DENSITY, DISTRIBUTION, AND HOME RANGE OF THE
BLACK HOWLER MONKEY (ALOUATTA PIGRA) AT
LAMANAI, BELIZE

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The population of black howler monkeys (Alouatta pigra) at the Lamanai Archaeological Reserve in northwestern Belize was studied for a total of 11.5 months during 2 wet and 2 dry seasons between October 1993 and May 1995. We estimated home-range size and range overlap of troops in order to examine territoriality, and tested the null hypothesis that the population is uniformly distributed throughout the reserve in order to examine habitat use. Home-range sizes were similar to those at Bermudian Landing, Belize, but smaller than those at Tikal, Guatemala. Mean home-range size was estimated as 15.3 ha with 52% overlap based on a 1.0-ha grid. There was no evidence for territoriality. Population distribution was generally uniform, but ruin sites appeared to be preferred habitat and edge habitat was least frequented.

Key words: Alouatta pigra, Belize, home range, howler monkey, territoriality

Howler monkeys belong to the most intensively and longest-studied genus of all New World primates, but most research has concentrated on 2 species: the mantled howler monkey (Alouatta palliata) of Central America and the red howler monkey (Alouatta seniculus) of northern South America. More-recent work examines the Central American black howler monkey (Alouatta pigra), which differs in its behavioral ecology from other species of the genus and shows intraspecific variation across different habitat types (Cornick and Markowitz 2002; Ostro et al. 1999, 2000, 2001) and at different densities (Arrowood et al. 2003; Silver et al. 1998).

Home-range estimates for black howler monkeys living in different areas vary dramatically. These differences may be related to different resource availability in different regions, which may be associated with human land-use patterns. For example, howler monkey habitat at Tikal, Guatemala, is mature, subtropical, semideciduous rain forest, and howler monkeys feed primarily on the ramon tree (Brosimum alicastrum—Milton 1980; Schlichte 1978). Habitat at Bermudian Landing, Belize, is riparian forest and dry farmland (Horwich 1990), and the monkeys feed on several species, including fig trees (Ficus), cashew trees (Anacardium occidentale), and Cecropia (Silver et al. 1998). Despite similar troop sizes (~4–10 individuals), home ranges in Tikal are up to 20 times larger than those at Bermudian Landing (100+ ha versus 5–18 ha, respectively—Caywood et al. 1979; Horwich 1983, 1990; Schlichte 1978). The wider variety of food resources at the latter site may enable the monkeys to feed in smaller areas, thereby decreasing the need for extensive home ranges. Alternately, the lower population density at Tikal (5 individuals/km²—Coelho et al. 1976a) could allow howler monkeys greater freedom of movement, whereas higher population density at Bermudian Landing (8 individuals/km²—Bolin 1981) may increase competition for space, which may account for observed differences in ranging behavior between the 2 sites.

The goal of this research was to establish a long-term project examining the ecology of A. pigra at a new site, the Lamanai Archaeological Reserve in northwestern Belize. This report documents the density, distribution, and home-range size and degree of overlap during the first 2 years of the project. We also examined whether A. pigra is territorial at this and other locations in Belize.

MATERIALS AND METHODS

Study site.—Lamanai Archaeological Reserve, established in 1986, is situated in northwestern Belize (17°46’N, 88°39’W),
about 27 km northwest of Bermudian Landing, an additional long-term study site of black howler monkeys in Belize (Fig. 1). The forest in the reserve is severely disturbed and in various stages of recovery. Human use of the area has a long history, including Mayan occupation from 600 BC to AD 1675 (Pendergast 1982), the establishment of 2 Spanish missions in the 1600s, operation of an English sugar mill in the mid-1800s, farmland in use until the 1920s (Lambert and Arnason 1978), and modern day tourist visitation. More than 700 ruins dot the 385-ha reserve. Logging of mahogany (Swietenia macrophylla), Santa Maria (Calophyllum brasiliense), and cedar (Cedrela odorata) continued in the reserve through the 1970s, as did slash-and-burn agriculture by residents of the adjacent village (Lambert and Arnason 1978).

The reserve has been characterized as moist tropical lowland forest, broadleaf deciduous forest in the dry tropical zone, and semievergreen seasonal forest (Lambert and Arnason 1978). It is fairly level at about 30 m above sea level, with hills that are most often unexcavated Mayan mounds. The site receives about 1,500 mm of rainfall per year, primarily between June and November. Daily temperatures vary from 18°C to 35°C, averaging 27°C (Lambert and Arnason 1978).

