Robinson J. G. and Ramirez C. J. 1986. Conservation biology of Neotropical primates. In: *Mammalian Biology in South America*, M. A. Mares and H. H. Genoways (eds.), pp. 329-344. Special Publication Series No. 6, Pymatuning Laboratory, University of Pittsburgh, Linesville. PA.

Roussillhon C., 1988. The general status of monkeys in French Guiana. *Primate Conserv.* (9): 70-74.

Schürholz, G. 1991. Proposal for Expansion and Management of Kaieteur National Park, Guyana. Unpublished report to Guyana National Parks Commission, Guyana Agency for Health and Science Education, Environment and Food Policy, the Ministry of Trade and World Wildlife Fund (US).

Schulze, M. D., 1998. Forest fires in the Brazilian Amazon. *Conserv. Biol.* 12: 948-950.

Sussman, R. W. and Phillips-Conroy, J. 1995. A survey of the distribution and diversity of the primates of Guyana. *Int. J. Primatol.* 16: 761-792.

Tate, G. H. H. 1932. Life zones at Mount Roraima. *Ecology* 13: 235-257.

Tate, G. H. H. 1939. The mammals of the Guiana region. *Bull. Am. Mus. Nat. Hist.* 76: 151-229.

World Bank. 1998. *Guyana: National Protected Areas System Project.* The World Bank, Washington, D. C.

Survey of *Alouatta palliata* at the Bilsa Biological Reserve, North-west Ecuador

Sylvain Charlat
Oliver R. Thatcher
Nils Hartmann, Yogen G. Patel
Marjorie Saillan and Elsbeth Vooren

Introduction

Howler monkeys (*Alouatta*) are among the larger New World primates. They are found living in a wide range of forest habitats over most of South and Central America from Mexico to Argentina, with a total distribution of 483,000 km² (Marsh and Mittermeier, 1987). The mantled howler monkey *Alouatta palliata*, can be found from southern Mexico, through Central America, western Colombia and Ecuador to the northwest of Peru (Eisenberg, 1989). Throughout this geographical range, *A. palliata* occupies several different forest types: dense primary forest in many places, but also coastal mangrove forest in Panama, dry, deciduous forest in Costa Rica, secondary forest in Mexico and mountain forest in Guatemala (Wolfheim, 1983). Strong variations in density have been observed between these different habitats (Peres, 1997; Chapman and Balcomb, 1998). Thus, an important issue for *A. palliata* conservation is a better understanding of the links between habitat characteristics and population densities. In this paper, we report the results of a population survey of *A. palliata* at the Bilsa Biological Station of Ecuador. To our knowledge, this species has not previously been studied in Ecuador; nothing is known about their local ecology or abundance.

Methods

Alouatta palliata

Adult males of *A. palliata* weigh around 7.3 kg and females around 5.8 kg (Martin, 1990). The basic color of both sexes is black, sometimes brown, with a gold, white or brown fringe along the flanks (the mantle). The colour and shape of the mantle varies greatly within the species. *A. palliata aequatorialis*, the subspecies we have been working on, is listed as "Lower Risk" by Crockett (1998). The same status is given for *A. palliata palliata*. However, the subspecies *A. palliata mexicana* is listed as "Vulnerable" by Crockett (1998) as well as in the 1996 IUCN Red List of Threatened Animals.

Study Site

The Bilsa Biological Station (00°20.8' N, 79°42.7' W) (Fig. 1) is situated in the foothills of the Mache-Chindul Mountains in the Province of Esmereldas, at an altitude of 300-750m, in the western coastal region of Ecuador. The reserve covers 3000 hectares of some of the last remaining tropical pre-montane wet and humid coastal forest in Ecuador. A small fraction of the area is composed of very recent secondary forest, now submitted to reforestation. Altitude variations and moisture from the Pacific Ocean create microclimates that encourage local species endemism (Brame, 1995). Robin Foster (in Parker III and Carr, 1992) describes the area as pristine. The surrounding area has only been disturbed by colonisation and logging in the last 30 years. The temperature is fairly stable year round at Bilsa, and the climate is described as uniform temperate wet (Parker III and Carr, 1992). Average rainfall is often more than 3 m of rain per year. In the wet season, from January to June, the temperature range is usually between 24°C and 25°C. In the dry season, from July to December, the range is between 21°C and 22°C. During the time of our study (4th August to 10th September), the average temperature was 21.6°C. The maximum temperature recorded during that time was 27.5°C and the minimum

