Population Density of Black-Faced Lion Tamarin (Leontopithecus caissara)

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POPULATION DENSITY OF BLACK-FACED LION TAMARIN (*LEONTOPITHECUS CAISSARA*)

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Abstract

Here we present the results of a population survey of the black-faced lion tamarin, *Leontopithecus caissara*, on Superagüi Island, and we extrapolate this estimation to the entire population. We used the linear transect method for surveys of the area from November 2000 to January 2002. When lion tamarins were seen in transects, we noted the perpendicular distance from the path and the number of individuals sighted in a cluster. Using the software Distance 4.0 we estimated a density of 1.79 individuals/km² and a population of 205 individuals (95% CI: 79 – 537 ind/km²) on the Superagüi Island. The extrapolation of these results to populations on the mainland gave us an estimate of 187 individuals (95% CI: 72 – 489 ind/km²). Our estimate for the total population is 392 individuals (95% CI: 218 – 1,026 ind/km²). The lower population density of *L. caissara* compared to other species of the genus, in combination with its very small geographic range, indicate that it is critically endangered. We also discuss some aspects of the limitations of the linear transect method when densities are extremely low. The Distance 4.0 software suggested a minimum of 30 sightings for a density estimate; but from the sighting frequency in our study this would require 2,489 hours and 883 surveys, not logistically viable.

Key words: Black-faced lion tamarin, *Leontopithecus caissara*, population density, line transect methodology.

Resumo

Apresentamos a estimativa populacional do mico-leão-da-cara-preta, *Leontopithecus caissara*, na Ilha do Superagüi e a extrapolação desses resultados para a população continental. Amostramos 12 trilhas por transecção linear entre os meses de Novembro de 2000 a Janeiro de 2002. Quando avistávamos micos-leões-da-cara-preta anotávamos a distância perpendicular ao transecto e o número de indivíduos presentes no grupo avistado. Utilizando o software Distance 4.0 estimamos uma densidade de 1.79 indivíduos/km² e uma população de 205 (IC 95% 79 – 537) indivíduos na Ilha do Superagüi. A extrapolação desses resultados para a porção continental de distribuição da espécie resulta em uma estimativa de 187 indivíduos (IC 95% 72 – 489). A estimativa para a população total é de 392 indivíduos (IC 95% 218 – 1,026). Estes resultados indicam uma baixa densidade de *L. caissara* comparada com as demais espécies do gênero, o que somado a sua restrita distribuição geográfica resulta em seu estatus de espécie criticamente ameaçada. Também discutimos alguns aspectos da limitação do método de transecção linear na estimativa de espécies com densidade muito baixas. O software Distance 4.0 sugere um mínimo de 30 avistamentos para a estimativa de densidade, mas com a freqüência de avistamentos desse estudo seriam necessárias 2489 horas e 883 amostragens em transectos, o que se torna inviável em termos operacionais e econômicos.

Palavras-chaves: Mico-Leão-da-Cara-Preta, Leontopithecus caissara, densidade populacional, método de transectos lineares.

Introduction

The black-faced lion tamarin, *Leontopithecus caissara*, was described in 1990, from Superagüi, an island just off the coast in the north of the state of Paraná, Brazil. It was later also found to occur in a small area of the continent, in Paraná and the extreme south of the state of São Paulo, Brazil (Lorini & Persson 1990, 1994). Lorini & Persson (1994) found the population of *L. caissara* to be very small.

From their surveys by the linear transect method, they estimated an overall density of 0.3 groups/km² or 1.5 individuals/km², and a total population of 260 individuals in three separate subpopulations. The largest of these subpopulations, with 121 individuals, was that on the Island of Superagüi, with two mainland subpopulations in the states of Paraná (Guaraqueçaba) and São Paulo (Cananéia). Population density was found to be lower, and the total population and geographic range smaller (approximately

300 km²), than any of the other lion tamarins. As a result, *L. caissara* is ranked as "Critically Endangered" on the *IUCN Red List of Threatened Species* (IUCN, 2011).

Superagüi Island is part of the Superagui National Park, decreed in 1989 with an area of 24,500 ha. The initial surveys were carried out in the early 1990s, and the objective of the present study was to verify the current population size of *L. caissara* on Superagüi Island. We used the linear transect method and carried out some analyses concerning about the use of this methodology in the censusing of rare species. The fact that Superagüi is the stronghold for this species has considerably influenced investment in the management of the park. As a result of findings concerning the distribution of lion tamarin groups on Superagüi, the size of the park was increased in 1997 to 33,928 ha. Basic quantitative information on the population of this species on the Superagüi Island is crucial to our understanding of its status and viability, and for the future management of the park.