Lambert and Arnason (1978) described 5 plant communities in the reserve: shoreline, cohune ridge, high bush, ruin, and bajo. Shoreline vegetation along the New River Lagoon is dominated by black olive trees (Bucida buceras), which are covered by epiphytes and vines. The shoreline is flooded in the rainy season. Cohune ridge, forest dominated by Cohune palm (Attalea cohune), is found in several patches in the reserve, particularly in the southern and central portions. High bush, the most common community in the reserve, is diverse, but dominated by West Indian elm (Guazuma ulmifolia), acaja, known elsewhere in Belize as hopgum (Spondias mombin), caballo (Stemmadenia donnell-smithii), canelo (Nectandra), wild grape (Coccoloba belizensis), and fig. Large mahogany trees have been exhausted by logging, but several small trees remain, especially in the northern section of the reserve. The canopy varies in degree of openness and height, which ranges from about 8 m in thicket areas to about 25 m in more-mature forest areas. Few trees exceed 30 m in height. Ruin vegetation differs from surrounding forest and is dominated by ramon (Brosmum alcastrum), copal (Cupania belizensis), guayo (Talisia oliviformis), and allspice (Pimenta dioica). Bajo (forested swamp) lies in the northwestern portion of the reserve. Flooded during the rainy season, the bajo consists of thickets up to 15 m in height with occasional large trees.

Mapping and transects.—The reserve was mapped using a Trimble Navigation Basic Plus Global Positioning Satellite (GPS) receiver (Trimble Navigation, Sunnyvale, California), and checked using a compass and pacing distances. Positions on trails were differentially corrected using reference data collected at a nearby base station, reducing error from ±100 m to ±5 m. Trails were marked with surveyor’s tape every 50 m in order to identify observer location during sightings. Global positioning system positions also were used to obtain the latitude and longitude of landmarks, trail markers, and troop positions.

During 1993, 4 transects were designed on the existing trail system (Fig. 1). Each transect was walked in opposite directions on alternating surveys to mitigate observer effects. Three additional transects, as well as extensions of some existing transects, were added in 1994 to include newly uncovered and improved trails.

Search effort.—Teams of trained volunteer observers led by the research team conducted preplanned surveys along the transect routes, stopping approximately every 15 m to scan for monkeys. If there was no sign of monkeys after 15 s, the team continued along the transect. At any sign of nearby monkeys (e.g., rustling or vocalizations), the team left the transect to search for the troop. Upon finding a troop, focal data were collected for 1 h, or until the monkeys were not visible for 5 min. The transect was then resumed from the last location. If time with monkeys precluded completing the transect in 1 session, it was continued from the last location at the next survey.

Data collection.—Data were collected over 2 wet and 2 dry seasons from October 1993 to May 1995. The 603 sightings of monkeys during the 11.5-month study were categorized from 1 to 3 based on confidence in identifying the troop. Level 1 sightings were defined as lengthy, providing sufficient data on total number of animals and each individual’s age and sex to exclude all other troops and guarantee the troop’s identification. Level 2 sightings were those in which enough members were classified to exclude allocation to other troops known to be in the vicinity, but the sighting was short or visibility was reduced, or sightings were assigned to troops whose composition was still unconfirmed. Level 3 sightings provided sufficient information to exclude troops normally seen in the vicinity, but not enough to differentiate between less-frequently seen troops. Sightings of 1 or 2 animals and those not matching any other sightings in the area were combined and categorized as unknown.

Focal animal behavioral data were collected at 5-min intervals by instantaneous scan sampling (Altmann 1974) of all visible animals for a period of 1 h, or until all of the monkeys were out of sight for 5 min. Age, sex, ingestion of plants, and height or position in the tree were noted for all visible howler monkeys at each interval. The proximity, age, and sex of the monkeys in nearest proximity to each focal monkey also were recorded by instantaneous sample. Age was categorized as adult, subadult, juvenile, or infant. Following age-class criteria established by Carpenter (1934) and Clarke (1990), juveniles were further subdivided into juvenile 1 (12–18 months) or 2 (18–36 months) based on proportion of adult female size, and infants were subdivided into infant 1 (<3 months), 2 (3–6 months), or 3 (6–12 months) based on proportion of adult female size, natal coat, and behavior. There was no physical contact with monkeys, and all observations were conducted according to guidelines approved by the American Society of Mammalogists (Gannon et al. 2007) and reviewed by the Institutional Animal Care and Use Committee at San Francisco State University.

