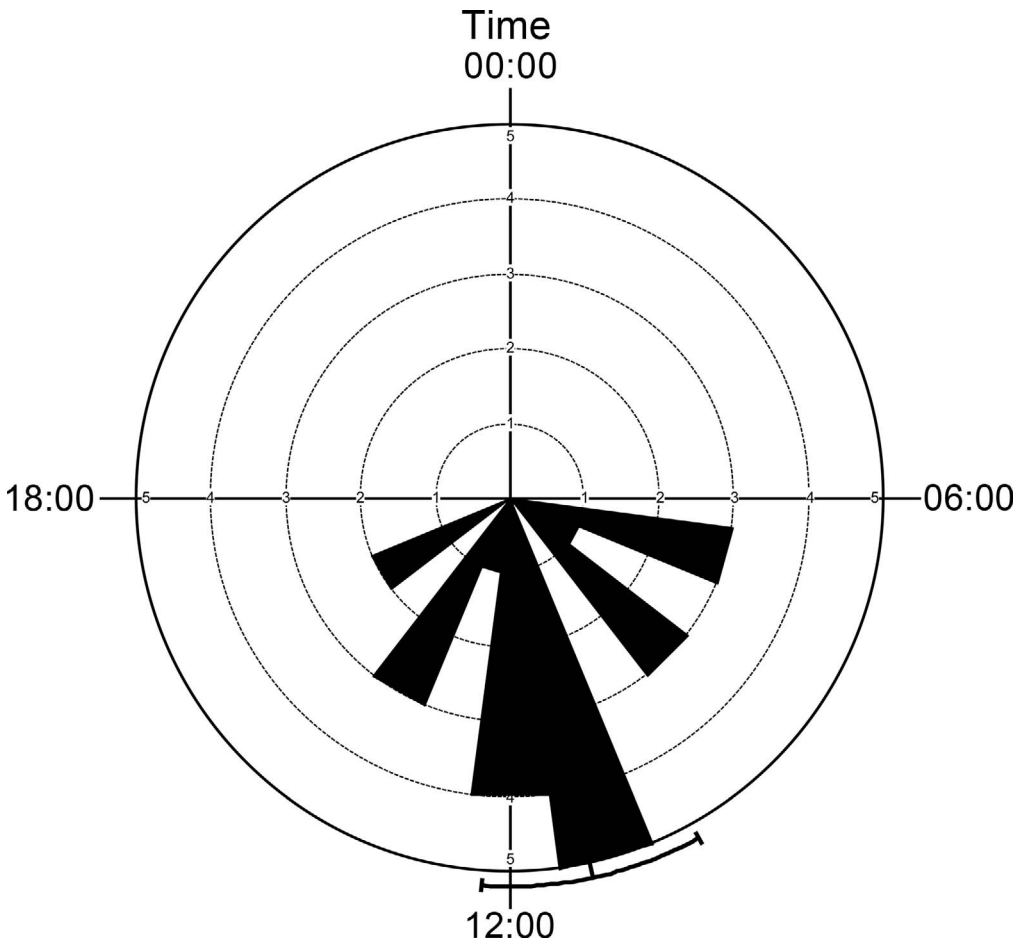

FIGURE 4. Daily activity pattern of *T. o. hershkovitzi* as registered by camera traps in Alto Fragua Indi Wasi National Park, Caquetá Department, Colombia. Each concentric circle is one record; black triangles are the number of records per hour, and the black arc outside the circle is the 95% confidence interval.

(up to 6 birds km^{-2}) in upland terra firme forest in Manu National Park, Peruvian Amazon. But the Great Tinamou (*T. major*), which is smaller, is more abundant (up to 17 birds km^{-2}) in the mature floodplain and late-successional secondary forest in Manu National Park (Schelsky 2004).

Most tinamou densities that we compiled came from the Amazon, which is an ecosystem with nutrient-poor soils. The Black Tinamou lives in the Andes, a younger montane ecosystem that is richer in nutrients. We speculate that differences in soil nutrients could be one factor that explains this higher density (Pomara et al. 2012). Moreover, the only other tinamou that we recorded in the area was the Little Tinamou (*Crypturellus soui*); therefore, the Black Tinamou seems to not have high competition, possibly making the species more abundant (Brooks et al. 2004). In the Amazon, up to 5 different species can be found in just 1 locality (Ridgely et al. 2003, Schelsky 2004).

The elevational range for the Black Tinamou is 300–2,100 m (Negret and Laverde-R. 2015), but ranges between the subspecies differ: *T. o. hershkovitzi* has not been recorded below 800 m, while *T. o. osgoodi* has been recorded down to 300 m, although more commonly between 1,000 and 1,350 m. *T. o. hershkovitzi* also prefers middle elevations: In the eastern foothills of the Ecuadorian Andes, it was reported as fairly common between 1,000 and 1,350 m in Cerro Shishicho (Pitman et al. 2002); in Alto Fragua Indi Wasi National Park it was very common between 1,400 and 1,500 m (Figure 2). The lowest record in the study area was 800 m, ~700 m lower than the lowest elevation previously reported for this subspecies (Hilty and Brown 1986).

Seasonal patterns of variation in animal signaling behavior provide insights into the function of these signals. The pattern of vocalizations in the Black Tinamou is clearly seasonal, with a peak between February and April, which might be related to the breeding season of the Black Tinamou in the area. An increase in vocal output in some tropical birds has been related to the breeding season (Lancaster 1964b, Topp and Mennill 2008, Tremain et al.

2008, Koloff and Mennill 2012). Barred Antshrike (*Thamnophilus doliatus*) vocal output was lowest before the start of the breeding season in late February, but increased and remained at a high level during the breeding season in Costa Rica (Koloff and Mennill 2012). In Rufous-and-white Wrens (*Thryophilus rufalbus*), peak vocal output was highly correlated with the female's fertile period, and declined after females began laying eggs (Topp and Mennill 2008). In the Slaty-breasted Tinamou (*Crypturellus boucardi*), males and females disappear after the mating period, with neither seen nor heard, and the male is silent during the entire incubation period (Lancaster 1964b). We infer that the mating season of the Black Tinamou ends between April and May, when the incubation period likely begins.

The circadian cycle that we observed in the Black Tinamou, which showed more activity in the hours close to noon, was similar to the one found for the White-throated Tinamou (*Tinamus guttatus*) in a Peruvian Amazonian forest (Brooks et al. 2004). This is not the normal trend for species of the genus, which in general have a twilight pattern of activity (Brooks et al. 2004, Kuhnen et al. 2012). However, in tinamous there is ample variation in this pattern (Brooks et al. 2004, Kuhnen et al. 2012).

Based on our observations, the Black Tinamou has a diet based on fallen fruit and seeds; however, we suppose that this diet could be supplemented with invertebrates and some small vertebrates, as occurs in other tinamou species (Lancaster 1964a).

Deforestation for logging, cattle ranching, and hunting are common activities in our study region, despite the dominance of steep slopes and the presence of a protected area. More detailed study of the true impact of these activities on the local fauna is imperative. Several species of importance for conservation, such as woolly monkeys, mountain tapirs, pumas, and curassows, are present in the area, and are affected by the anthropic factors mentioned above. The Black Tinamou is a forest-dwelling terrestrial bird of relatively large size, vulnerable to habitat loss or fragmentation. Knowing more about the ecology of the species, the true effect of habitat degradation on its populations, and its density throughout its range, as well as the threats to its populations, are critically important to determining its true status. This study is a first step in that direction.

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