Densidad poblacional de mancololas (Tinamidae) y crácidos (Cracidae) en el Parque Nacional Laguna Lachúa (Alta Verapaz, Guatemala)

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Population density of tinamous and cracids (Tinamidae and Cracidae) at Laguna Lachúa National Park (Alta Verapaz, Guatemala)

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Resumen: La densidad poblacional de los animales amenazados de extinción, o sujetos a la presión de cacería, es un parámetro clave para evaluar y adaptar las estrategias de conservación. Esta es una variable pocas veces disponible, sobre todo en especies inconspicuas, de hábitos reservados o propensas a huir. Los dos objetivos de esta investigación son: proponer una metodología para la estimación de la densidad poblacional de mancololas y crácidos a partir de registros de cámaras trampa, y presentar los resultados de implementar esta metodología con datos provenientes del Parque Nacional Laguna Lachúa. El parque es el más importante remanente de ecosistemas naturales en una zona de transformación agrícola. En este se distribuyen distintas especies de mancololas y crácidos, consideradas especies amenazadas de extinción, posiblemente presionadas por la cacería, y de hábitos crípticos. Se seleccionaron los coeficientes más pertinentes para el cálculo del rango diario estimado de cada especie, y así poder utilizar modelos de encuentros aleatorios. Las densidades poblacionales estimadas fueron (ind/km^2): *Tinamus major*, 7.460; *Crypturellus boucardi,* 4.231; *C. soui,* 3.119; *Crax rubra*, 2.972; *Ortalis vetula*, 0.400; *Penelope purpurascens*, 0.164. Los resultados son semejantes a los encontrados en poblaciones de otras especies emparentadas, y permiten afirmar el valor del parque como hábitat de aves amenazadas de extinción, y como el remanente de mayor extensión de los ecosistemas naturales en la región. Se recomienda utilizar esta metodología para comparaciones posteriores, así como la inversión de fondos públicos para la investigación en sostenibilidad y gestión de la diversidad biológica.

Palabras clave: estimación, modelos de encuentros aleatorios, rango diario, Áreas Clave para la Biodiversidad, Franja Transversal del Norte.

Abstract: Population density of animals that are endangered or subject to hunting pressure, is a key parameter for evaluating and adapting conservation strategies. This variable is rarely available, especially for inconspicuous species, with elusive habits or prone to fleeing. The two objectives of this research are: to propose a methodology for estimating the population density of tinamous and cracids from camera trap records, and to present the results of implementing this methodology with data from Laguna Lachúa National Park. This park is the most important natural ecosystems remant in an agricultural transformation. Various species of the tinamous and cracids distributed in the park, considered endangered species, possibly pressured by hunting, and with cryptic habits. The most relevant coefficients were selected to calculate the estimated daily range of each species, and then used in random encounter models. The estimated population densities were (ind/km^2): *Tinamus major*, 7.460; *Crypturellus boucardi*, 4.231; *C. soui*, 3.119; *Crax rubra*, 2.972; *Ortalis vetula*, 0.400; *Penelope purpurascens*, 0.164. Results are similar to those found in populations of other related species, and confirm the value of the park as habitat for extinction-threatened birds, and as the largest remaining natural ecosystem in the region. It is recommended to use this methodology for future comparisons, and to invest public funding in research on sustainability and biological diversity management.

Keywords: estimation, random encounter models, daily range, Key Biodiversity Areas, Northern Transversal Strip.

Introduction

Although the Mesoamerican region constitutes in its entirety a focal point (*hotspot*) of biological diversity (Myers et al, 2000), there are some areas within it, of a much more restricted extent, that present values of biological wealth notably higher than the majority of the territory. These areas can be defined as key biodiversity areas (International Union for Conservation of Nature [IUCN], 2022). One of these areas is the Lachuá – Ik'bolay key area, identified as a critical area for the conservation of restricted-range species (Key Biodiversity Areas Partnership, 2024).