Study area and methodology

Superagüi Island (25°23'40 S, 48°13'09 W) has a total area of 114.59 km² and altitudes ranging from sea level to some small isolated hills reaching 245 m. The vegetation includes low coastal scrub and tall forest on sandy soils (*restinga* and *floresta de restinga*), some mangroves, and dense large-leafed tropical lowland and submontane forest (Prado, 1999; Schmidlin, 2004).

The surveys were carried out between November 2000 and January 2002. The linear transect method (Burnham *et al.*, 1980; Buckland *et al.*, 1993; Thomas *et al.*, 2002) was used along 12 trails totaling 37.43 km, the mean length was 3.12 km, and transects ranged from 2.25 to 4.15 km in length. In order to sample all the study area, transects were distributed along the whole island of Superagüi (Figure 1).
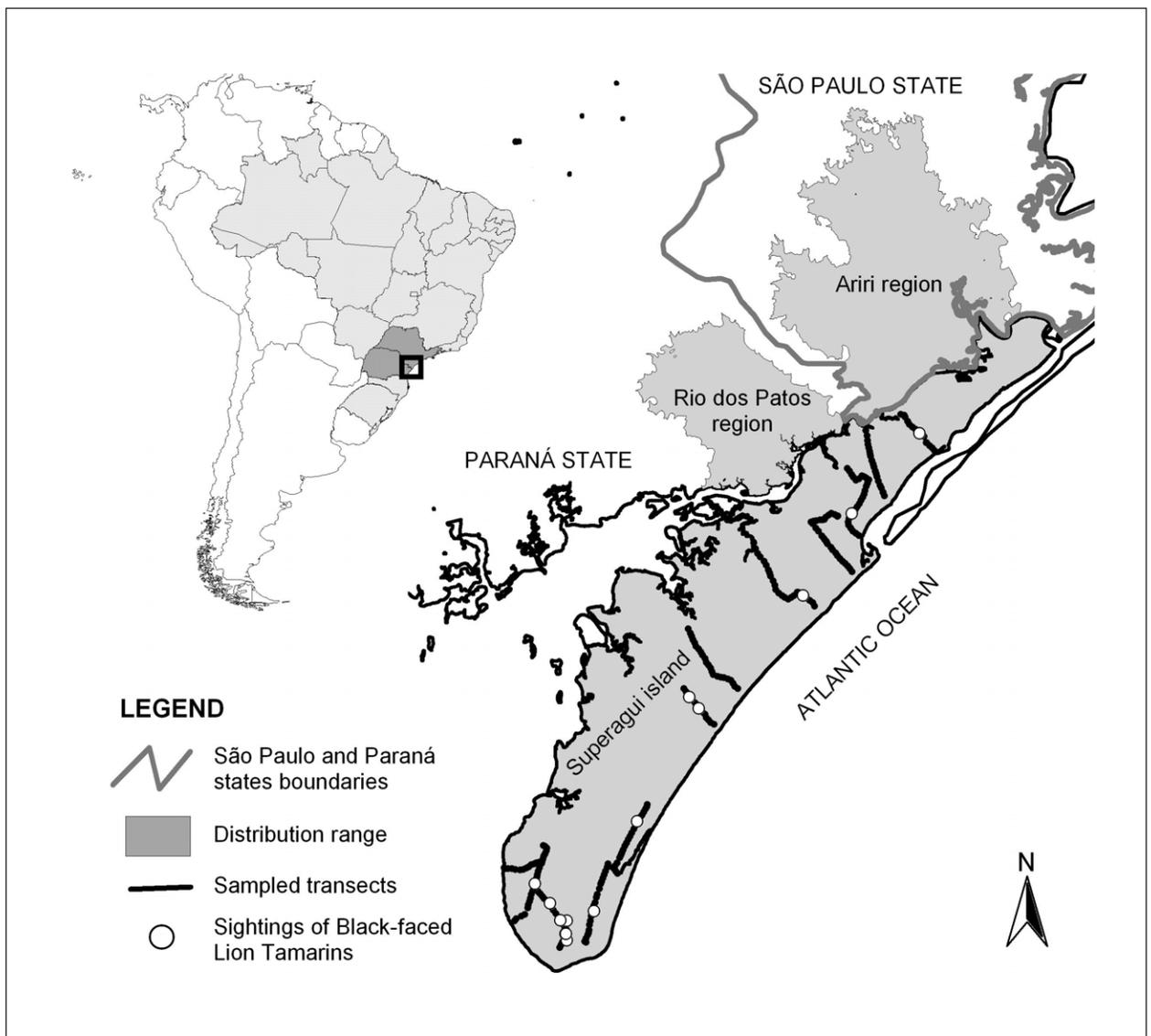
Figure 1. Location of transects on the island of Superagüi; Superagui National Park. The points indicate the locations of sightings of *L. caissara* groups.

