



FONDS FRANÇAIS POUR
L'ENVIRONNEMENT MONDIAL



PPI

Understanding the Remarkable Biodiversity of Príncipe Island – Scientific Report



Project Team: Frazer Sinclair, Yodiney Dos Santos, Ayres Pedronho, Aramis Andrade, Davide Dias, and Roldeney Fernandes.

Report prepared by Frazer Sinclair, Fauna & Flora International, October 2019.

For further information contact: info@fundacaoprincipe.org, or frazer_sinclair@yahoo.co.uk

How to cite this document:

Fundação Príncipe. (2019) *Understanding the Remarkable Biodiversity of Príncipe Island – Scientific Report*. Fundação Príncipe, Santo Antonio, Príncipe Island, www.fundacaoprincipe.org.

Summary

Príncipe is home to a diversity of unique fauna and flora including globally threatened species such as the Critically Endangered Príncipe Thrush (*Turdus xanthorhynchus*) and the Vulnerable Obô Snail (*Archachatina bicarinata*). The implementation of conservation plans in Príncipe has previously been impeded by a lack of capacity and resources. Our project – *Understanding the Remarkable Biodiversity of Príncipe Island* – has built local capacity and implemented priority actions from existing conservation plans through the completion of a series of biological and social field surveys. These included an island wide survey of bird species using a point-count method; camera trap and nesting surveys to examine threats to the Príncipe Thrush; sampling of terrestrial molluscs at 10 sites across the island; & a questionnaire based survey of 14 communities to examine forest resource use and knowledge of the Obô Snail. Key findings included:

- An inventory of 32 bird species, with distribution models produced for 20 of these
- Confirmation of a March-July breeding period for the Príncipe thrush
- Camera trap images of non-native mammal species within the Parque Natural do Príncipe, including feral cats, dogs, African civets, Mona monkeys, and black rats.
- An inventory of 29 terrestrial mollusc species, including 6 species that are new to science
- Evidence for severe reduction in range and population size of the Obô Snail over the past 20 years
- Ranking of forest resource use activities by their importance for community wellbeing

In the near future, these results shall support the development of a conservation action plan for the Obô Snail; inform updates to the Príncipe Thrush Action Plan and the Parque Natural do Príncipe Management Plan; and contribute to Red List re-assessments for birds and molluscs.

Contents

Summary	2
Introduction	3
Methods.....	4
Bird surveys.....	4
Opportunistic encounters	5
Camera trapping and nesting surveys	5
Mollusc sampling	5
Questionnaires.....	5
Results.....	6
Bird Surveys.....	6
Príncipe Thrush	11
Obô Snail	15
African Giant Snail.....	18
Other terrestrial molluscs	18
Forest Resource Activities.....	20

Discussion:	25
Threatened species:.....	25
Protected areas.....	27
Future priorities:	30
Acknowledgements.....	31
Grievance Mechanism	31
References	32

Introduction

The Island of Príncipe in the Gulf of Guinea has a remarkably high degree of endemism of terrestrial fauna and flora. The Island was designated as a UNESCO Biosphere reserve in 2012, and its forests are also an Important Bird Area, and part of the Guinean Forests of West Africa Hotspot. Much of the remaining native forest is protected within the Parque Natural do Príncipe (PNP) in the south of the Island.

At least 8 of Príncipe’s birds and 18 of its previously reported terrestrial mollusc species are single island endemics. Its threatened species include the Critically Endangered Príncipe Thrush (*Turdus xanthorhynchus*, Birdlife International, 2018a; Dallimer et al, 2010), the Endangered Príncipe White-eye (*Zosterops ficedulinus*, Birdlife International 2018), the Endangered Grey Parrot (*Psittacus erithacus*, BirdLife International, 2018), and the Vulnerable Obô Snail (*Archachatina bicarinata*, Clarke & Naggs, 1996; Dallimer & Melo, 2010). Of these, the Príncipe Thrush is the only species with a Conservation Action Plan (BirdLife International, 2014), but the implementation of this was initially impeded by a lack of local capacity and resources. Similarly, the PNP has an existing Management Plan (for the period 2015-2020, Albuquerque & Carvalho, 2015), but implementation has been limited by lack of capacity, particularly in terms of conducting biodiversity surveys and monitoring.