Within this priority zone are three protected áreas: the Chajumpec Private Nature Reserve, the Entre Ríos Private Nature Reserve, and the largest of all, the Laguna Lachuá National Park (LLNP). In addition to the official designation of the LLNP as a protected area, it has also been recognized as part of a wetland area of international importance, that is, a Ramsar site (BirdLife International, Lachuá Ecoregion, 2024). For decades, public policies and production relations based on the exploitation of natural resources have driven deforestation in the area (Secretaría de Planificación y Programación de la Presidencia, [SEGEPLAN], 2011).

Currently, protected areas are the last and most important remnants of the natural ecosystems that are distributed throughout the territory.

The contingent value of protected areas for Guatemalan society, and for humanity in general, has increased as natural ecosystems are lost and degraded. These become truly strategic areas for the conservation of biological diversity and the processes that have produced and maintain it, especially when ecological criteria are integrated into their designation and prioritization. One of these criteria considers, in addition to species richness, the presence and coincidence of taxa with restricted distribution range (rarity), an attribute found at the highest level in the PNLL (Veach et al., 2017). This is one of the last remnants where the largest Mesoamerican mammals are still distributed: tapirs, jaguars, pumas, and collared peccary (Consejo Nacional de Áreas protegidas & Fondo Nacional para la Conservación de la Naturaleza [Conap-Fonacon], 2018).

Therefore, understanding the distribution and use of habitats is essential for evaluating and adapting conservation efforts to conserve biological diversity, in addition to being a crucial topic in Ecology. Two of the most frequently analyzed variables regarding animal distribution are density and home range (home range; Carbone et al., 2005; Haskell et al., 2002). Although the relationship between these two variables is unclear, a third variable, the daily range, enables the first two to be modeled. This variable, key to research, has also been referred to as daily distance traveled, average daily displacement (Carbone et al., 2005), or speed (speed in Rowcliffe et al., 2008; velocity in Lucas et al., 2015), which has been estimated mainly based on body size and feeding strategy.

This research aims to enhance the utility and significance of data generated by camera trap photo captures in the PNLL, recorded in the field during September and October 2018. Although the original Project focused on the study of médium and larger mammals (Conap & Fonacon, 2018), photocaptures of birds were also recorded and stored for later analysis.

This analysis is possible by implementing the numerical methodology adapted in this research for mancololas and cracids, based on methods developed for mammals (Carbone et al., 2005; Lucas et al., 2015). Birds of the Tinamidae and Cracidae families are medium-to-large-sized species, and therefore tend to require larger territories to meet their needs, making them more susceptible to habitat loss and degradation (Thiollay, 2006). In tropical ecosystems, these species often play critical ecological roles, such as seed dispersal (Côrtes et al., 2009). Their presence can be interpreted as an indicator of ecosystem health.

Mancololas and cracids frequently face pressure from hunting and habitat destruction, with some species listed as threatened with extinction (Conap, 2022). Moreover, these birds are secretive, cautious, and inconspicuous, and some can be detected almost exclusively by these minimally invasive means (Suwanrat et al., 2015). Their conservation is a priority as part of efforts to manage biological diversity (Thiollay, 2006).

The two objectives of this research are: to propose a methodology for estimating the population density of mancololas and cracids from camera trap records, which is a minimally invasive and viable methodology that provides high-quality data; and to present the results of implementing this methodology with data from Laguna Lachúa National Park. Although based on an ecological justification, the development is primarily statistical, so the scope of the results, while comparing estimates with other studies and methodologies, leaves room for a more in-depth ecological analysis. In any case, the decisive contribution of the PNLL to the conservation of national biological diversity, including endangered bird species, is confirmed.

Materials and methods

Data collected in Laguna Lachúa National Park (LLNP), located in the municipality of Cobán, Alta Verapaz, Guatemala, were analyzed. This park covers an area of approximately 142 km^2, of which 4.2 km^2 corresponds to the lagoon. It is bordered to the northeast and west by the Chixoy and Ik'bolay rivers, and to the south by the La Sultana and El Peyán mountains. The area includes low hills and valleys of the Sedimentary Highlands to the south, and in the central and northern parts, the Chixoy River floodplain, which is part of the Petén Interior Lowlands. The soils are karst, and their formation began in the Late Cretaceous. The altitude varies from 173 meters above sea level at the lagoon to 700 meters above sea level in the southern hills. Rainfall is 3,000 to 4,000 mm, with less than 3.5 months of drought per year (Ministerio de Agricultura, Ganadería y Alimentación [MAGA], 2001).