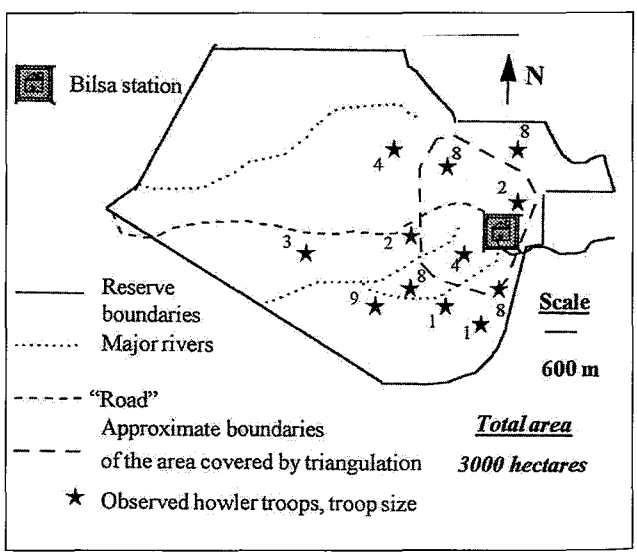

Figure 1. Map of the Bilsa Biological reserve, from Carlos Aulestia.

was 18.2°C. The average precipitation was 1.6 mm per day and the total precipitation for 30 days was 48.7 mm.

The Survey: Troop Density Estimation

We took advantage of the fact that howlers make very loud calls at dawn, which allowed us to use a triangulation method (Milton, 1982; Stoner, 1994; Brockelman and Ali, 1987). The idea of this method is to place as many groups of people into the field as possible in order to record simultaneously the time and the direction of calling troops. The groups of listeners are placed at known, predetermined locations on the map. Calls from one monkey troop at a specific time were recorded by different observers, so that the point where the direction lines crossed indicated the position of a monkey troop. This method provided an estimation of the minimum density since not all troops may not howl on a given morning.

Data were collected on 20 August, 1998 between 05.00 a.m. to 08.00 a.m. with the help of 34 volunteers (17 groups of two). Volunteers included staff from the station, park guards, European university students and North American peace-corps volunteers. Group sites were determined the day before and marked with GPS. Sites on hills allowing the best listening were preferred. The positions of the listeners and the topography allowed us to estimate the area covered (positioned on Fig. 2) as 4 km². The precise times and directions of the first howls of each troop were noted. As only seven compasses were available, north was clearly marked at all sites.