The current project grew from the need to develop local capacity for conservation, and improve the implementation of conservation plans. The goals were fourfold:

1. To strengthen local capacity for implementing conservation actions, particularly relating to conducting biological field surveys and species monitoring
2. To improve understanding of the diversity and distributions of Príncipe’s bird and terrestrial mollusc species, particularly within the PNP and thus contributing to the update of its management plan
3. To improve understanding of threats to biodiversity in Príncipe, particularly those affecting the Príncipe Thrush and Obô Snail
4. To generate updated information on the ecology, distribution, and population size/trends for the Príncipe Thrush and Obô Snail, to support conservation action planning and updates to their Red List status.

To achieve this, from June 2018 to September 2019 our team of project staff from Fundação Príncipe, local eco-guides, and PNP technicians, carried out a series of ecological and social surveys. The focus was on birds and terrestrial molluscs, particularly the Príncipe Thrush and the Obô Snail. Training in

field methods was provided by international experts, and technical support throughout was contributed through the partnership between Fundação Príncipe and Fauna & Flora International.

In this report, we describe our methods and results and discuss their relevance for biodiversity conservation in Príncipe. It is envisioned that the information herein shall inform conservation stakeholders in Príncipe – and the wider scientific community – and enable more effective conservation of Príncipe’s remarkable biodiversity.

Methods

Bird surveys

To assess the diversity and distribution of birds in Príncipe we used a point count method, whereby our surveyors established fixed point locations and recorded all birds seen or heard for a period of 10 minutes. The island was divided into 1km² quadrats, based on the Universal Transverse Mercator grid system, and between July 2018 and March 2019, five point-counts were carried out within each quadrat. Counts took place throughout the day (between 6 am and 6 pm), but not during periods of heavy rainfall. Point locations were at least 200m apart to avoid resampling of the same birds, and were positioned so as to be broadly representative of the types of habitats present within the quadrat. Any quadrats where it was not possible to fit 5 points were discarded.

Species distributions were predicted using maximum entropy models with MaxEnt software (Phillips et al, n.d.). The models were based on presence/absence within point counts, and were completed for all species that were present at 10 or more points. The following environmental variables were included in the models, either in their linear form (for species with 10-50 presences), or in both linear and quadratic forms (species with >50 presences):

- Altitude – based on a NASA’s SRTM Digital Elevation Model
- Distance to coast
- Rainfall – based on a 30 years of compiled dataset
- Remoteness – based on population density from 2012 census
- Slope - calculated from the Digital Elevation Model
- Topography - Index with 5 levels based on the mean elevation of pixels within a 250 meters radius (flat areas (1), valleys (2), middle slope (3), upper slope (4), ridges (5)).
- Land use – classification with 4 levels (Native forest, Secondary forest, Shade plantation, and Non-forest), derived from botanic field data, historic maps, and current satellite imagery.

To evaluate performance, we performed 20 cross-validation runs for each model and derived the area under the models averaged receiver operating characteristic curve (AUC). This metric was considered to give a rough indication of predictive accuracy, with higher AUC’s indicating that a model can better distinguish between presences and absences in test datasets.

To allow for population estimates, further point counts were conducted during June-July 2019, across a range of habitats, during which only birds present at the start of the count were included, and the distance between the surveyor and all birds was estimated. Two methods for population estimation were applied; the first followed Equation 1, based on numbers of birds within and beyond a 20m radius of the point; the second was based on distance bands and detectability thresholds. More detailed descriptions of the analytical methods for distribution modeling and population estimation are available via the Fundação Príncipe website, or upon request from the author.

$$\hat{D} = \frac{\left\{ (n_1 + n_2) \log_e \left[\frac{(n_1 + n_2)}{n_2} \right] \right\}}{\pi k Z^2}$$

Equation 1. Estimation of density (\hat{D}) based on two zones around a point, where the first zone is a circle of radius Z and the second zone is everything beyond Z , n_1 is the number of animals detected in the first zone, n_2 is the number of animals detected in the second zone, and k is the number of points.

