# Expedition Mahazo Loko

**A chameleon population study in the littoral forests of Madagascar**

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**A University of Edinburgh Expedition**

## 1. Introduction

Expedition Mahazo Loko set out to determine the health of the forest and the chameleon populations in the Ste. Luce region of Madagascar. Widely regarded as an area of megadiversity (Glaw and Vences, 1994), Madagascar is now a global priority for conservation owing to the islands exceptional diversity and the ongoing loss of natural habitat (Raxworthy *et al*, 2003). Madagascar is home to two-thirds of the worlds chameleons (Parcher, 1974), and a robust pet-trade has resulted in nearly all of these being added to either Appendix II or I of CITES (*Convention on International Trade in Endangered Species of Wild Flora and Fauna*). Despite their importance relatively little is known about chameleon population dynamics within Madagascar, making the effects of the pet trade on their populations impossible to quantify. Expedition Mahazo Loko aimed to address this issue, by performing our own chameleon population density study and presenting our results to the appropriate Madagascan scientists and authorities.

Upon talking to scientists both inside and outside Madagascar, we quickly realised that we could easily perform other research that would be directly useful both to ourselves and to others studying within the area. Consequently, the second focus of our expedition was to assess the health of the littoral forests in the Ste. Luce area, and if possible, relate forest health to the health of the chameleon populations. The littoral forests of Madagascar are a top conservation priority due to their high endemicity of flora. Ste. Luce boasts the largest remaining fragments within the south east region, and are an important habitat for the chameleons that reside there. These remaining fragments are still under strong anthropogenic pressures from the surrounding villages who depend on the forests for their livelihood. We assessed forest health through basal area measurement, canopy cover and stump counts, which have all been shown to correlate strongly with forest health (Bhat et al., 2000; Bhuyan et al., 2002; Chittibabu & Parthasarathy, 2000; Macedo & Anderson, 1993). The research we conducted, if repeated and compared in several years time, could provide valuable information in the management of the littoral forest and their inhabitancies both locally and nationally.

The following report summarises our methods and findings. The complete version is available on request.

## 2. Aims

The aim of this project were to (i) collect ecological information on the chameleon community of the Ste Luce littoral forests fragments, focusing primarily on determining population densities; (ii) determining forest health and degradation status of forest fragments by ground based surveys of stem density, canopy cover and stump counts; and (iii) through analysis of chameleon density against forest health information assess whether forest degradation has an influence on chameleon density.

## 3. Site Description

The site where this study took place is situated in the small region of Ste. Luce (24°45'S 47°11'E), which lies 50km north of the town Fort Dauphin on the South Eastern coastline of Madagascar. We focused our study on four littoral forest fragments, S7, S8, S9 and S17, ranging from very good condition to moderate degradation, which were defined by QMM in 2001 as well as by Normalised Difference Vegetation Index values obtained from a satellite image taken in 2007.