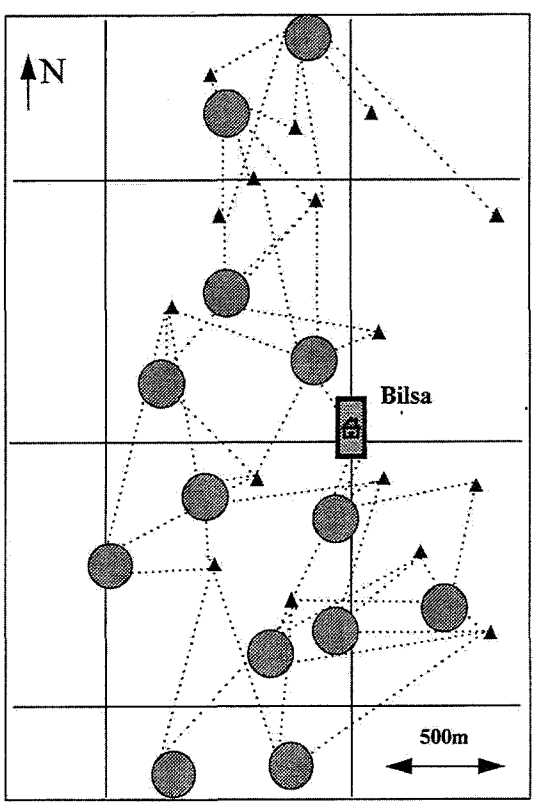

Figure 2. Results of the triangulation. Triangles represent listener pairs. Circles represent howler troops. Doted lines represent directions allowing to locate howler troops. As an example, the troop located at the top of this map as been heard by six listener pairs at the same time.

The Survey: Troop Size Estimation

Troop sizes were determined by direct observations. We looked for howler troops in different randomly chosen areas. We formed three groups of two and worked in shift. One team worked from 5 a.m. to 2 p.m., one from 5 a.m. to 5 p.m., and the third from 2 p.m. to 5 p.m. As a consequence there was at least one group of observers in the field at any time of the day, and two for most of the day. Each area was surveyed for three days. The researchers walked throughout the day, with occasional stops to listen for howler calls and cracking branches that indicated monkey troops. Using troop size and composition as well as GPS position allowed identification of the different troops encountered. All observations using this method between 4 August and 10 September,1998, were recorded. Troops were studied until all observers agreed on their size. Two major observations by park guards were added to the data.

Mapping of the area and the positions of the troops used a Global Positioning System (Garmin 12). Field notes were taken on AquaScribe waterproof notebooks.

Results

Troop Size

The location and size of the troops encountered is shown in Figure 1. Of a total of 12 encounters,two were solitary individuals. Troop sizes ranged from two to nine animals. Including solitary individuals, mean troop size is estimated at N = 4.8 individuals per troop (SD 3.1).

Troop Density

Thirteen troops were detected in an area of 4 km² (Fig. 2). Troop density is therefore estimated to be 3.25 troops/km² in the covered area. Using N = 4.8 (SD 3.1), we estimate the density to be 15.6 individuals/km² (± 9.3). Given that the area surveyed covers 1/8 of the whole reserve, and that it roughly presents the different habitat types of Bilsa, and in similar proportions, extrapolation of the density estimate to the whole reserve seems justified.

Discussion

Ecological factors affecting howler density at Bilsa

Our survey indicates a density of 15.6 individuals/km² (± 9.3). This density falls below the mean observed for the genus, estimated by Peres (1997) as 29.5 (estimation based on 106 densities for different habitat types). However, it is important to notice that many sites reported in this study show low densities while only a few show extremely high ones. Hence, even though the density observed in Bilsa is inferior to the mean for the genus, it is superior to the median (mean of ranks: 12.8). The same kind of conclusion can be drawn from literature data concerning *A. palliata* only (Table 1). Indeed, we record that even though some sites harbour very high densities (some of them (Baldwin and Baldwin, 1976) being probably very unstable and due to recent disturbance in surrounding areas), densities around 15 individuals / km² are common.

Table 1. *Alouatta palliata* population densities from various sites.

Site	Densities (/km^2)	Source
Barro Colorado Island, Panama	16.2	Collias and Southwick, (1952)
Barro Colorado Island, Panama	27-52	Carpenter (1934, 1962)
Barro Colorado Island, Panama	62.7	Chivers (1969)
Barro Colorado Island, Panama	62.6	Mittermeier (1973)
Barro Colorado Island, Panama	75.8	Smith (1977)
Barro Colorado Island, Panama	82.2-91.7	Milton (1982)
Chirique, Panama	1050	Baldwin and Baldwin (1976)
La Pacifica, Costa Rica	74.3	Heltne *et al.* (1976)
La Pacifica, Costa Rica	77	Glander (1978)
La Pacifica, Costa Rica	74.3-103.3	Clarke and Zucker (1992)
La Selva, Cosra Rica	7-15	Stoner (1994)
La Selva, Costa Rica	12-19	Fishkind and Sussman (1988)
Los Tuxlas, Mexico	23.3	Estrada (1982)
Palo Verde, Costa Rica	89.7	Rodriguez (1985)
Rio Jesus, Costa Rica 1	4.9	Sanchez Porras (1991)
Rio Jesus, Costa Rica 2	169	Sanchez Porras (1991)
Santa Rosa, Costa Rica	1.2	Freese (1976)
Santa Rosa, Costa Rica	10.1	Chapman *et al.* (1989)
Santa Rosa, Costa Rica	4.9-7.9	Fedigan *et al.* (1998)