Opportunistic encounters

For the Príncipe Thrush and Obô snail, the project team recorded the GPS location of all encounters during fieldwork. For the Obô snail, this included both live individuals and empty shells. For the Príncipe Thrush, new observations were added to a database of all known records from 2007 onwards. Distributions were predicted using MaxEnt as described above, using the recorded encounters and as presences, and any point count locations where the species were not recorded as absences. The presence or absence of live individuals of the invasive African Giant Snail (*Archachatina marginata*) within each 1km² quadrat was also recorded.

Camera trapping and nesting surveys

Little is known about the breeding behaviour of the Príncipe Thrush, but it potentially has two breeding periods per year – one during September-December, based on knowledge of other species in Príncipe and the closely related São Tomé Thrush; and one during March-June, based on a record from April 2015 (with photo) of a bird on its nest within a tree hole. To assess potential threats during the breeding period, sites where the thrush was consistently present were identified and camera traps (Bushnell E3 model, 2-3 per site) were attached to trees close to ground level. They were left in place from March-June 2019 and were checked at 2-week intervals. Animals within the images were identified by experienced local surveyors, and the number of records of each species was tallied. Multiple images of a single species at the same trap during any 1 hour period were considered duplicates and only counted as one record. Also during this period, surveyors attempted to find and follow adult thrush, recording any breeding behaviours, and placing additional camera traps at any accessible nests. Potential nesting sites that could not be accessed from the ground were examined using a drone (Mavic Air™).

Mollusc sampling

To assess the diversity of terrestrial molluscs, accessible sites covering a range of habitats were selected and sampled between December 2018 and June 2019. For each sample, teams of 1-6 surveyors spent 1-2 hrs actively searching for molluscs, paying particular attention to stems and leaves of accessible plants; undersides of fallen leaves, rocks, and decaying logs; rock faces with moss and/or trickling water; and crevices in tree bark. At most sites, one or more 5-litre bags were filled with leaf litter, which was dried and then sieved through a fine mesh (0.5 mm aperture). The resulting ‘fines’ caught by the mesh were then examined under a microscope. Mollusc specimens were drowned in water, preserved in 80% ethanol, and sent to specialists for identification.

Questionnaires

During December 2018 to February 2019, the project team conducted focal groups with mixed groups of men and women in 14 communities around the Parque Natural do Príncipe (PNP). Groups were presented with a list of 18 forest resource-based activities – identified through earlier scoping

exercises – and were asked “to what extent is this activity important for the community”, using the following scale: not present (0), not important (1), not very important (2), important (3), very important (4), essential (5). For activities with a score of 1 or more, groups were then asked: “what is the maximum distance that the community goes into the forest for this activity”.

Following the focal groups, the project team conducted individual questionnaires with men and women (~10 per community) that were involved in one or more of the community’s forest resource use activities. Participants were asked about which activities they were involved in, and how far they travelled (i.e. as validation for the focal group questions). They were then shown an image of the Obô Snail and asked if they could recognise and name it. Those who answered positively were given a series of follow up questions, including whether they thought there were more or less than in the past; when changes had occurred and what caused them; and where it could be found now and in the past.

Results

Bird Surveys

During the initial phase of field surveys, 760 point counts were conducted across 152 1km² quadrats, and 13492 birds were recorded from 32 species (Table 1). All species were previously known from the island and most could be confidently identified by sight and sound. The only exceptions were the Príncipe Starling (*Lamprotornis ornatus*) and Splendid Starling (*L. splendidus*), which could not be distinguished without a clear view of upper wings, and so were often grouped as *Lamprotornis* sp.