The average temperature is above 25 °C. Lowland broadleaf tropical evergreen forest dominates the area, varying from moderately to well-drained. Portions of submontane broadleaf tropical evergreen forest are also found in the southern hills (World Bank & Central American Commission on Environment and Development, 2000).

In 2018, 24 camera traps were placed in the LLNP (Figure 1), as part of the study Relative abundance and distribution of medium and large mammals within the Laguna Lachúa National Park using camera traps (Conap & Fonacon, 2018). The first 20 cameras (Bushnell Trophy Cam HD Agressor) were activated in early September. In early October, four cameras were added and remained in the field until the first week of November. The cameras were placed at sites where rangers identified evidence of animal movement in the field. A single camera was installed per study site, oriented perpendicular to paths or animal crossings, and at a height between 30 and 50 cm from the ground, ensuring that the photography/detection field was not obstructed by branches or leaves. The cameras were separated from each other by an average of 6 km.

The photographs obtained from the camera traps were analyzed to record the species, the number of individuals per species, the sampling station, the date, and the time of each record. Each image was classified as an independent or duplicate encounter, considering as independent encounters: (i) consecutive photographs of different species, (ii) consecutive photographs of the same species with an interval >60 min, or (iii) non-consecutive photographs of the same species (modified from O'Brien et al., 2003). Duplicate encounters were discarded.

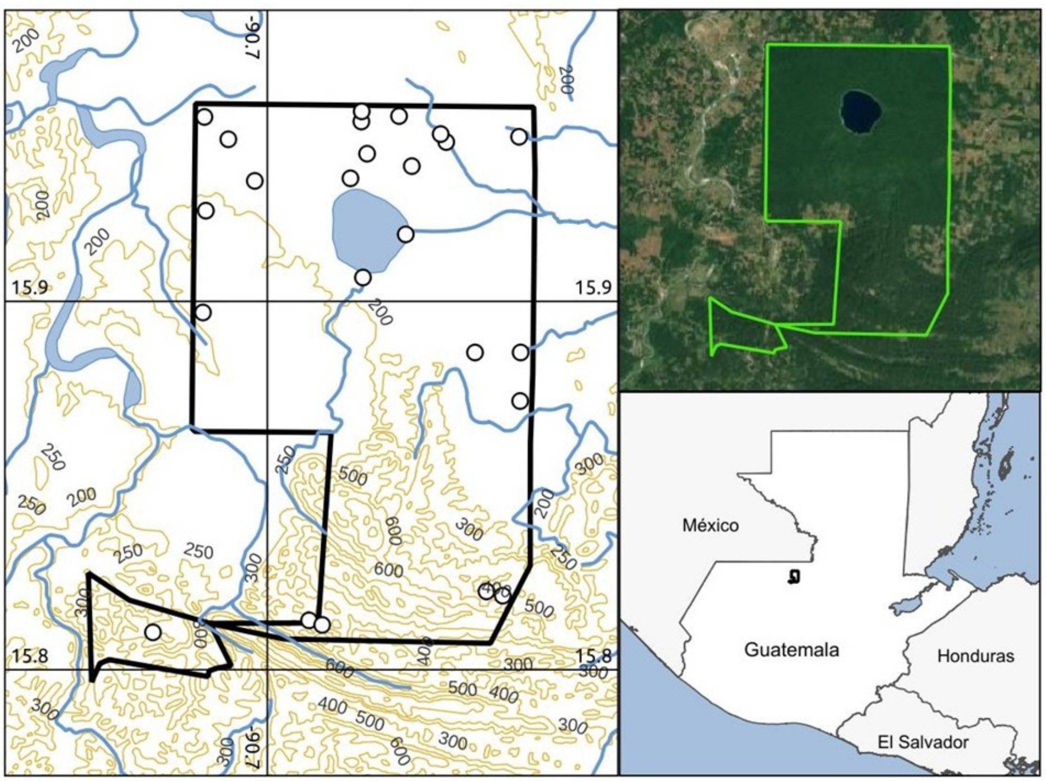

Figure 1.
Location of trap cameras in Laguna Lachuá National Park

Note: The reference coordinate system is WGS84, with coordinates in decimal degrees; the altitude is presented in ochre isolines, expressed in meters above sea level. Sources: MAGA, 2001; Google XYZ Tiles, 2024; fieldwork.