Thus, it seems that the howler density in Bilsa is low compared to what is seen in some habitats, but not compared to what is ordinary observed. We will now try to explain this pattern by considering the different ecological factors known to affect howler density: hunting pressure, interspecific competition, and food quality and availability. These factors are ultimately determined by abiotic factors such as soil fertility, altitude, seasonality and rainfall.

Hunting pressure has been shown to be a very significant factor affecting the population structure of howler monkeys (Peres, 1997; Marsh and Mittermeier, 1987). Howlers are hunted for food, medicine and fur, which has resulted in their extinction from many areas, including parts of Ecuador (M. Dilger, pers. comm.). However, discussion with park guards as well as personal observations suggest that hunting pressure is very low or non-existent at Bilsa.

Inter-specific competition for resources can affect howler population densities in communities rich in primate species (Eisenberg, 1979). *Cebus albifrons* (white-fronted capuchin) is the only other monkey species present at Bilsa. However, capuchins seem rare and are found mainly in secondary forest. Therefore the resource overlap is small, suggesting that inter-specific competition is not likely to be a factor affecting the observed howler troop size and population density at Bilsa.

The floristic composition can have a profound influence on the population structure of howler monkeys. The flora of Bilsa is remarkable by the fact that it contains low numbers of Leguminosae and *Ficus* species (R. B. Foster in Parker III and Carr, 1992), which have been shown to be very important components of howler diet. Therefore, it may be that howler density and troop size is limited in Bilsa because of floral composition. However, howler diet should be precisely ascertained for this hypothesis to be confirmed.

Based on a wide comparison of population densities at different sites, Peres (1997) concluded that once hunting pressure differences are controlled for, two remaining factors are the main determinants of *Alouatta* densities: (i) primary productivity (which is increased by soil fertility and forest heterogeneity) and (ii) toxin concentrations in leaves (which is decreased by seasonality and soil fertility). Bilsa is composed mainly of primary forest, probably harbouring high concentrations of toxic secondary compounds in leaves with limited primary productivity. Seasonality is significant but not as important as in sites showing the highest howler densities. Furthermore, because the area is mountainous, leaching of nutrients from the soil is to be expected.

Thus, it seems that hunting pressure and interspecific competition are not limiting howler density at Bilsa. However, low abundance of food sources commonly consumed by howlers, together with relatively low primary productivity and high toxin concentrations may limit the carrying capacity of this habitat.

Conservation Implications

The original distribution of the tropical rain forest and the populations of *A.palliata* has been reduced by at least 90 percent in the last 40 years as a result of the conversion of natural habitat to pasture and agricultural fields (Estrada and Coates-Estrada, 1988). Conservation initiatives are needed to save this species from extinction. Habitat fragmentation and destruction, hunting, and pet trade are the factors responsible in most cases for the decline of the species. In the Mache-Chindul Mountains, hunting and pet trade do not seem to

play a role, however deforestation has been incredibly intense during the last 30 years.

Howler conservation requires preservation of primary forest habitat, as this is the type of habitat that is suitable for these animals. Our results show that the Bilsa population is not currently at a critical stage. The surrounding areas of Bilsa are still covered by primary forest at the present time. These areas must be protected from destruction by including them in the reserve as well as continuing the education activities of Fundación Jatun Sacha to increase the awareness of the local people. Furthermore, the effects of overall population reduction due to the destruction of the outlying forest may not yet have begun to show the long- term deleterious effects of genetic diversity loss and genetic drift.