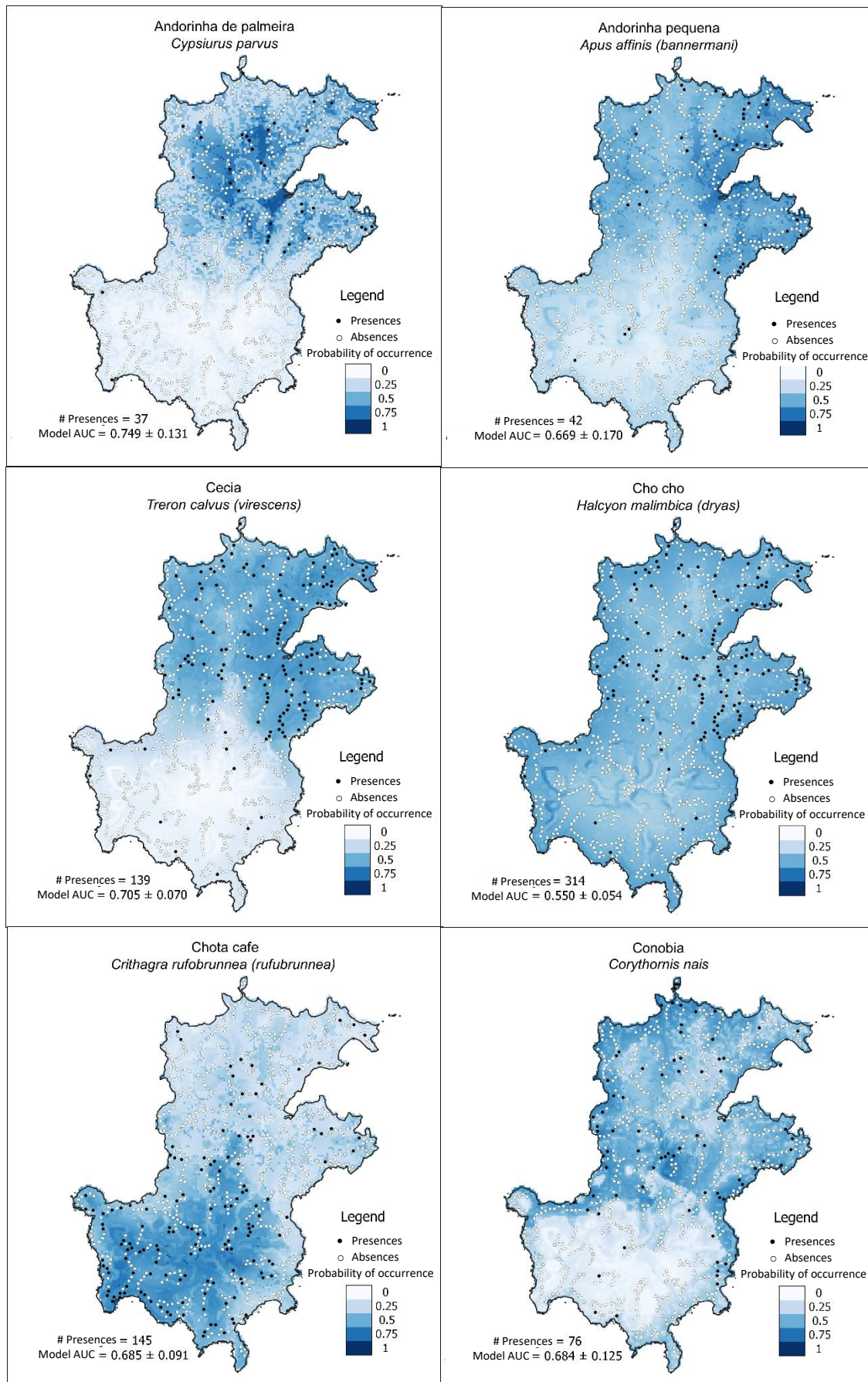
Distribution models were produced for 20 species (Figure 1) and indicated that most were more likely to occur in the northern part of the island. The only exceptions were Dohrns Thrush Babbler and the Grey Parrot, which occurred more or less evenly throughout, and the Príncipe seedeater that was most likely to occur within native forest areas in the south of the island.

