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Population densities and home range sizes of the Chestnut Wood-quail

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ABSTRACT. We present the first report of population density and home range estimates for the Chestnut Wood-quail (*Odontophorus hyperythrus*), an endemic and nearly threatened species of the Colombian Andes. Density estimates were obtained using playbacks and spot mapping and point transect methods. Home range sizes were estimated by radio tracking five wood-quail. Estimated densities varied from 0.3 to 0.4 groups per hectare. These densities are similar to those reported for other mountain wood-quail, but higher than those for lowland wood-quail and other species in the family Odontophoridae. Estimates of home range size varied from 2.6 to 9.0 hectares per group, and seemed to be correlated with group size. We also found evidence of overlap in the home ranges of neighboring groups. Population densities may vary with factors such as habitat type, but our estimates allow a first approximation of the population sizes of Chestnut Wood-quail in forest fragments.

SINOPSIS. **Densidad poblacional y area territorial de *Odontophorus hyperythrus***
Este estudio presenta los primeros estimados de densidad poblacional y tamaños de áreas de actividad para la perdiz colorada (*Odontophorus hyperythrus*), una especie endémica y casi amenazada de los Andes colombianos. Por medio de la reproducción de cantos grabados, obtuvimos estimados de densidad poblacional usando los métodos de mapeo total y conteo por puntos. Los estimados de área de actividad fueron obtenidos por medio de radio-localización. Los estimados de densidad fueron similares para los dos métodos y variaron entre 0.3 y 0.4 grupos por hectárea. Estos valores son similares a los reportados para otras perdices de montaña del género *Odontophorus*, pero superiores a los estimados para las especies de tierras bajas y otros géneros la familia Odontophoridae. Los estimados de área de actividad variaron entre 2.6 y 9.0 ha por grupo, y aparentemente se correlacionan con el tamaño del grupo. Encontramos evidencias de superposición entre las áreas de actividad de grupos vecinos. Aunque se espera que las densidades poblacionales varíen espacialmente en relación a factores como el tipo de hábitat, nuestros estimados permiten una primera aproximación a la estimación de tamaños poblacionales en fragmentos de bosque.

Key words: Chestnut Wood-quail, Colombia, density, home range size, *Odontophorus hyperythrus*

Chestnut Wood-quail (*Odontophorus hyperythrus*) are endemic to Colombia (Hilty and Brown 1986; Salaman et al. 1999), and have been categorized as near-threatened because of habitat loss and fragmentation (Renjifo et al. 2002; Birdlife International 2004). Although usually reported as scarce and local (Hilty and Brown 1986), this species seems to be regular in some areas such as Cueva de los Guácharos National Park (P. Gertler in Hilty and Brown 1986). However, as with most species in the genus, there are no quantitative estimates of population densities or home range sizes. Such data are essential for adequately establishing the status of the species and determining conservation actions.

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Chestnut Wood-quail inhabit montane forests at elevations between 1600 and 2700 m. Although typically found in old-growth forests, these quail can also be found in older second-growth forests. Family groups of up to nine individuals forage on the forest floor for fallen fruits, seeds, and invertebrates in the leaf-litter and among tree roots (Hilty and Brown 1986; del Hoyo et al. 1994). Groups are usually composed of a breeding pair and offspring that remain with parents for up to a year (P. Franco and K. Fierro-Calderón, pers. observ.).

Groups of Chestnut Wood-quail apparently defend home ranges. As reported for other species, such as the Gorgeted Wood-quail (*O. strophium*) and the Black-breasted Wood-quail (*O. leucolaemus*), neighboring groups sometimes engage in vocal contests for prolonged periods of time (Sarria 2003; Hale 2004; P. Franco and K. Fierro-Calderón, pers. observ.). Neighboring

groups of Black-breasted Wood-quail may defend ranges using vocalizations, displays, chases, and physical contact (Hale 2004). Here we estimate population densities and home range sizes of Chestnut Wood-quail in the Central Cordillera of the Colombian Andes.