Howler conservation at Bilsa is an excellent way of protecting the whole habitat. Howlers are probably among the largest animals in the area and their presence is undoubtedly necessary for the stability of the ecosystem, especially in the role of seed dispersal (Estrada and Coates-Estrada, 1984). Given the vast number of plant species consumed by howlers their continued presence requires the protection of the entire ecosystem. The mantled howler monkey is therefore an effective umbrella species.

Surveys are indispensable for conservation planning. They allow estimations of population status and provide material for inter-site comparisons. Surveys must be performed several times to provide information concerning population dynamics which allows the recognition of declining primate populations in areas where conservation efforts are most needed. More detailed information must be obtained, particularly on how the *A. palliata* diet in Bilsa differs from other sites. Local alimentary habits must be known for conservation actions to be conducted through reforestation. As a peculiar and unique habitat, Bilsa may reveal many new and interesting aspects of howler ecology. Sufficient data are already available in the literature to allow fruitful comparisons. Hopefully such projects will be realised at Bilsa in the near future.

Acknowledgments

We are deeply grateful to Prof. M. Hollingdale and the University of Leeds School of Biology, the charity Equafor, the Expedition Committee, Travel Bursaries, Roger Stevens,Travel Bursary of the University of Leeds, the Leeds Philosophical and Literary Society, the Gilchrist Educational Trust, the staff of the School of Biology and especially Prof. R. McNeill Alexander, for funding this study. The following companies contributed equipment, for which we are grateful: Johnson-Progress Ltd, Hawkins & Manwaring Ltd, Chefaro Proprietaries Ltd, Stafford Miller Ltd, Johnson & Johnson Ltd, Oasis Nets Ltd, and Care for the Wild International. Thanks to A. Davis for advice during the preparation. Thanks to Françoise Bayart for advice and comments on the manuscript. And last but not least, many thanks to the staff of the Fundación Jatun Sacha and the Bilsa Biological Station for help conducting the triangulation.

Sylvain Charlat, Institut Jacques Monod, Laboratoire Dynamique du Génome et Evolution, Tour 42 4ème étage, 2 Place Jussieu, 75251 Paris Cedex 05, France, e-mail: <charlat@ijm.jussieu.fr>, **Oliver R. Thatcher,** Department of Entomology, Natural History Museum, Cromwell Road, London, SW7 5BD, UK, **Nils Hartmann,** Molekulare Parasitologie, Institut fuer Biologie, Humboldt-Universitaet Berlin, Philippstr. 13, 10115 Berlin, Germany, **Yogen G. Patel,** Department of Biological Anthropology, University College London, Gower Street, London WC1E 6BT, UK, **Marjorie Saillan,** Institut Jacques Monod, Laboratoire Dynamique du Génome et Evolution, Tour 42 4ème étage, 2 Place Jussieu, 75251 Paris Cedex 05, France, and **Elsbeth Vooren,** Institut Jacques Monod, Laboratoire Dynamique du Génome et Evolution, Tour 42 4ème étage, 2 Place Jussieu, 75251 Paris Cedex 05, France.

References

Baldwin, J. D. and Baldwin, J. I. 1976. Primate populations in Chiriqui, Panama. In: *Neotropical Primates. Field Studies and Conservation*, R. W. Thorington and P. G. Heltne (eds.), pp.20-31. National Academy of Science, Washington, DC.

Barnett, A. 1995. *Expedition Field Techniques: Primates.* The Expedition Advisory Centre, Royal Geographical Society, London.

Brame, C. W. 1995. The Bilsa Reserve Biological Station, north-west Ecuador, Management plan. Fundación Jatun Sacha, Quito, Ecuador (Unpublished).

Brockelman, W. Y., and Ali, R. 1987. Methods of surveying and sampling forest primate populations . In: *Primate Conservation in the Tropical Rain Forest*, C. W. Marsh, and R. A. Mittermeier (eds), pp.23-62. Alan R. Liss, New York.