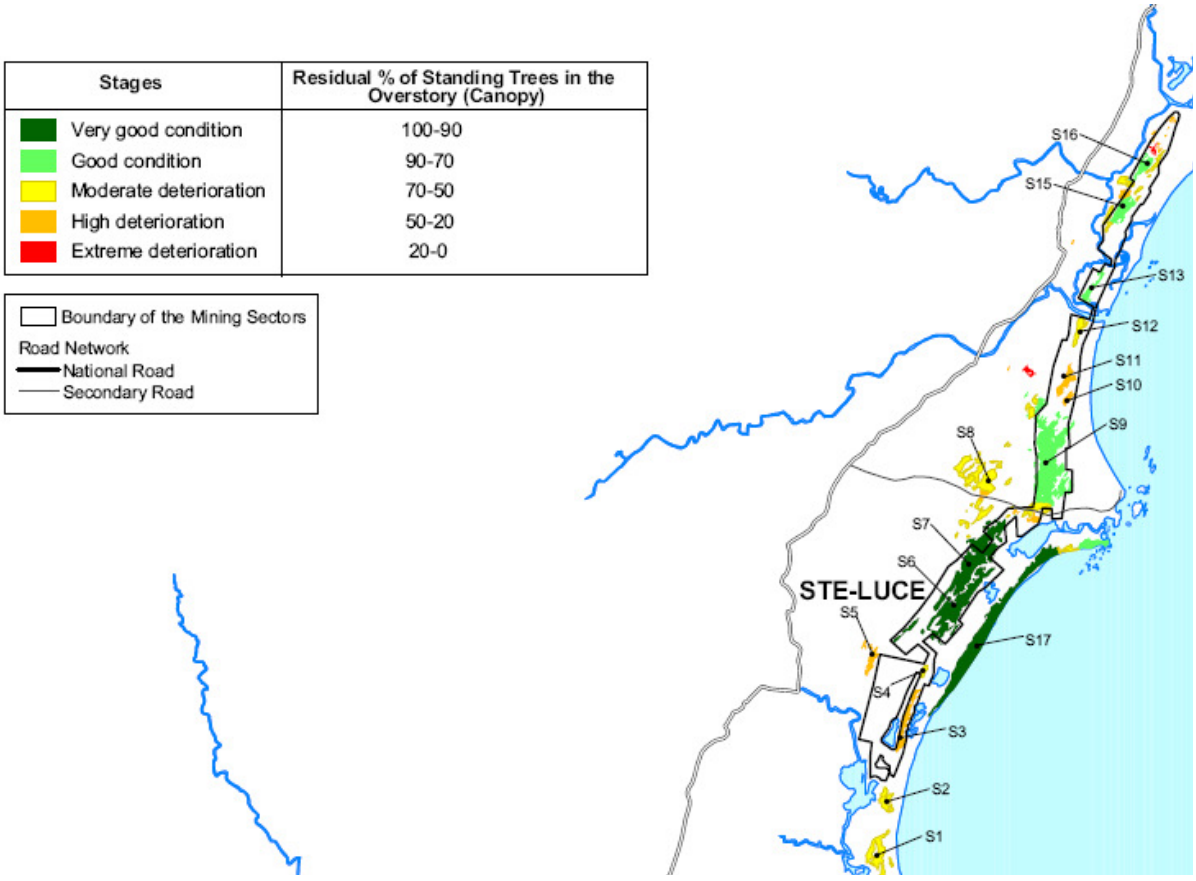


**Fig. 1.** The Residual Littoral Forest in 2000 in the region of Ste. Luce. Adapted from QMM Social and environmental impact assessment (2001), Vol. 1, ch.3 p. 57.

## 4. Methods

### *4.1 Chameleon population study*

Chameleon population density values were obtained using the Distance sampling technique, where a line transect is set out randomly within the forest fragment to be sampled. The line transect was then left undisturbed for a 24 hour period, in order to reduce the effect of the immediate human disturbance in laying out a line transect. As chameleons are more easily detected at night, our study took place from 1800-2300 pm. The body length (distance from the tip of the snout to the end of the tail) and the tail length (distance from the end of the tail to the pelvis) were measured to help identify sex and maturity (adult or juvenile) of the individual. Identification of the chameleon species was carried out using the field guide by Glaw and Vences (1993). Population density estimates were calculated by use of the software package DISTANCE for each fragment.

### *4.2 Sampling forest structure parameters*

Four littoral forests fragments S7, S8, S9, and S17, in the Ste Luce region were surveyed for basal area, stem density, stump counts and canopy cover in June and July of 2007. Basal area was calculated by recording the DBH (Diameter at Breast Height) at 1.3 m from the forest floor. All trees with a DBH value > 5 cm were recorded within a 4 m wide transect with varying lengths. Canopy cover was also estimated using a simple device, involving a piece of card with 10 small holes. The number of trees > 5 cm DBH which had recently been cut to stumps were also recorded within the 4 m wide transects.

### *4.3 Population density correlation to forest condition and structure*

Simple correlations were conducted between *Brookesia nasus* density estimates and stem density, basal area, canopy cover, stump count and total fragment size to determine if any correlation exists between these parameters.