METHODS

Our study was conducted from December 2003 to December 2004 at the Santuario de Flora y Fauna Otún Quimbaya, a 489-ha protected area located on the western slope of the Central Cordillera of the Colombian Andes. This sanctuary is a mosaic of old-growth forest and secondary forests of different ages, exotic Chinese ash (*Fraxinus chinensis*) and native Andean oak (*Quercus humboldtii*) plantations, and a few small pastures (Durán and Kattan 2005). The sanctuary is contiguous with Ucumarí Regional Park, which extends over 4240 ha at an elevation of 1750–2600 m. Thus, several thousand hectares of potential habitat are available for the wood-quail in this region. The rain regime in the area is bimodal, with rainfall peaks in April and October and an annual mean precipitation of 2667 mm.

Within the sanctuary, we selected an area of 44.25 ha of old-growth and late second-growth forest (> 20 years) consisting of a ravine and its framing slopes for intensive study (Fig. 1). The area was crossed by two lateral trails (2 and 3)

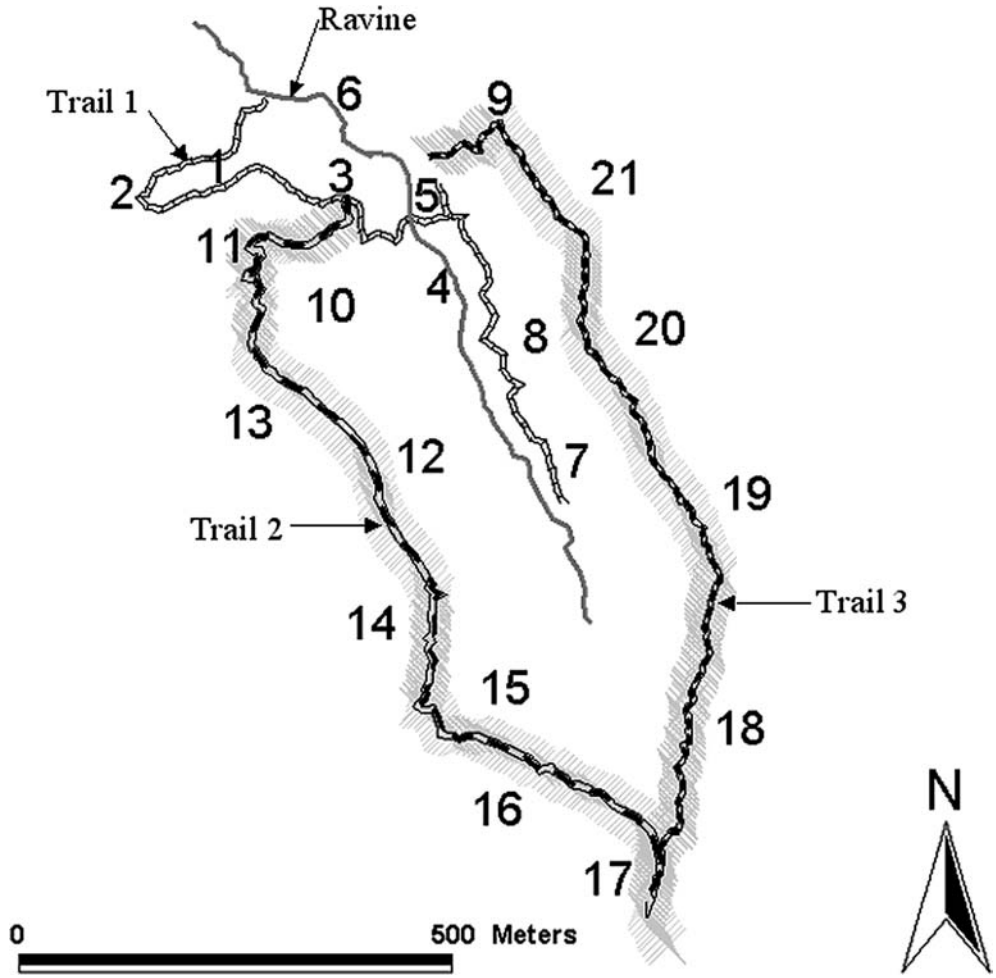

Fig. 1. Study area showing the ravine, trails, and approximate position of Chestnut Wood-quail groups (numbers) within the Otún-Quimbaya Fauna and Flora Sanctuary in the central Andes of Colombia.