All trails were marked at 50 m intervals to take the geographical coordinates using a GPS. The trails were censused an average of 15 times each (SE = 3.56); all between 07:00 and 16:00 h. The walking speed along the trails was approximately 1 km/hour. In order to make each census an independent sample, we use a minimum of 30 minutes to separate censuses along a trail when going out and returning, as suggested by the linear transect method (Buckland et al. 1993). On sighting a lion tamarin group, we took note of the time, the perpendicular distance from the trail of the first animal seen, the number of individuals, age/sex composition of the group where possible, and the name, height and geographical coordinates of the tree in which the individual or group was sighted. No more than 10 minutes were spent collecting the data for each group sighted. Unhabituated animals move away quickly after they perceive the presence of researchers.

Population size and density of individuals were calculated using the software DISTANCE 4.0 (Buckland *et al.*, 1993, Thomas *et al.*, 2001, 2002). The detection function for *L. caissara* was fitted by the model Half Normal Simple Polynomial, based on the smallest value of AIC (Aikaike's Information Criterion) and the larger value of GOF (Goodness of fit) (Cullen & Rudran, 2003). The estimates for the island were extrapolated to the mainland as well, in order to present an estimate of the overall population of *L. caissara*. Thomas *et al.* (2001) suggested that a minimum of 30 sightings are necessary for the survey method using linear transects. We estimated the number of surveys and hours spent in the field necessary to attain this number of sightings from the sighting rate we achieved, using the accumulated number of sightings, the distance censused and the time taken in censusing. A power function was fitted to the relationship between number of sightings and distance censused using a non-linear procedure with minimum squares as loss function and in a Quasi-Newton estimation process (Zar, 1999).

Results

Lion tamarins were sighted 13 times during 575,512 km of censusing (mean = 44.27 km per sighting). The density of black-faced lion tamarins was estimated at 1.79 individuals/km² (95% CI 0.69 – 4.69 ind/km²), and the total population for the island (114.59 km²) at 205 (95% CI 79 – 537 ind/km²) with a coefficient of variation (CV) of 48.2%. Extrapolating the same population density to the mainland occurrence area (104.28 km² including the Paraná and São Paulo populations) results in an estimate of 187 mainland individuals (95% CI 71.95 – 489.07 ind/km²). The estimate for the total population size was 392 individuals (95% CI 151 – 1,026.5 ind/km²). The mean number of individuals per group observed on the island was 4.5 (95% CI 3.64 – 5.56 ind.).

The relation between the accumulated time spent censusing (in hours) and the number of sightings showed a progressive correlation (Figure 2). According to the equation of the line estimated from the data in Figure 2, time spent surveying would have to be 7.56 times greater than was done on this study (2,489 hours) in order to obtain 30 sightings of *L. caissara*, as suggested by Thomas *et al.* (2001).

We conducted 182 independent censuses (including those on the same trail - going up the trail and then back after an interval of a half-hour or more) on the 12 transects. When the number of surveys increased, there was a non-exponential increase in the number of sightings, and, according to the equation of the curve in Figure 3, it would be necessary to carry out 883 censuses to obtain 30 sightings of lion tamarin groups.
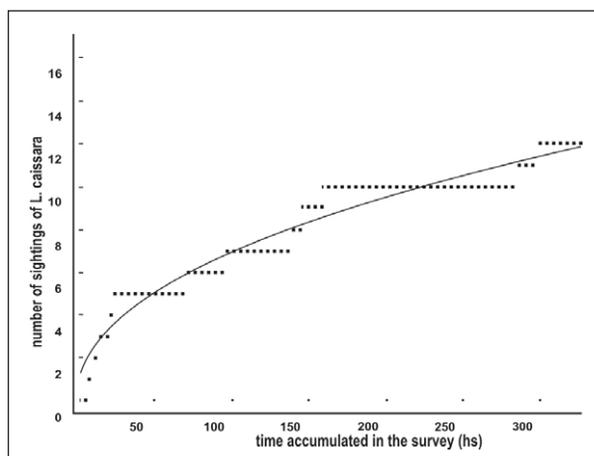