Data analysis.—Sightings were 1st classified to troop based on composition and number of individuals. Of 22 troops and an
adolescent band tentatively identified, 16 were confirmed. Six were seen less frequently and were close enough in composition to other troops to be considered unconfirmed.

A 0.25-ha and a 1.0-ha grid system were applied to a map of the reserve to estimate the home-range size of the 22 troops and adolescent band. Discontinuous cells with sightings were connected by the shortest possible route. Level 3 sightings that would increase home-range size were excluded from the calculation.

Mean home-range size was calculated by sorting the number of sightings of each troop in each cell. Means were calculated based on all troops with decreasing numbers of sightings. Thus, a mean was calculated for all troops with more than 60 sightings, 50 sightings, and so on, until all home ranges were
In order to examine troop distribution throughout the reserve, sightings were compared by transect, reserve area (northern, southern, or tourist), edge versus interior, and sightings on archaeological mounds using the binomial test (Siegel and Castellan 1988). The expected number of troops for each comparison was calculated based on the assumption of uniform distribution throughout the reserve. Tourist areas included only trails utilized by guided tourist groups and occurred within the southern portion of the reserve. Edge transects were defined as those bounded on 1 side by clearings or trails > 3 m wide. For the edge versus interior test only, length of trail segments bounded on 1 side by nonforest habitat, such as a village or milpa (plantation) in early stages of regeneration, were divided by 2. A sighting was deemed to be on a mound if it was within 20 m of a major known Mayan, Spanish, or English ruin. Mound lengths were estimated in multiples of 50 m.

**Density.**—Densities were estimated for the northern and southern sections of the reserve, with troops observed at the boundary assumed to spend one-half of their time in each area. Density was calculated for both the number of confirmed and total observed troops and individuals per square kilometer in the north and south separately, and for the entire reserve area. Differences in density between the north and south were examined using the chi-square test (Siegel and Castellan 1988), with the expected population in each section proportional to its area. Results are reported as mean ± 1 SD unless otherwise noted. Alpha levels were set at $P < 0.05$.

**Results**

**Home range.**—Home ranges of all 22 troops and the adolescent band are shown in Fig. 1. There was a significant correlation between home-range size and the number of sightings of a troop (Spearman’s rank correlation, $r_s = 0.68$, $P < 0.0005$). There were insufficient sightings of any troop to determine mean home range from the 0.25-ha grid; therefore the 1.0-ha grid was used for all remaining analyses. Mean home-range size determined from the 1.0-ha grid was 14.0 ± 5.1 ha (range 8–21 ha). The asymptote of the curve was 15.3 ha (Fig. 2).

Overlap was calculated for all 22 observed troops, the 16 confirmed troops, and the 7 troops used to estimate mean home range (Table 1). There was no correlation between the number of sightings and overlap in home ranges. Mean percent overlap ranged from 52% ± 29% in the 7 troops used to estimate mean home range to 63% ± 28% in the 16 confirmed troops. Mean percent overlap for all 22 sighted troops was 54% ± 32%.

All troops seen in > 1 season were found in the same areas from season to season with 2 exceptions. Troop A, seen most often just south of the main tourist area, also was seen further southeast during fall 1993 and spring 1994. It was not seen at all in fall 1994, and in spring 1995 was seen only immediately south of the main Mayan ruins. In spring 1994 the adolescent band was seen along the eastern edge of the reserve from the southeastern tip to the southern edge of the main tourist center. It was not seen at all in either fall season. In spring 1995, it was seen in the vicinity of the sugar mill and at the southern edge of the main tourist center. Overall, fewer troops were observed in both fall seasons (rainy) than in the 2 spring (dry) seasons.