Although all the birds captured in the photographs were identified and recorded, the density was estimated for six species, the rest only the frequency is presented (Table 1). The estimation of the density of animal populations from data generated by trap cameras is generally carried out by means of probability models of random encounters, derived from the analysis of particle mechanics and gas laws. Among these models are those proposed by Rowcliffe and collaborators (2008), modified by Lucas and collaborators (2015). The models use six variables: number of independent capture events (encovers), detection angle of the camera sensor (θ), angle of occupation of the species in the lens (α), distance at which the individual is detected (r), number of hours of receptive activity of the cameras (tm) and the daily range of the species (v).

The density estimates were made using the “RandEM” package (v. 0.0.1.9000; Caravaggi & Lucas, 2023), in the software "R" (v. 4.3.0; R Core Team, 2023). The following parameters were generally used: $\theta = 1.5$ radians, $\alpha = 2.5$ radians, $r = 10$ meters, and $tm = 29{,}472$ hours. The number of independent encounters (trap camera data) and the daily rank were variable for each species (Table 3). The estimation of density using random encounter models requires that the estimated value of the daily range is previously counted. The selection of the most relevant coefficients, used for the estimation of the daily range, is part of the results and proposals of this research.

Results

The 2018 study allowed the accumulation of 29,472 hours of effort using 24 trap cameras distributed in 24 study sites (Conap & Fonacon, 2018). With this, 311 bird catching events were obtained, of which 284 are considered independent (91.3%).

It was identified that the birds detected belong to 30 different species, among these, three are mancololas and three are cracids (Table 1). The species with the highest number of photocaptures are the major mancolola (*Tinamus major*; Figure 2) and the pajuil or pheasant (*Crax rubra rubra*; Figure 3).

Tabla 1
Aves registradas en el Parque Nacional Laguna Lachúa en 2018, utilizando cámaras trampa

No.	Order	Family	Species	Encounters
1	Tinamiformes	Tinamidae	*Crypturellus boucardi*	19
2		Tinamidae	*Crypturellus soui*	11
3		Tinamidae	*Tinamus major*	52 (45)
4	Galliformes	Cracidae	*Crax rubra rubra*	38 (29)
5		Cracidae	*Ortalis vetula*	2
6		Cracidae	*Penelope purpurascens*	1
7	Apodiformes	Trochilidae	*Heliothryx barroti*	2
8		Trochilidae	*Phaethornis longirostris*	2
9	Cuculiformes	Cuculidae	*Piaya cayana*	6
10	Columbiformes	Columbidae	*Geotrygon montana*	28 (27)
11		Columbidae	*Leptotila cassini*	27
12		Columbidae	*Leptotila plumbeiceps*	30 (25)
13	Gruiformes	Aramidae	*Aramus guarauna*	1
14	Pelecaniformes	Ardeidae	*Egretta tricolor*	1
15	Coraciiformes	Momotidae	*Hylomanes momotula*	3
16		Momotidae	*Momotus lessonii*	1
17	Passeriformes	Thamnophilidae	*Taraba major*	1
18		Grallariidae	*Grallaria guatimalensis*	16 (14)
19		Formicariidae	*Formicarius moniliger*	21 (20)
20		Furnariidae	*Sclerurus guatemalensis*	2
21		Troglodytidae	*Henicorhina leucosticta*	5
22		Turdidae	*Hylocichla mustelina*	17 (15)
23		Emberizidae	*Arremon aurantiirostris*	5
24		Parulidae	*Geothlypis formosa*	9
25		Parulidae	*Mniotilta varia*	1
26		Parulidae	*Seiurus aurocapilla*	3
27		Parulidae	*Setophaga citrina*	1
28		Thraupidae	*Lanio aurantius*	1
29		Thraupidae	*Ramphocelus sanguinolentus*	3
30		Thraupidae	*Saltator maximus*	2

Note: The number in parentheses in the Encounters column corresponds to the number of independent photocaptures, when this is different from the number of total encounters. Source: analysis of trap camera records obtained in the field.