Figure 2. Time accumulated on the survey in hours in relation to the number of sightings. The equation of the line $y = 0.84x^{0.45}$ explains 94.67% of variation.
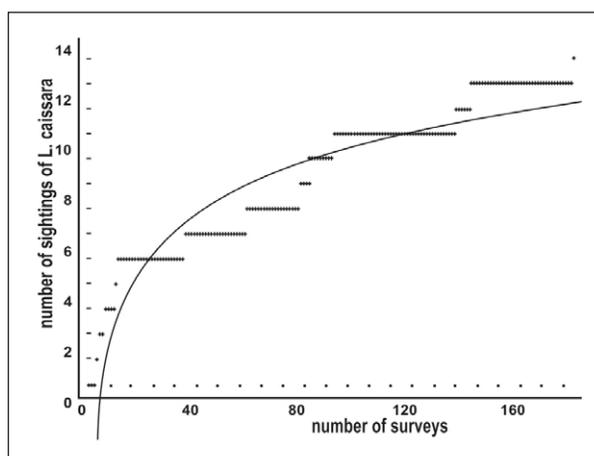

Figure 3. Correlation between the accumulation in the number of surveys and the number of sightings. The graph indicates that 95.78% of the variation displayed by the non-linear regression is explained by the equation of the line $y = 0.78x^{0.53}$.

Discussion

The estimate of 205 black-faced lion tamarins on the island of Superagüi, and our extrapolation of an estimated 187 individuals on the mainland and a total population of 392 wild individuals, has a relatively wide margin of error due to the small number of sightings (n=13) during the censuses. The coefficient of variation (48.2) of the population size estimate reflects the variation between transects (n=12) (Magnusson, 2001), resulting from such as: i) variation in the structure of the vegetation, ii) seasonality and availability of food resources, and iii) presence or absence of the capuchin monkey (*Sapajus nigritus*), a possible competitor. The two species were frequently seen eating the same fruits, and the lion tamarins seemed to avoid the capuchin monkeys.

The surveys illustrate a problem with regard to repeat transect censusing as a method for estimating population densities of rare species such as the black-faced lion tamarin. As indicated by DISTANCE 4.0, 2,489 hours of survey (Figure 2) and 883 censuses (Figure 3) would be necessary to achieve the 30 sightings necessary to reduce the confidence interval and the standard error to a more acceptable level. It would not be logistically viable. The question is whether 30 sightings are really necessary. We believe additional efforts must focus on research design and event counts, both factors affecting the error of Distance Sampling (Buckland et al., 2001). The method's accuracy would also benefit from alternative estimations of population density and the incorporation of ecological parameters into models. In this study, we propose novel strategies for population density estimates, including the use of confidence intervals and the use of home-range and home-range-overlap in association with group size.

A mean home range of 250 ha with an overlap of approximately 19%, based in data from four groups studied on Superagüi Island (F. Prado, unpublished data), and an average group size of 4.5 individuals, provides an approximate population of 244 individuals for the 11,459 ha of the island. This estimate represents the environmental carrying capacity (K) of the black-faced lion tamarins on Superagüi Island, and is within the confidence interval of the estimate from the censuses. As such it reduces the maximum value of the population of *L. caissara* in Superagüi to 244 individuals. The only previous estimate for the Superagüi population, reported by Lorini & Persson (1994), indicated 121 individuals. Ours, seven years on, is 40.98% higher, and 121 is within the confidence interval for our estimate. It important to highlight that it may also reflect a real increase in the numbers of lion tamarins due to protection in the park and the environmental education program, initiated in 1996 (Padua *et al.*, 2002).

The population density we estimate for *L. caissara* on Superagüi is lower than those found for the other lion tamarins. An understanding of density and population size is, of course, a key factor, in future contingencies for the genetic management of the three sub-populations as a metapopulation. However, further research is needed to understand the habitat requirements of *L. caissara*, and what may well be significant differences in the population dynamics in the subtly diverse vegetation types they occupy in terms of structure and floristic composition, both on the island and on the mainland. Small populations with restricted geographical distributions and low population densities, as it is the case for *L. caissara*, are more susceptible to extinction, genetic problems, environmental fluctuations and extreme environmental conditions (Gilpin & Soulé, 1986; Soulé, 1987; Lacy, 1987, Ralls *et al.*, 1988, Purvis *et al.*, 2000). The small population and low population density confirm that the black-faced lion tamarin should be considered "Critically Endangered" and given top priority for conservation programs.