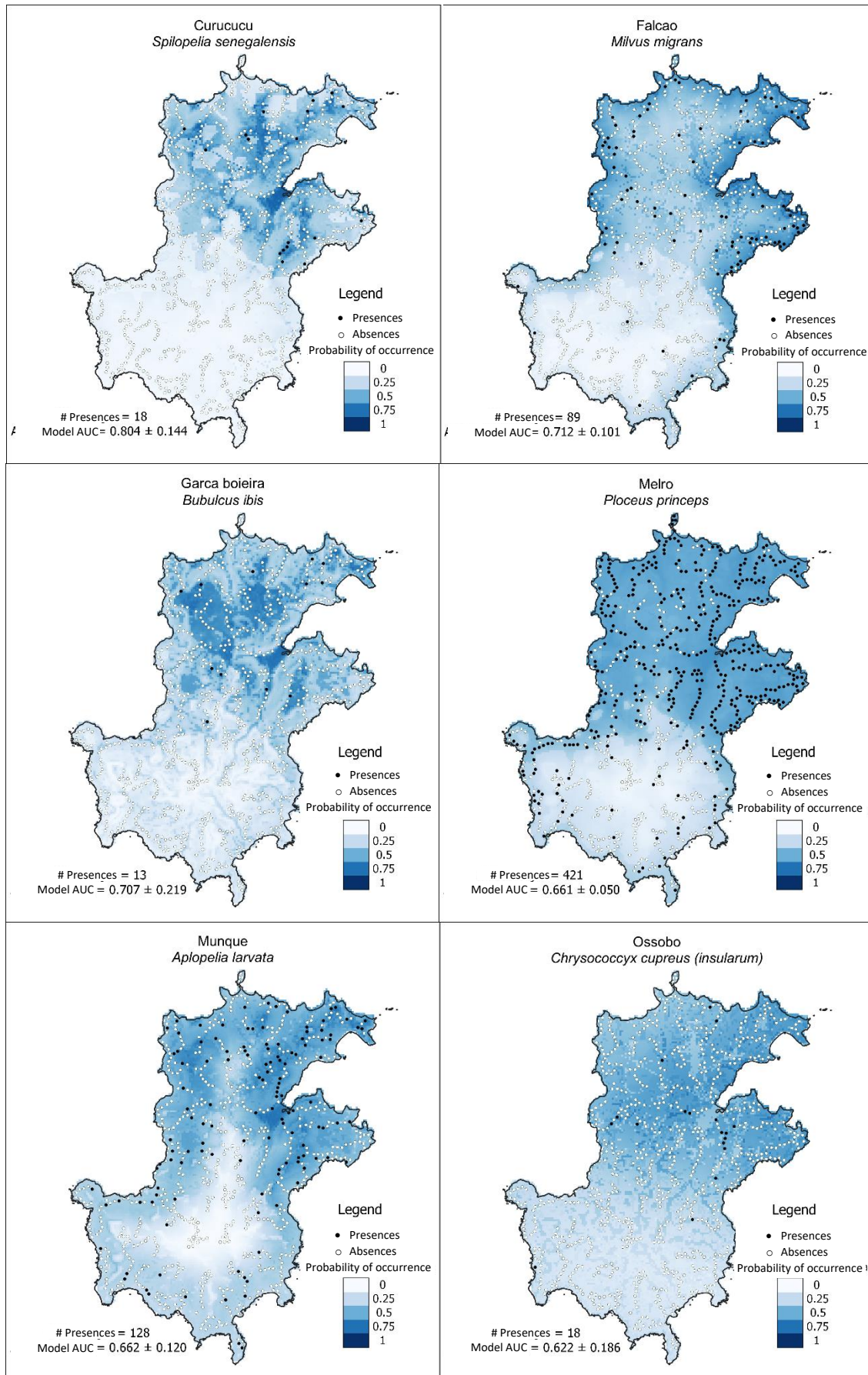
During the second phase of field surveys, 173 point counts were conducted, and distances were measured for 1169 birds from 28 species. Estimation Method 1 – based on numbers of birds within two zones - was considered inapplicable for all but the most common species, as it would tend to underestimate densities unless one or more birds were recorded from both zones within each forest type. Estimation method 2 was more widely applicable, as for rare species it used detectability thresholds from comparable species. Populations could be estimated with at least one method for 12 of the species (Table 1), and estimates ranged from 884 for the São Tomé Bronze-Naped Pigeon, to 34852-39801 for Dohrns Thrush Babbler.