and one central trail (1) that were marked at 25 m intervals. From December 2003 to May 2004, this area was sampled by two observers for 15 days each month. The first observer sampled the three trails, while the second sampled only Trail 1. The first observer slowly walked two of the three transects each day (alternating them on different days), one between 6:00 and 8:00 A.M. and the other between 8:00 and 10:00 A.M. During surveys, the observer played recordings of wood-quail choruses every 10 min at stations located 100 m apart. At each station, one chorus (30–45 s) was played consecutively three times, and the same chorus was used at all stations each day. We had previously obtained recordings of wood-quail from the study area using a tape recorder (Sony TCM-5000EV; Sony Corporation, Japan) and microphone (Sennheiser ME-66). The second observer sampled Trail 1 between 6:00 and 8:00 A.M. This observer also opened a series of traps and mist-nets along the trail to capture and mark wood-quails with leg bands and wing tags. Both observers also made *ad libitum* observations near Trail 1 at other times of the day. Thus, an area encompassing 18.1 ha around Trail 1 was sampled by two observers using complementary methods.

To estimate group densities in the study area, we recorded the angle and approximate distance of recorded groups with respect to trail marks. These data were then used to spot map the approximate position of all wood-quail groups within the study area each month. Additionally, a subset of the stations (those more than 200 m from each other; $N = 14$) were used to estimate densities using the point transect or variable circular plot method (Buckland et al. 2001). Only detections within an estimated 100 m and point counts performed between 06:00 and 08:00 A.M. were used because most vocalizations were detected during the first two hours after sunrise. Density was estimated with the program DISTANCE 4.1 Release 2 (Thomas et al. 2004). Various combinations of the key and adjustment functions were evaluated and the model was selected based on criteria (model robustness, shape criterion, efficiency, and model fit) described by Buckland et al. (2001). These results were then compared with densities obtained using the spot mapping method.

Five captured wood-quail belonging to three different groups were fitted with radio-transmitters (Advanced Telemetry Systems, Isanti, MN). From February 2003 to December 2004, we determined the positions of radio-tagged wood-quails by triangulation using a receiver (Fieldmaster 16, Advanced Telemetry Systems). Positions were estimated every hour between sunrise and sunset 15–25 days per month, during the duration of the batteries (approximately 3 mo). Because wood-quails moved up to 120 m in one hour, we considered these positions to be independent. Home ranges (95% contours) were estimated using the fixed Kernell method in the Animal Movements extension (Hooge and Eichenlaub 2000) for the program ArcView 3.2 (ESRI, Redlands, CA, USA). The bandwidth parameter "*h*" for each individual was defined using the least squares cross-validation method.

RESULTS

At least 21 groups of wood-quail were detected within the 44.25 ha study area (Fig. 1). The number of groups detected varied among months. However, at least 14 groups were counted each month and the maximum number detected was 18 groups in December 2003 and January 2004, respectively. Thus, monthly densities within the area varied between 0.31 and 0.4 groups/ha. Eight groups were detected within the 18.1 ha area around Trail 1. Seven of these groups persisted throughout the six months of observation, but one disappeared during the third month. Thus, in the Trail 1 area (assuming 18.1 ha and seven groups), density was 0.38 groups/ha.