Figure 2
Photocapture of a major mancolola (*Tinamus major*) in the PNLL

Figure 3
Photocapture of a pajuil or pheasant (*Crax rubra rubra*) in the PNLL

For the estimation of the daily range, the most relevant coefficients were selected from the proposal of Carbone and collaborators (2005), based on two key ecological observations by Haskell and collaborators (2002): the domestic range of mammals and faunivorous birds has a similar observed growth factor, depending on body size; the domestic range of species that seek and take advantage of resources in a two-dimensional space (animals that forage only on the ground such as mancololas) has a growth factor, depending on body size, superior to that of animals that forage in a three-dimensional space (animals that fly or climb trees).

Therefore, considering that mancololas and cracids are almost totally frugivorous (Fagan & Komar, 2016; Peña, 2004; Rivas, 1995; Rivas et al., 2003), it is expected that the daily range or average daily displacement is intermediate between herbivorous and faunivorous animals (Carbone et al., 2005), although more similar to that of the former. In addition, the mancololas and Crax rubra exhibit a two-dimensional foraging strategy (looking at ground level, in the forest), while Ortalis vetula and Penelope purpurascens develop a three-dimensional strategy (flying and foraging on the branches). The possibility of moving in groups or not is considered insignificant within the forest, as it is considered that it presents the maximum possible density of food resources with respect to fragmented landscapes (Haskell et al., 2002).

In addition, it is recognized that cracids have an important role as seed dispersers, but they are also potential predators of these (Rivas et al., 2003), similar to what is observed in tropical rodents of the Cuniculidae and Dasyproctidae families, with whom they could share ecological niche in two-dimensional forage (Reid, 2009), and with some frugivorous primates, in three-dimensional forage. The models proposed here (Table 2) allow us to estimate the daily range of each species based on its body mass, assuming a forage strategy (two-dimensional or three-dimensional), frugivorous diet, and ecological resemblance with groups of tropical mammals.

Table 2

Estimation models of the daily range of each species of mancolola and crácido detected by trap cameras in the Laguna Lachúa National Park.

		Daily range estimation model				
Family	**Specie**	**mass**	***a***	**ln(mass)**	***b***	**ln (daily range)**
Bidimensional foraging strategy						
Tinamidae	*Crypturellus boucardi*	0.436	0.345	-0.8301	-0.321	0.0346
Tinamidae	*Crypturellus soui*	0.216	(0.088)	-1.5325	(0.196)	-0.2077
Tinamidae	*Tinamus major*	1.026		0.0257		0.3299
Cracidae	*Crax rubra rubra*	4.133		1.4190		0.8106
Three-dimensional foraging strategy						
Cracidae	*Ortalis vetula*	0.563	0.028	-0.5745		0.3049
Cracidae	*Penelope purpurascens*	2.060	(0.063)	0.7227		0.3412

Note: The slope (a) and the intercept (b) of the model show the standard error in parentheses. The mass is expressed in kilograms, and the daily range in kilometers. Sources: Carbone et al., 2005; Tobias et al., 2022.

The density of six species of birds (mancololas and cracids) was estimated, finding that the species with the highest density were *Tinamus major* and *Crypturellus boucardi* (Table 3). The two birds with the lowest estimated density were the turkeys (*Ortalis vetula* and *Penelope purpurascens*), both of which have a three-dimensional forage strategy (arboreal; Table 2).

Table 3
Estimated density of mancololas and cracids detected in the Laguna Lachúa National Park in 2018, using trap cameras.