Carpenter, C. R., 1934. A field study of the behaviour and social relations of howling monkeys. *Comp. Psychol. Monogr.* (10): 1-168.

Carpenter, C. R., 1962. Field studies of a primate population. In: *Roots of Behavior*, E. L. Bliss (ed.), pp.286-294. Harper and Row, New York.

Chapman, C. A., Chapman, L. J. and Glander, K. E. 1989. Primate populations in northwestern Costa Rica: Potential for recovery. *Primate Conservation* (10):37-44.

Chapman, C. A. and Balcomb, S. R. 1998. Population characteristics of howlers: ecological conditions or group history. *Int. J. Primatol.* 19: 385-403.

Chivers, D. J.1969. On the daily behaviour and spacing of howling monkey groups. *Folia Primatol.* 10:48-102.

Clarke, M. R. and Zucker, E. L. 1992. Survey of the howling monkey population at La Pacifica: as seven-year follow-up. *Int. J. Primatol.*, 15: 61-73.

Collias, N and Southwick, C. 1952. A field study of population density and social organization in howling monkeys. *Proc. Am. Phil. Soc.* 96: 143-156.

Crockett, C. M. 1998. Conservation biology of the genus *Alouatta. Int. J. Primatol.* 19:549-578.

Eisenberg, J. F. 1979. Habitat, economy and society: some correlation and hypotheses for the Neotropical primates. In: *Primate Ecology and Human Origins: Ecological Influences on Social Organization*, I. S. Bernstein and E. O. Smith (eds), pp.215-262. Garland Press, New York,

Eisenberg, J. F. 1989. *Mammals of the Neotropics. Vol. 1. Panama, Colombia, Venezuela, Guyana, Suriname, French*