## 5. Results

### *5.1 Chameleon population study*

A total of 490 chameleons representing two species (*B. nasus,* 98% and *Furcifer oustaleti,* 2%) were found in four forest fragments. There were too few *F.oustaleti* to conduct density estimates and all were found to be juveniles. The results for density estimates for *B. nasus* showed that S7, S9, and S17 had significantly greater densities (*D* $ha^{-1}$) than S8, but not between each other (Table 1). The population structure of *B. nasus* showed that there was no sex bias in fragments S7, S8 or S9 (ratios of 1:1), but S17 displayed a male biased sex ratio of 1:4. Likewise there was no bias of juveniles to adults in fragments S7 and S17 (ratios of 1:1), but S8 and S9 showed a slight adult bias with ratios of 1:2 (Table 2).

**Table 1.** DISTANCE calculated, showing density estimates and population size estimates, for *Brookesia nasus* populations within four littoral forest fragments in the Sainte Luce region, Toalagnaro

| | Density estimates (*D* $ha^{-1}$)** | | | |
|---|---|---|---|---|
| Fragment | *D* ($ha^{-1}$) ± SE | *n* * | % CV * | 95 % CI * |
| S7 | 200.2 ± 40.2 | 145 | 20.1 | 129.3 – 309.8 |
| S8 | 82.4 ± 15.3 | 50 | 18.5 | 56.1 – 121.0 |
| S9 | 195.1 ± 37.9 | 187 | 19.4 | 132.4 – 287.6 |
| S17 | 99.4 ± 31.2 | 96 | 31.4 | 51.1 – 193.2 |

* *n*, number of observations; % CV, percent coefficient of variation; 95 % CI, 95 percent confidence intervals

** areas were based on 2001 estimates provided by Watson *et al* (2005) and Banks (unpublished).

**Table 2.** Population structure of *Brookesia nasus* within four forest fragments in the Sainte Luce region, Toalagnaro

| | Sex | | | Life-stage | | |
|---|---|---|---|---|---|---|
| Fragment | *n* * | Male | Female | *n* | Juvenile | Adult |
| S7 | 78 | 0.51 | 0.49 | 145 | 0.46 | 0.54 |
| S8 | 34 | 0.44 | 0.56 | 50 | 0.32 | 0.68 |
| S9 | 114 | 0.47 | 0.53 | 187 | 0.35 | 0.65 |
| S17 | 46 | 0.76 | 0.24 | 96 | 0.52 | 0.48 |

* *n* does not correspond between sex and life-stage, as it was not possible to sex any of the juveniles

*5.2 Structural features of the forest fragment*

The structural categories basal area, canopy cover and stump counts all showed significance difference at the 1% level, but there was no significant difference in stem densities (Table 3). This is compared with a previous classification of the forest fragments by QMM in 2001, which was based solely on canopy cover.

**Table 3.** A summary of the values associated with the forest structural features, basal area, stem density, stump counts and canopy cover for four fragments of littoral forest in the Sainte Luce region, Toalagnaro. All values are means apart from the stump counts, which are medians.

| Fragment* | Degradation Status in 2001 (Canopy Cover %)* | Basal Area ($cm^2$ per $m^2$) | Stem Density (No. of Trees per $m^2$) | Stump Count (No. of Stumps per $m^2$) | Canopy Cover (%) |
|---|---|---|---|---|---|
| S17 | Very Good Condition (100-90%) | 38.92 | 0.2230 | 0.0037 | 76.08 |
| S7 | Very Good Condition (100-90%) | 31.13 | 0.2783 | 0.0537 | 60.33 |
| S9 | Good Condition (90-70%) | 28.95 | 0.2025 | 0.0188 | 68.20 |
| S8 | Moderate Condition (70-50%) | 28.78 | 0.2327 | 0.0491 | 59.44 |

*Defined and graded by QMM's Social and Environmental impact assessment 2001.

Although differences were identified in three of the structural properties, not all of the fragments were different from each other when we applied Tukey tests between each of the fragments.