Family	Specie	mass	daily range	encounters	density	amt
Tinamidae	*Tinamus major*	1.026	0.732	45	7.460	1028
Tinamidae	*Crypturellus boucardi*	0.436	0.545	19	4.231	583
Tinamidae	*Crypturellus soui*	0.216	0.428	11	3.119	430
Cracidae	*Crax rubra rubra*	4.133	1.184	29	2.972	410
Cracidae	*Ortalis vetula*	0.563	0.714	2	0.400	55
Cracidae	*Penelope purpurascens*	2.060	0.740	1	0.164	23

Note: The data are presented ordered from highest to lowest density; the mass is expressed in kilograms, the daily range in kilometers, the density in individuals per square kilometer; the number of independent encounters is shown; the last column presents the estimated number of individuals of each species, considering 137.8 km2 of land extension in the PNLL.

Discussion

The estimated densities for mancololas and cracids detected in the PNLL are valid to the extent that the assumptions of this research are correct: i) it is possible to estimate the daily range of each species from its body mass; ii) the daily range depends on the forage strategy, depending on whether it is two-dimensional or three-dimensional (Haskell et al., 2002); iii) the diet of these birds is almost entirely frugivorous, which implies that the daily range would be intermediate between that of herbivores and faunivores; iv) there is similarity in terms of the trophic ecological niche of the study frugivorous birds and the orders of frugivorous mammals (Carbone et al., 2005).

In any case, the values produced by the estimates offer two practical services for the management of conservation in the PNLL: i) one has an idea of the density and number of individuals of mancololas and cracids in the area; ii) when this methodology is replicated, comparisons can be made with the results derived from the 2018 study, at least in terms of relative measures of abundance (density).

The protocol generally used to estimate the density of birds involves the use of routes or observation points where the observation distance of each study individual is recorded (Alves et al., 2017; Bernardo et al., 2011; Bezerra et al., 2019; Londoño et al., 2007; Martínez-Morales, 1999; Prado et al., 2022; Roncancio et al., 2023; Suwanrat et al., 2015), and then the information is processed in specialized software packages, mainly Distance (Thomas et al., 2010). Regularly, population estimates generated in this way can only be contrasted or validated using other complementary methodologies, such as telemetry and capture, marking, and recapture protocols (Desbiez et al., 2020; Suwanrat et al., 2015).

The field methodology that uses trap cameras is minimally invasive, useful for detecting species with reserved, cautious, and inconspicuous habits (Suwanrat et al., 2015). This is mainly useful for estimating the density of animals whose behavior is modified by the presence of researchers, for example, birds of the genus Crax, where males are easier to detect than females, since they vocalize more audibly, remain in a place after vocalizing, and are less likely to hide (Alves et al., 2017).

Regarding the statistical analysis of data from trap cameras for the estimation of animal density, it is considered that the use of random encounter models (REM, Random Encounter Models) is preferable compared to random encounters models and time of permanence (Random Encounter and Staying Time), and also with respect to models on the distance from the camera trap (Distance Sampling with camera traps; Palencia et al., 2021). REM models produce an intermediate estimated density compared to other types of models, and present better performance when the detection capacity of the cameras is more compromised by the characteristics of the environment, as observed in the PNLL. The estimated density can be taken to a spatial dimension consistent with the extent of the study areas.

The Models based on presence and absence can also adapt to the use of trap cameras, but they require the configuration of these to capture photographs at regular intervals of time (Suwanrat et al., 2015). In any case, they also produce values of estimated density, unlike model-free methodologies, in which only a value or index of relative abundance is produced for the registered species (Díaz, 2015; Peña, 2004).

The density values found in this research (Table 3) are similar to those reported in other regions of Latin America: 4 ind/km2 of Crax rubra rubra in Guatemala (Eisermann, 2004); 1.6 ind/ km2 of Crax blumenbachii in Brazil (Alves et al., 2017); 0.5-13.3 ind/km2 of Pipile jacutinga in Brazil (Bernardo et al., 2011); 13.1 ind/km2 of Penelope jacucaca in Brazil (Bezerra et al., 2019); 13.7 ind/km2 of Chamaepetes goudoti in Colombia (Londoño et al., 2007); 0.9 ind/km2 of Crax rubra griscomi in Mexico (Martínez-Morales, 1999); 29.2 ind/km2 the Ortalis columbiana and Colombia (Roncancio et al., 2023); 4.8 ind/km2 the Pauxi pauxi and Colombia (Setina et al., 2012).