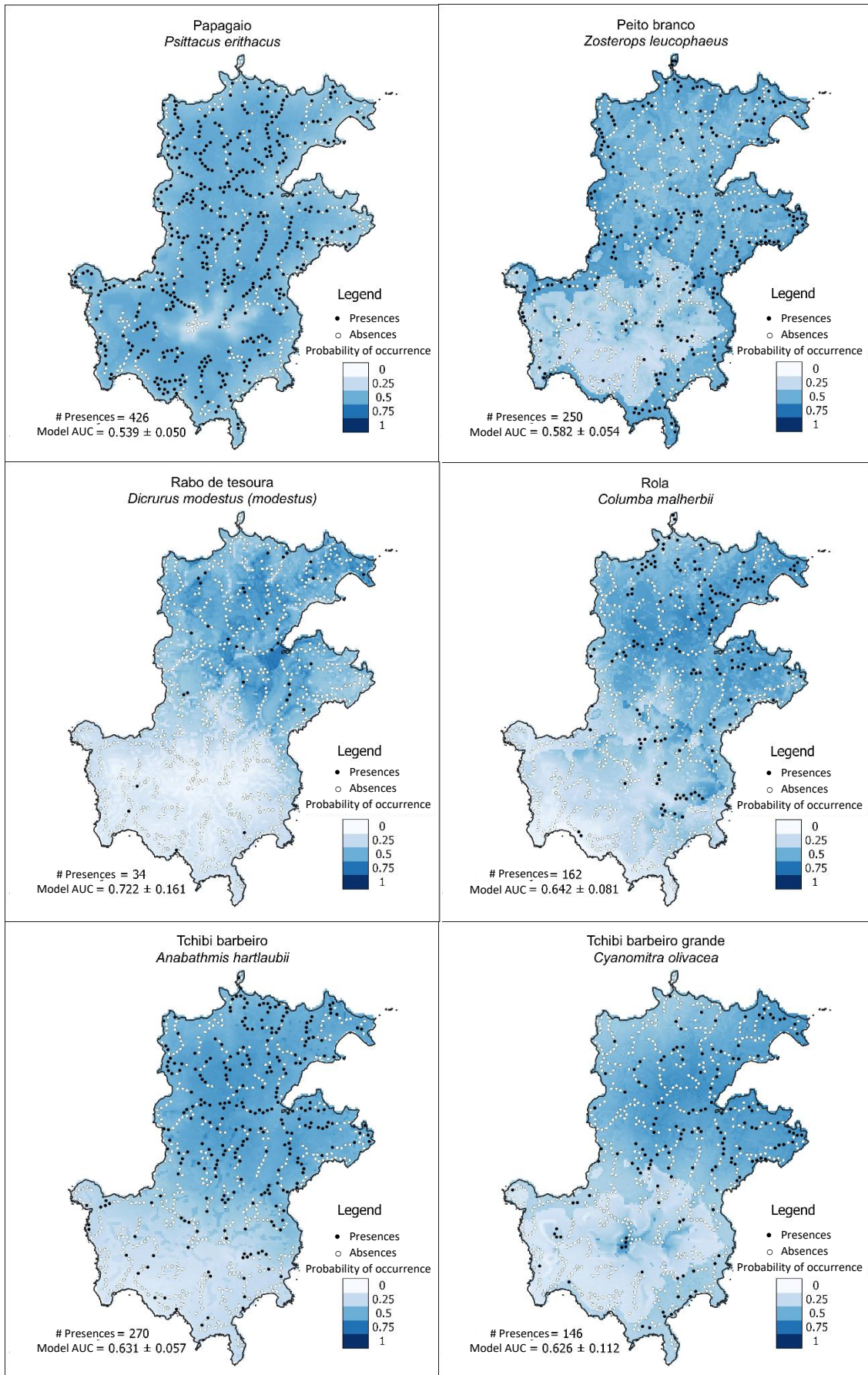
Table 1. List of bird species recorded during initial 760 point-counts, with their current Red List status, the total number of individuals recorded, the percentage of points in which they were present, and the estimated population size (where applicable). An * in the % of points column indicates species where there were sufficient presences to produce a distribution model. Superscripts following the scientific name indicate that a species or subspecies is endemic to islands in the Gulf of Guinea, where ^P is Príncipe, ^{STP} is both São Tomé & Príncipe, and ^A is Annobón.