### Table 1—Percent overlap in home ranges of black howler monkeys (*Alouatta pigra*) at Lamanai, Belize (1.0-ha grid).

<table>
<thead>
<tr>
<th>No. troops in calculation*</th>
<th>$\bar{X}$ (%)</th>
<th>$SD$ (%)</th>
<th>Median (%)</th>
<th>Range (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>52</td>
<td>29</td>
<td>50</td>
<td>19–100</td>
</tr>
<tr>
<td>16</td>
<td>63</td>
<td>28</td>
<td>67</td>
<td>19–100</td>
</tr>
<tr>
<td>22</td>
<td>54</td>
<td>32</td>
<td>61</td>
<td>0–100</td>
</tr>
</tbody>
</table>

*Troops used in calculation are distributed by: 7 = number of troops used to estimate home-range size in 1.0-ha grid (see Fig. 2); 16 = number of confirmed troops; 22 = total number of troops sighted throughout study.
Troops with home ranges around the main tourist sights, including the Spanish Church and the sugar mill, were seen consistently each season. Troops with home ranges beyond the main tourist areas were seen less frequently.

Distribution.—Mean number of sightings per kilometer on each route and results of binomial tests are shown in Fig. 3a. Overall, the number of troops seen on each transect did not differ significantly from a uniform distribution of troops within the reserve. However, the number of sightings on transect 3/4 in the northeastern portion of the reserve was significantly greater than on all other transects except 5/6, covering the northwestern portion of the reserve, including the edge. The number of sightings on transect 5/6 also was significantly greater than on transects 7/8 (north-central) and 11/12, which consisted mainly of edge habitat in the southwestern portion of the reserve. There were no significant differences between transects 1/2, 7/8, 9/10, 11/12, or 13/14.

Mean number of monkeys per kilometer on each route and results of binomial tests are summarized in Fig. 3b. The results are comparable to those found for number of sightings per kilometer. The number of monkeys per kilometer on transect 3/4 was significantly greater than on all other transects except 5/6. There also were significantly more monkeys per kilometer on transect 5/6 than on transects 7/8 and 11/12. There were no significant differences between transects 1/2, 7/8, 9/10, 11/12, or 13/14.

<table>
<thead>
<tr>
<th>Area</th>
<th>No. sightings on trail(s)</th>
<th>Total no. sightings on trail(s)</th>
<th>$P_{actual}$</th>
<th>$P_{expected}$</th>
<th>$P$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spanish Church</td>
<td>4</td>
<td>6</td>
<td>0.6667</td>
<td>0.1037</td>
<td>0.0014</td>
</tr>
<tr>
<td>Sugar Mill</td>
<td>4</td>
<td>6</td>
<td>0.6667</td>
<td>0.0992</td>
<td>0.0012</td>
</tr>
<tr>
<td>Trail M</td>
<td>2</td>
<td>4</td>
<td>0.5000</td>
<td>0.0347</td>
<td>0.0067</td>
</tr>
<tr>
<td>Ceremonial Center</td>
<td>38</td>
<td>60</td>
<td>0.6333</td>
<td>0.2945</td>
<td>0.0000</td>
</tr>
</tbody>
</table>

There were 38 total sightings in the southern portion of the reserve, 38 along main tourist trails, and 46 in the north. Sightings in each area were significantly different from a uniform distribution (expected south = 46 sightings, $P = 0.0246$; expected tourist = 15, $P < 0.0001$; expected north = 61, $P = 0.0015$). A total of 7 confirmed and 9 total troops were seen in the southern portion of the reserve, 4 confirmed troops along main tourist trails, and 7 confirmed and 10 total troops in the north. These frequencies did not differ significantly from a uniform distribution.

Of the 122 sightings of individual troops on transects, 48 occurred on mounds. The number of sightings on mounds of all types was significantly greater than expected ($P < 0.0001$). The number of sightings on mounds in 4 specific areas of the reserve was then compared to the number of transect sightings not on mounds. Sightings on the 11 unexcavated or partially excavated major Mayan ruins in and around the main tourist area, on the 17th-century Spanish Church ruins in the southern section of the reserve, on the 19th-century ruins of the English sugar mill, and on the unexcavated Mayan mound along trail M in the northern portion of the reserve were all significantly higher than expected (Table 2).

The number of sightings of unique troops along edge habitat was significantly lower than along narrow trails bounded on both sides by forest (15 of 122 sightings, $P = 0.0456$). Because 11 of the 15 sightings along edge habitat occurred on mounds, reserve edges bounded by the village of Indian Church and milpas were tested without the internal trails B and N. There were no sightings on portions of these boundary trails along which clear-cutting had occurred.