Using the point transect method, 104 detections were made in 263 point counts. The half-normal key function with one-term cosine adjustment was the model selected. The percentage coefficient of variation for this model was 13.08, the effective detection radius was 64.69 m, and the estimated density was 0.30 ± 0.19 (mean $\pm$ SD) groups/ha.

The size of home ranges estimated for radio-tagged individuals varied, even for individuals in the same group (Table 1). For each individual, the least squares cross-validation method indicated a different best bandwidth parameter "*h*." Home range size appeared to increase with group size, but small sample sizes precluded a significance test. Three radio-tagged individuals belonging to the same group had different home ranges. The first wood-quail radio-tracked in this group was a juvenile and was marked when the

Table 1. Fixed Kernell home range (KHR) estimates for five radio-tracked wood-quails. Group size did not include chicks, only juveniles and adults.

Quail number (Group number)	KHR 95% (ha)	h^{b}_{lscv}	Number of locations	Number of days	Months tracked	Group size	Number of adults
1[a] (1)	2.66	15.75	77	27	Feb–Apr	5	2
2 (7)	5.39	20.60	78	31	Feb–Apr	4	4
3 (4)	2.84	16.37	51	17	Jun–Jul	2	2
4 (1)	9.06	24.80	111	16	Sept–Oct	9	5
5 (1)	6.17	18.69	277	49	Sept–Dec	9–7	5

[a] Juvenile.
[b] Bandwidth parameter (h) defined using the least squares cross validation method.

group had five members. The other two individuals were tracked when the group had nine and then seven members. These two individuals were tracked simultaneously and were always together until one was killed by a Taira (*Eira barbara*) on 14 October 2004. Despite these differences in home range sizes, the center of activity for this group did not change between the two tracking periods (92% overlap between the two periods).

DISCUSSION

During our study, the mean density of Chestnut Wood-quail ranged from 0.31 to 0.4 groups/ha. With a mean group size of five birds (P. Franco and K. Fierro-Calderón, unpubl. data), this means a population density of 1.55–2.0 birds/ha. Available population densities for other *Odontophorus* species are provided in Table 2. Available density estimates for other highland wood-quail are similar to those reported here. In contrast, density estimates reported for two lowland species of *Odontophorus*, and other forest-dwelling species in the family Odontophoridae are much lower (Table 2). Thus, *Odontophorus* wood-quail inhabiting montane forests seem to have higher densities than other species in the family. Differences among montane and lowland species of *Odontophorus* may be due differences in the suite of predators and competitors and differences in habitat productivity, as all species seemingly have similar social systems (Skutch 1947; Hale 2004; P. Franco and K. Fierro-Calderón, unpubl. data). On the other hand, differences in density estimates with other genera of New World Quails may be due to differences in social systems as well as habitat productivity (del Hoyo et al. 1994).

Density estimates obtained using the point transect method may be biased due to violations of some assumptions (Buckland et al. 2001).

Table 2. Population densities of species of *Odontophorus* and other genera of Odontophoridae reported in the literature.

Species	Density Groups/ha	Study location	Elevation (m)	Reference
O. strophium	0.30	Colombia	1800–2600	Sarria 2003
O. leucolaemus	0.30	Costa Rica	1350–1500	Hale 2004
O. hyperythrus	0.31–0.40	Colombia	1800–2000	This study
O. stellatus	0.08	Peru	40–400	Terborgh et al. 1990
O. gujanensis	0.02	French Guiana	400	Thiollay 1994
O. gujanensis	0.08[a]	Panama	35–80	Robinson et al. 2000
Dendrortyx macroura	0.21[a]	Mexico	1800–3100	Chávez-León and Velazquez 2004
Dendrortyx leucophrys	0.30[a]	Mexico		Johnsgard 1973
Oreortyx pictus	0.09–0.3[a]	North America	1100–2100	Brennan et al. 1987
Dactylortyx thoracicus	0.09[b]	Mexico	1200	Warner and Harrell 1957
Dactylortyx thoracicus	0.62[b]	Mexico	1200	LeFebvre and LeFebvre 1958

[a] Individuals per hectare.
[b] Pairs per hectare.