*5.3 Correlation of population density estimates and forest health parameters*

Correlations between *B. nasus* population density estimates and forest health parameters showed that there was no evident correlation between density estimates and any of these parameters (Fig. 2). Due to there only being four data points in the correlations, it would not be possible to assess to any significant level whether or not a correlation between the population density estimates and forest health parameters exist or not. There is a trend of increasing population density with increasing total fragment area, but our data cannot quantifiably support this suggestion and will therefore not be discussed further.

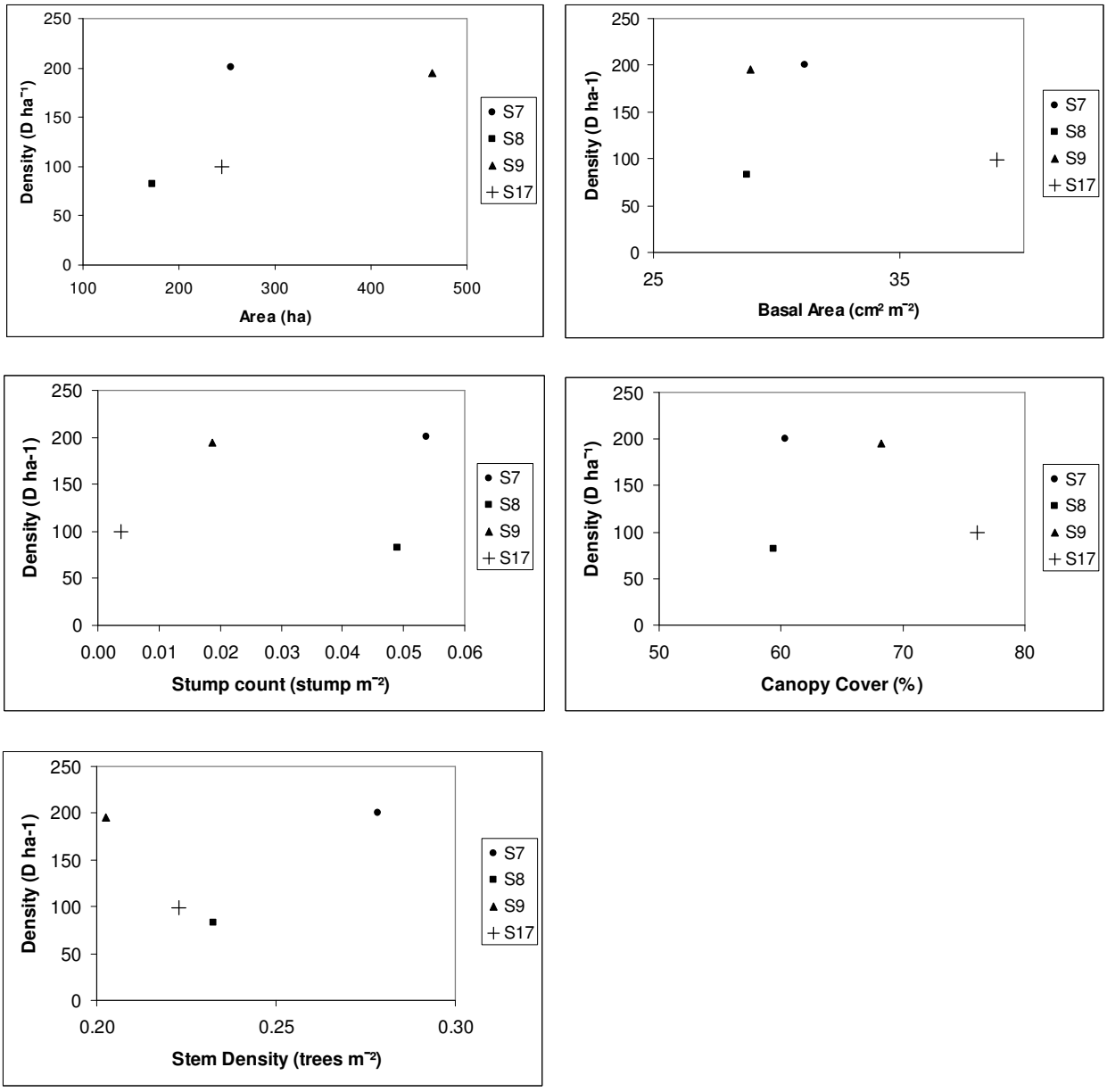


**Fig. 2**. Correlation regressions between population density estimates of *B. nasus* to forest health parameters of total area, mean basal area, median stump count, mean canopy cover and mean stem density within the four forest fragments S7, S8, S9 and S17.

## 6. Discussion

### *6.1 Chameleon study*

Our study suggests that the *B. nasus* populations in the fragments are healthy and well maintained. Edge effects and forest size may explain why S17 and S8 had the lowest density estimates. The highest *B. nasus* population densities were found in the fragments S9 and S7. These were both considered to be in good condition of forest health. Therefore it may be worth considering conserving these two fragments from

further fragmentation and degeneration as they may support important metapopulations for *B. nasus* in the region of Ste Luce.

Jenkins *et al* (1999) conducted a study on chameleon densities in Ranomafana national park in the warmer rainy season. The study also found a healthy *B. nasus* population in Ranomafana national park (densities estimates of 37.8 ± 7.4 and 26.8 ± 5.4). This could suggest that *B. nasus* are plentiful in other regions as well. Jenkins found no *F. oustaleti* in his study, and if our findings of low population sizes are indicative of other regions, this could mean that *F. oustaleti* populations may be at risk.