Guiana. The University of Chicago Press, Chicago.
Eisenberg, J. F. and Thorington, R. W. 1973. A preliminary analysis of Neotropical mammal fauna. *Biotropica* 5: 150-161.
Estrada, A. 1982. Survey and census of howler monkeys (*Alouatta palliata*) in the rain forest of "Los Tuxtlas" Veracruz, Mexico. *Am. J. Primatol.* 2: 363-372.
Estrada, A. and Coates-Estrada, R. 1984. Fruit eating and seed dispersal by howling monkeys (*Alouatta palliata*) in the tropical rain forest of Los Tuxtlas, Mexico. *Am. J. Primatol.* 6: 77-91.
Estrada, A. and Coates-Estrada, R. 1988. Tropical rain forest conversion and perspectives in the conservation of wild primates (*Alouatta* and *Ateles*) in Mexico. *Am. J. Primatol.* 14: 315-327.
Fedigan, L. M., Rose, L. M. and Morera Avila, R. 1998. Growth of mantled howler groups in a regenerating Costa Rican dry forest. *Int. J. Primatol.* 19: 405-432.
Fiskind, A. S. and Sussman, R. W. 1988. Preliminary survey of the primates of the Zona Protectora and La Selva Biological Station, northeast Costa Rica. *Primate Conserv.* (8): 63-66.
Freese, C. 1976. Censusing *Alouatta palliata, Ateles geoffroyi* and *Cebus capucinus* in the Costa Rican dry forest. In: *Neotropical Primates. Field Studies and Conservation*, R. W. Thorington Jr. and P. G. Heltne (eds.), pp.4-9, National Academy of Science, Washington, DC.
Glander, K. E., 1978. Howling monkey feeding behaviour and plant secondary compounds: A study of strategies. In: *The Ecology of Arboreal Folivores*, G. G. Montgomery (ed.), pp.561-573. Smithsonian Institution Press, Washington, DC.
Heltne, P. G., Turner, D. C. and Scott, N. J. 1976. Comparison of census data on *Alouatta palliata* from Costa Rica and Panama. In: *Neotropical Primates. Field Studies and Conservation*, R. W. Thorington Jr. and P. G. Heltne (eds.), pp.10-19. National Academy of Sciences, Washington, DC.
IUCN Red List of Endangered Animals. Website:http://www.wcmc.org.uk/species/ animals/animal_redlist.html
Marsh, C. W. and Mittermeier, R. A. 1987. *Primate Conservation in the Tropical Rain Forest.* Alan R. Liss, New York.
Martin, R. D. 1990. *Primate Origins and Evolution.* Chapman and Hall, London
Milton, K. 1980. *The Foraging Strategy of Howler Monkeys: A Study in Primate Economics.* Columbia University Press, New York.
Milton, K. 1982. Dietary quality and demographic regulation in a howler monkey population. In: *The Ecology of a Tropical Forest: Seasonal Rhythms and Long-term Changes*, E. G. Leigh Jr, A. S. Rand, and D. M. Windsor (eds.), pp.273-290. Smithsonian Institution Press, Washington, DC.
Mittermeier, R. A. 1973. Group activity and population dynamics of the howler monkey on Barro Colorado Island. *Primates* 14: 1-19.
Myers, N. 1988. Threatened biotas: Hotspots in tropical forests. *The Environmentalist* 8: 187-208.
Parker, T. A., III and Carr, J. L. 1992. *Status of Forest Remnants in the Cordillera de la Costa and Adjacent Areas of Southwestern Ecuador. RAP Working Papers 2.* Conservation International, Washington, DC.
Peres, C. 1997. Effects of habitat quality and hunting pressure on arboreal folivore densities in Neotropical forests: A case study of howler monkeys (*Alouatta* spp.). *Folia Primatol.* 68: 199-222.
Rodriguez, M. A. R. 1985. Algunos aspectos sobre compartamiento, alimentación y nivel de problemación de los monos (Primates:Cebidae) en el Refugio de Fauna Silvestre Palo Verde (Guanacaste, Costa Rica). In: *Investigaciones Sobre Fauna Silvestre de Costa-Rica*, Editorial Universidad a Distancia, San Jose, Costa Rica.
Sanchez Porras, R. E. 1991. Utilización del habitat, comportamiento, y dieta del Mono Congo (*Alouatta palliata*) en un bosque premontano humido, Costa Rica. Master's thesis, Universidad Nacional, Costa Rica.
Smith, C. C. 1977. Feeding behavior and social organization in howling monkeys. In: *Primate Ecology*, T. H. Clutton-Brock, (ed.), pp.97-126. Academic Press, London.
Stoner, K. E. 1994. Population density of the mantled howler monkey (*Alouatta palliata*) at la Selva Biological Reserve, Costa Rica: A new technique to analyze census Data. *Biotropica* 26:332-340.
Wolfheim, J. H. 1983. *Primates of the World: Distribution, Abundance and Conservation.* Harwood Academic Publishers, Seattle.

Demography of a Group of Tufted Capuchin Monkeys (*Cebus apella nigritus*) at the Estação Biológica de Caratinga, Minas Gerais, Brazil

Jessica Ward Lynch
José Rímoli

Introduction

Demographic variables play an important role in understanding primate behavioral ecology (Dunbar, 1987; Strier 1991, 1999a) and are crucial components of conservation biology strategies for species' management (Dobson and Lyles, 1989). While attention has focused on collecting demographic data on endangered species, it is also important to monitor demography of abundant and widespread species, both for comparison to those which are threatened (Hubbell and Foster, 1986) and for understanding dynamics among species in primate communities (Waser, 1987; Strier, 1999b). Long-term studies in the Amazon, the llanos of Venezuela, and Central America have yielded demographic information on groups of *Cebus apella* (Izawa, 1988, 1990, 1992, 1994a, 1994b, 1997), *C. olivaceus* (Robinson, 1988a, 1988b), and *C. capucinus* (Fedigan *et al.*, 1996), but, until recently, there was no data available for the capuchin monkeys of the Atlantic forest in Brazil. Here we present information on group composition and membership