Sightings along those portions of trail G classified as edge habitat also were compared to those sections of trail G bounded by forest on both sides. There were 6 sightings on the forested sections of G and none on those portions bordered by milpas, which was significantly different from the assumption of uniform sightings ($P = 0.0195$).

Density.—The number of monkeys in the reserve ranged from 109 individuals for the 16 confirmed troops to 146 individuals for all 22 observed troops, including the adolescent band and 2 solitary males seen in the spring of 1995. Based on an estimated area of 3.85 km$^2$, the estimated density of howler monkeys in the reserve ranged from 27.5 to 35.3 individuals/km$^2$, averaging 31.4 ± 3.9 individuals/km$^2$.

The crude density of monkeys in the southern 130 ha of the reserve ranged from 36.9 to 41.0 individuals/km$^2$. The crude
density in the northern 255 ha ranged from 22.7 to 32.5 individuals/km². These estimates assume that troops A, ElderHostel, J2, L, and Z utilized both portions of the reserve equally. Although troop Oboe’s home range extended north of the high temple, 93% of sightings occurred at or south of the ruin. Therefore, troop Oboe was treated as a southern troop. The densities in the north and south, based on all 22 observed troops, did not differ significantly from the overall reserve density ($\chi^2 = 1.7655$, $d.f. = 1$, $P > 0.05$). If only the 16 confirmed troops are considered, density in the north was significantly lower than in the south ($\chi^2 = 6.2865$, $d.f. = 1$, $P < 0.05$).

**Discussion**

*Home range.*—Home-range estimates at Lamanai (14.0 ± 5.1 ha) were far more similar to those at Bermudian Landing (10.4–15.8 ha—Ostro et al. 1999) than to those at Tikal (100–125 ha—Caywood et al. 1979; Schlichte 1978). Differences in grid size account for only a portion of the variation in home-range estimates between Lamanai and Tikal. The most common grid size used in studies of home range is 0.25 ha, but grids as large as 1 ha (Milton 1980) and 6.25 ha (Coelho et al. 1976b; Schlichte 1978) also have been applied. Olson (1986) tested the effect of grid size on home-range estimates in colobus monkeys (*Colobus*) using grids of 0.25 ha and 6.25 ha, and found that the larger the grid size, the larger the home-range estimate. In that study, the larger grid size produced the more accurate result when data from only 5 complete days per month were included, because the troops were not followed over a complete annual cycle. Using a grid size of 6.25 ha results in a mean home range for the 5 most frequently sighted troops at Lamanai of 30 ± 9 ha (range 19–44 ha). Although this method nearly triples the estimated home-range size, the home-range size estimates at Lamanai using the 6.25-ha grid remain less than one-third of those at Tikal.

Because we did not follow troops continuously and troops were not typically followed off trails, home ranges were initially calculated based on both a 0.25-ha and a 1.0-ha grid. The 1.0-ha grid contained the largest proportion of sightings for calculation of robust home-range estimates, suggesting that a larger grid may be preferable in surveys with limited sightings of many troops, particularly because a larger number of troops may be included in the computation. The asymptote of the best-fit curve on the 1.0-ha grid of 15.3 ha is the best estimate of home-range size at Lamanai during the study period (Fig. 2).

The later stage of succession of the forest at Tikal, greater interspecific competition with spider monkeys (*Ateles Geoffroyi*), and lower population density all may contribute to the variation in home range found at the 2 sites. The Tikal surveys were conducted in the late 1970s, soon after a yellow fever epidemic had decimated howler monkey populations throughout Central America. A more current census of the Tikal population could reveal the same recovery seen at Bermudian Landing during the 1980s, with concurrent reduction in home-range size.

Mean overlap in home ranges ranged from 52% to 63% (1.0-ha grid), and areas of exclusive use by a single troop were not observed. This high degree of overlap, combined with data from sightings of multiple troops, suggests that the howler monkeys at Lamanai do not exhibit strictly territorial behavior. This finding concurs with results from studies of howler monkey vocal behavior conducted at Lamanai in 1996–1997 (Cornick and Markowitz 2002). Vocal confrontations were seen rarely and do not provide clear evidence of territoriality, particularly when they may occur in any portion of the home ranges of observed troops (Chivers 1969), as was the case during this study. These findings support Carpenter’s (1965) assertion that howler monkeys defend their current location (defined as group space by Klein [1974]) rather than a defined territory. Withdrawal was uncommon; when it did occur, invariably the interaction was between 2 troops of unequal number and the smaller troop left the area. Active patrolling, a behavior necessary for territorial defense (Grant et al. 1992; Mitani and Rodman 1979) was never observed in this study, or by Cornick and Markowitz (2002) in more than 800 h of observation at Lamanai. In the tourist center, vocal confrontations were common only on or near mounds, preferred locations that were visited by several troops.