The present could be the most exhaustive study on mancololas and cracids in the region. Although studies have been developed with less field effort and using mainly distance-based methodologies for density estimation, this presents the greatest amount of effort and information on these and other groups of birds that forage, at least partially, in the soil of the evergreen tropical forest of the lowlands.

Díaz (2015) developed an index of relative abundance in northern Guatemala (Naachtún Dos Lagunas Protected Biotope) from trap detections. This study used 10 trap cameras, which were active for an average of 69 days, accumulating 58 independent records of Crax rubra rubra and a record of *Tinamus major.* Your data are only comparable with this study as a reference, since a variable number of cameras distributed in only 4 study sites were assigned.

The PNLL is an important area for the conservation of biological diversity in general, and as an indicator of this, it can refer to the birds present. There are at least 18 species of birds of restricted geographical distribution, which are considered determining values of their categorization as a key area of diversity and an important area for birds (BirdLife International, 2024; Key Biodiversity Areas Partnership, 2024). Three of these species were detected with the trap cameras: *Ortalis vetula*, *Lanio aurantius*, and *Ramphocelus sanguinolentus*.

Other birds difficult to observe and identify, due to their propensity to flee and being not very conspicuous, were: *Geotrygon montana*, *Leptotila cassini*, *Leptotila plumbeiceps*, *Grallaria guatimalensis*, *Formicarius moniliger*, and *Sclerurus guatemalensis*. It is possible that the way with the least influence of the researcher to approach the estimation of its density is by using trap cameras and the models proposed here.

By chance or incidentally, several other species of birds were detected, including aquatic and migratory. It is possible that the methodology of estimating abundance using trap cameras is not suitable for these, since they are more showy and easier to observe and identify in branches and clear forests.

Knowledge of population density allows us to estimate the relative impact of hunting on the viability of hunting species populations, with respect to other sources of pressure such as habitat degradation and fragmentation. As interpreted by Kattan and collaborators (2016), although hunting has a negative effect on the population density of cracids, in some cases, if it is carried out at a low or moderate level, it does not cause any difference compared to sites without hunting. In addition, animals frequently perform local migrations related to seasonality, rainfall, and the availability of resources. This could help explain the low density of turkeys (*Ortalis vetula* and *Penelope purpurascens*) with respect to peacocks (*Crax rubra rubra*), since they would be expected to have similar densities, even a little lower in the latter. It is estimated that, if hunting is an important source of pressure, it usually affects mainly peacocks, reducing the pressure on turkeys (Kattan et al., 2016).

It is possible to find high population densities in wooded fragments of reduced extension, as an overcrowding phenomenon derived from the decrease in favorable conditions in other surrounding land uses (Haskell et al., 2002; Roncancio et al., 2023). Therefore, conservation efforts must consider idiosyncratic aspects of the different species, which cause their population variations (Kattan et al., 2016).

Research is one of the fundamental means to adapt the management of biological diversity to the changing reality. It is necessary to recognize the decisive role of public funds for conservation and sustainability, and, therefore, it is inevitable to regret the end of life of the National Fund for Conservation of Nature, which supported the development of science and technology in the environmental field, and social development by continuity. In the specific case of the project referred to here (Conap & Fonacon, 2018), it allowed to know population aspects of mammals and birds, several of which are threatened with extinction (15 of 30 species of birds included in the List of Threatened Species of Guatemala, Conap, 2022), and, above all, little studied (Figure 4).

Figure 4
Hylomanes momotula, a bird considered threatened with extinction, photographed in Laguna Lachúa National Park.

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Densidad poblacional de mancololas (Tinamidae) y crácidos (Cracidae) en el Parque Nacional Laguna Lachúa (Alta Verapaz, Guatemala)

Population density of tinamous and cracids (Tinamidae and Cracidae) at Laguna Lachúa National Park (Alta Verapaz, Guatemala)

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