*B. nasus* are some of the least-studied chameleon species in Madagascar and we therefore recommend more chameleon population studies to be carried out in other regions of Madagascar to determine the distribution and abundance of this species. Baseline information on specific species population abundances, fluctuations, and distributions are necessary to understand the effects that forest degradation and deforestation may have on chameleons in the future.

### *6.2 Forest structure*

Our results identify QMM's study as too simplistic and one-dimensional. It also shows how the forest fragments have degraded since 2001, predominantly due to human disturbance due to the high stump counts. These results confirm that the fragments S9, S7 and S8 are tropical secondary forest fragments, typified by selective logging, fewer large stems and reduced canopy cover.

## 7. Conclusion

In conclusion this study found that there was a high abundance of one species of chameleon, *B. nasus*, in four littoral forest fragments of the Ste Luce area, and a low abundance of *F. oustaleti*. The *B. nasus* population is in good health and exhibits even male to female and adult to juvenile ratios. Furthermore, the distance sampling method used to estimate population density estimates was proven to work well for the study of chameleon populations.

The study also showed that forest conditions of the unprotected forest fragments has worsened since 2001. However further studies need to be done before

the exact effects of forest degradation upon the chameleon population can be fully understood.

## Acknowledgements

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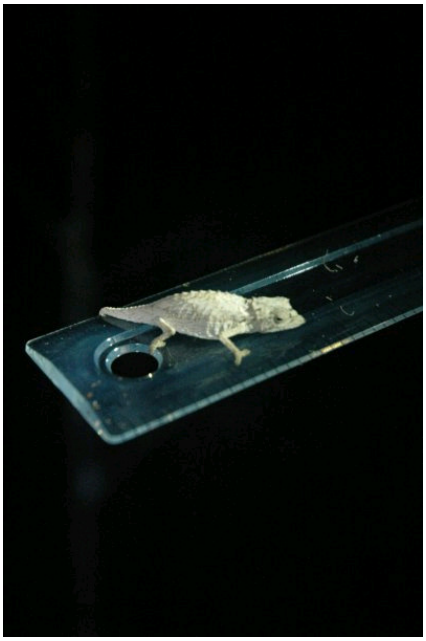
## Photo Gallery

*Furcifer oustaleti* juvenile at night (left) and in the day (right)



*Brookesia nasus* the species we found most of

Measuring tree diameters (left) and taking in a transect (right)