Groups of quail are not necessarily detected at their initial location because some movement might be provoked by playback prior to the vocal answer. In addition, responses to playback by one group may elicit vocalizations by individuals in neighboring groups. Thus, detections of the latter might not be independent. In our study, this possible bias was minimized by only using responses detected just after (within 4 min) playback (Thomas et al. 2002). Despite the possible effects of these violations, estimates were similar to those obtained using the total mapping method. This is not unexpected because distance sampling methods are robust to violations of some assumptions (Thomas et al. 2002). Thus, a double-sampling method (Bart and Earnst 2002), where a large area is sampled using rapid methods such as point counts and a smaller area is surveyed intensively, might be the most efficient way to estimate densities of wood-quail and other similar species.

The mean home range size of radio-tracked individuals was 5.22 ha, but ranged from 2.66 – to 9.06 ha. Based on these values, our density estimates are possible only if adjacent groups had overlapping home ranges or if individuals or groups without permanent home ranges (floaters) responded to playbacks and the vocalizations of individuals in other groups. Floating groups may be new associations of individuals that roam between limits of established home ranges, or groups of individuals that have split from an established group and are relegated to a small area within the limits of their previous home range. This seemed to be the case for Group number 2, which was the only one not detected every month. All detections of this group were within the home range of Group number 1. This suggests that Group 2 may have been formed by former members of Group 1 who were ready to disperse. Groups detected once may also provide evidence of floaters.

We also have indirect evidence that adjacent groups have overlapping home ranges. Although not followed simultaneously, the home ranges of radio-tracked individuals 2 and 3 overlapped by 0.75 ha. While following radio-tagged birds, we frequently heard individuals from another group vocalizing within the home range of the group under observation. In addition, we found a nest belonging to members of Group 3 inside the home range of Group 1.

Our home range estimates are the first for *Odontophorus* quails and are smaller than those reported for other New World quail inhabiting more open habitats in the north temperate zone (del Hoyo et al. 1994). For example, home ranges of Scaled Quail (*Callipepla squamata*) and Northern Bobwhite (*Colinus virginianus*) have been estimated to be over 10 ha, whereas home ranges of California Quail (*Callipepla californica*) and Montezuma Quail (*Cyrtonix montezumae*) vary in size between 2–18 ha and 6–50 ha, respectively (del Hoyo et al. 1994).

Differences in the size of home ranges of radio-tagged individuals may be due to several factors. For example, larger groups may have larger home ranges because of increased energy requirements (Curry and Grant 1990; Rabenold 1990; Jansen 1999). During our study, the size of Group 1's home range decreased after two members were lost in October and, in general, smaller groups had smaller home ranges. Our results suggest that each adult requires approximately 1 ha (Table 1). On the other hand, home ranges may also change in relation to other factors such as the beginning of the rainy season, which apparently signals the initiation of the breeding season for this species (P. Franco and K. Fierro-Calderón, unpubl. data). Rain may also affect the phenology of other forest phenomena including the availability of leaf-litter arthropods (Kattan et al., in press).

Our density estimates indicate that up to 147 Chestnut Wood-quail groups could occur in the 489-ha Otún-Quimbaya Flora and Fauna Sanctuary, and that 1272 groups could occur in the adjacent 4240-ha Ucumarí Regional Park. This extrapolation assumes that densities are spatially homogenous. Although the entire area is covered by forest, densities are likely to vary according to forest type and elevation, so these numbers are approximate values only. Because each group has only one breeding pair, these numbers also represent reproductive units. Given the highly fragmented and relatively small geographic range of this species, its near-threatened status is warranted and populations should be monitored. Additional threats to this species include illegal hunting and depredation of birds and nests by domestic dogs. Both factors are likely to be exacerbated in small fragments.

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