Mitani and Rodman (1979) contend that primates will defend a home range only if their foraging regime permits active patrolling. As facultative frugivore–folivores with plastic food habits (Grant et al. 1992; Ostro et al. 1999), day-ranging patterns of howler monkeys may change substantially across seasons (Arrowood et al. 2003; Ostro et al. 1999), making active patrolling and defense of a defined territory prohibitive. Defense of leaves, in particular, is not profitable relative to the cost of active patrolling (Grant et al. 1992). This is supported by the substantial overlap in home ranges of howler monkeys, particularly at low densities. Ostro et al. (1999) noted that levels of intergroup aggression were much higher at the Community Baboon Sanctuary, where density was highest, compared to the Cockscomb Basin Wildlife Sanctuary, where density is lower. Therefore, it is likely that howler monkeys primarily defend their current group space, particularly when feeding, and that the dawn chorus and periodic vocal confrontations between adjacent groups are used to space troops in order to avoid aggression (Cornick and Markowitz 2002; Milton 1980). It is important to note that these conclusions are based in large part on the degree of overlap as measured on a 1.0-ha grid. It would be beneficial to confirm these results using the 0.25-ha grid with additional data.

Strong site fidelity is suggested by the consistency of sightings of confirmed troops in the same locations during all seasons. The range of the adolescent band changed over time, most likely because at the time of the surveys they were still attempting to develop a home range. Alternatively, this group may have immigrated into the reserve from the south and continued to move north.

**Distribution.**—The null hypothesis that the population in the reserve was uniformly distributed cannot be rejected based on the results of this study. However, there was variation in utilization of specific microhabitats. Howler monkeys were most frequently seen on mounds, both Mayan and more recent ruins. They were least frequently seen in edge habitat,
particular along trails bordering the village and plantations. Sightings per kilometer were greater than expected on transects covering the main tourist center and lower than expected in the north and south. The number of individuals per kilometer also was greater on transects within the main tourist area. However, the number of troops observed on those transects was not significantly greater than on the other 5 routes. This is not surprising given the high degree of overlap in home ranges.

All transects on which the number of sightings and troops were greater than expected included ruins, and the number of sightings on mounds was greater than expected compared to all transect sightings within the reserve. Although we believe that this is suggestive of preference for food trees on these sites, a vegetation analysis was not conducted during this study, so we were unable to draw definitive conclusions regarding the cues for differences in distribution between microhabitats.

Significantly fewer sightings occurred in edge habitat than predicted by a uniform distribution, especially those along reserve borders. Human disturbance is higher along the reserve boundaries, as residents tend their milpas along the western boundary and the remaining borders are roads on which motor traffic increased throughout the study period. The stoning of a monkey in a nearby village and other reports of the historical capture of monkeys for pets provide evidence of opportunities for monkeys to learn to avoid people. Although 3 caretakers and their families lived and worked in the major tourist areas, acoustic disturbances were limited to the sounds of motorboats in the lagoon and infrequent air traffic. Continuous contact with tourists and caretakers resulted in increased habitation of the animals to human presence in the ceremonial center.

The distribution of all 22 observed troops was uniform between the northern and southern areas of the reserve if the 5 troops seen close to the boundary between north and south are assumed to spend one-half of their time in both areas. Three of the 5 troops were seen north of trail L. The other 2 troops were not seen north of trail L; however, lack of trails just north of the north–south boundary prevented adequate surveys in this area.

Density.—Overall density in the reserve was uniform when all 22 observed troops are included in density estimates. If only the 16 confirmed troops are considered, the density in the south was 26% higher than in the north. Future studies at Lamanai should include a complete vegetation analysis, more thorough description of the northern areas, and seasonal use of core areas in each troop’s home range in order to fully describe differences in microhabitat use. Given the continued encroachment of human settlement around Lamanai, continued investigation of habitat use and population trends is critical if this small population of howler monkeys is to remain stable.

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Literature Cited


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