Acknowledgments

References

Buckland, S. T., Anderson, D. R., Burnham, K. P., Laake, J. L. 1993. *Distance Sampling, Estimating Abundance of Biological Populations*. Chapman and Hall, London.

Buckland, S. T., Anderson, D. R., Burnham, K. P., Laake, J. L., Borches, D. L., Thomas, L. 2001. *Introdution to Distance Sampling*. Oxford University Press, Oxford.

Burnham, K.P., Anderson, D. R., Laake, J. L. 1980. Estimation of density from line transect sampling of biological population. *Wildl. Monog.* 72: 1–202.

Cullen Jr., L. and Rudran, R. 2003. Transectos lineares na estimativa de densidade de mamíferos e aves de médio e grande porte. In *Métodos de Estudos em Biologia da Conservação & Manejo da Vida Silvestre*. (Cullen Jr. L, Rudran R, Valladares-Padua C, editors), pp 169–179. Editora UFPR, Curitiba, Paraná, Brasil.

Gilpin ME, Soulé ME. 1986. Minimum viable populations: processes of species extinction. In *Conservation*

Biology: The Science of Scarcity and Diversity. (Soulé ME, editor), pp 19–34. Sinauer Associates, Sunderland, Massachusetts.

IUCN 2011. IUCN Red List of Threatened Species. Version 2011.1. <www.iucnredlist.org>. Downloaded on 14 October 2011.

Lacy, R. C. 1987. Loss of genetic diversity from managed populations: interacting effects of drift, mutation, immigration, selection and population subdivision. *Conserv Biol* 1: 143–158.

Lorini, M. L. and Persson, V. G. 1990. Nova espécie de *Leontopithecus* Lesson 1840 do sul do Brasil (Primates, Callitrichidae). *Bol Mus Nac*, Rio de Janeiro 338: 1–14.

Lorini, M. L. and Persson, V. G. 1994. Status and field research on *Leontopithecus caissara*: The Black-faced Lion Tamarin Project. *Neotrop Primates* 2(Suppl): 52–55.

Magnusson, W. E. 2001. Standard errors of surveys estimates: What do they mean? *Neotrop Primates* 9: 53–54.

Padua, S. M., Deitz, L. A., Rambaldi, D. M., Souza M das G de, Santos, G. R dos. 2002. In situ conservartion education and the lion tamarins. In *Lion Tamarins: Biology and Conservation* (Kleiman DG, Rylands AB, eds.), pp 315–335. Smithsonian Institution Press, Washington, DC.

Prado, F. 1999. *Ecologia, comportamento e conservação do mico-leão-da-cara-preta (Leontopithecus caissara) no Parque Nacional do Superagüi, Guaraqueçaba, Paraná.* Master's thesis, Universidade Estadual Paulista, Botucatu, Brasil.

Purvis, A., Gittleman, J. L., Cowlishaw, G., Mace, G. M. 2000. Predicting extinction risk in declining species. *Proc R Soc Lond, B* 267: 1947–1952.

Ralls, K., Ballou, J. D., Templeton, A. 1988. Estimates of lethal equivalents and the cost of inbreeding in mammals. *Conserv Biol* 2: 185–193.

Schmidlin, L. A. J. 2004. Análise da disponibilidade de habitat para o mico-leão-da-cara-preta (*Leontopithecus caissara* Lorini & Persson, 1990) e identificação de áreas preferenciais para o manejo da espécie por técnicas de geoprocessamento. Master's thesis. Universidade Federal do Paraná, Curitiba, Brazil.

Soulé, M. E. 1987. *Viable Populations for Conservation.* Cambridge University Press, Cambridge, UK.

Thomas, L., Laake, J. L., Strindberg, S., Marques, F., Borchers, D. L., Buckland, S. T., Anderson, D. R., Burnham, K. P., Hedley, S. L., Pollard, J. H. 2001. *Distance 4.0, Beta 2.* Research unit for Wildlife Population Assessment. University of St. Andrews, St. Andrews, UK. http://www.ruwpa.st-and.ac.uk/distance/

Thomas, L., Buckland, S. T., Burnham, K. P., Anderson, D. R., Laake, J. L., Borches, D. L., Strindberg, S. 2002. Distance sampling. In *Encyclopedia of Environmetrics* (El-Shaarawi AH, Piegorsch WW, eds.), Volume 1, pp 544–552. John Wiley & Sons, Ltd, Chichester.

Zar, J. H. 1999. *Biostatistical Analysis.* (4th ed.), New Jersey, Prentice Hall.