Local name	English name	Scientific name	Red list status	Number	% of points	Population
Andorinha de barriga branca	São Tomé spinetail	<i>Zoonavena thomensis</i> ^{STP}	LC	60	0.66	NA / NA
Andorinha de palmeira	Palm swift	<i>Cypsiurus parvus</i>	LC	134	4.87 *	NA / NA
Andorinha pequena	Little swift	<i>Apus affinis (bannermani</i> ^{STP})	LC	198	5.53*	NA / NA

Cécia	African green pigeon	<i>Treron calvus (virescens^P)</i>	LC	358	18.29*	5449 / 6633
Cho Chó	Blue-breasted kingfisher	<i>Halcyon malimbica (dryas)</i>	LC	499	41.32*	2890 / 2432
Chota café	Príncipe seedeater	<i>Crithagra rufobrunnea^{STP} (rufobrunnea^P)</i>	LC	224	19.08*	NA / 941
Conóbia	Príncipe Malachite kingfisher	<i>Corythornis nais^P</i>	LC	119	10.00*	NA / 1327
Curucucu	Laughing dove	<i>Spilopelia senegalensis</i>	LC	26	2.37*	NA / NA
Estorinho bobo	Splendid starling	<i>Lamprotornis splendidus</i>	LC	376	15.00	NA / NA
Estorinho do Príncipe	Príncipe starling	<i>Lamprotornis ornatus^P</i>	LC	32	2.63	NA / NA
Estorinho sp.	Starling sp.	<i>Lamprotornis sp.</i>	-	2606	80.66	NA / NA
Falcão	Black kite	<i>Milvus migrans</i>	LC	132	11.71*	NA / NA
Galinha dagua	Moorhen	<i>Gallinula chloropus</i>	LC	1	0.13	NA / NA
Garça boieira	Cattle egret	<i>Bubulcus ibis</i>	LC	15	1.71*	NA / NA
Garça dos recifes	Western reef heron	<i>Egretta gularis</i>	LC	2	0.26	NA / NA
Melro	Príncipe golden weaver	<i>Ploceus princeps^P</i>	LC	1628	55.39*	24144 / 19663
Muquê	Lemon dove	<i>Aplopelia larvata (principalis^P)</i>	LC	173	16.84*	20026 / 11277
Negrinha	Chestnut-breasted nigríta	<i>Nigrita bicolor</i>	LC	11	0.66	NA / NA
Ossobô	African emerald cuckoo	<i>Chrysococcyx cupreus (insularum^{STP})</i>	LC	18	2.37*	NA / NA
Papa tela grande	Whimbrel	<i>Numenius phaeopus</i>	LC	1	0.13	NA / NA
Papa tela pequeno	Common sandpiper	<i>Actitis hypoleucos</i>	LC	2	0.13	NA / NA
Papagaio	Grey parrot	<i>Psittacus erithacus</i>	EN	1612	56.05*	NA / NA
Peito branco	Príncipe speirops	<i>Zosterops leucophaeus^P</i>	NT	1017	32.89*	35907 / 34494
Quebra cana	Common waxbill	<i>Estrilda astrild</i>	LC	11	0.39	NA / NA
Rabo de tesoura	Velvet-mantled drongo	<i>Dicrurus modestus (modestus^P)</i>	LC	40	4.47*	NA / NA
Rola	São Tomé bronze-naped pigeon	<i>Columba malherbii^{STP & A}</i>	NT	363	21.32*	NA / 884
Tchibi barbeiro	Príncipe sunbird	<i>Anabathmis hartlaubii^P</i>	LC	482	35.53*	12984 / 8815
Tchibi barbeiro grande	Olive sunbird	<i>Cyanomitra olivacea</i>	LC	197	19.21*	NA / 1327
Tchibi fixa	Dohrn's thrush babbler	<i>Sylvia dohrni^P</i>	LC	3090	91.71*	34852 / 39801
Tchibi singa	Bronze mannikin	<i>Spermestes cucullata (cucullata)</i>	LC	39	2.11*	NA / NA
Tchibi tete	Príncipe white-eye	<i>Zosterops ficedulinus^P</i>	EN	22	1.18	NA / 3052
Tchonzu	Striated heron	<i>Butorides striata</i>	LC	1	0.13	NA / NA
Tordo do Príncipe	Príncipe Thrush	<i>Turdus xanthorhynchus^P</i>	CE	3	0.39	NA / NA







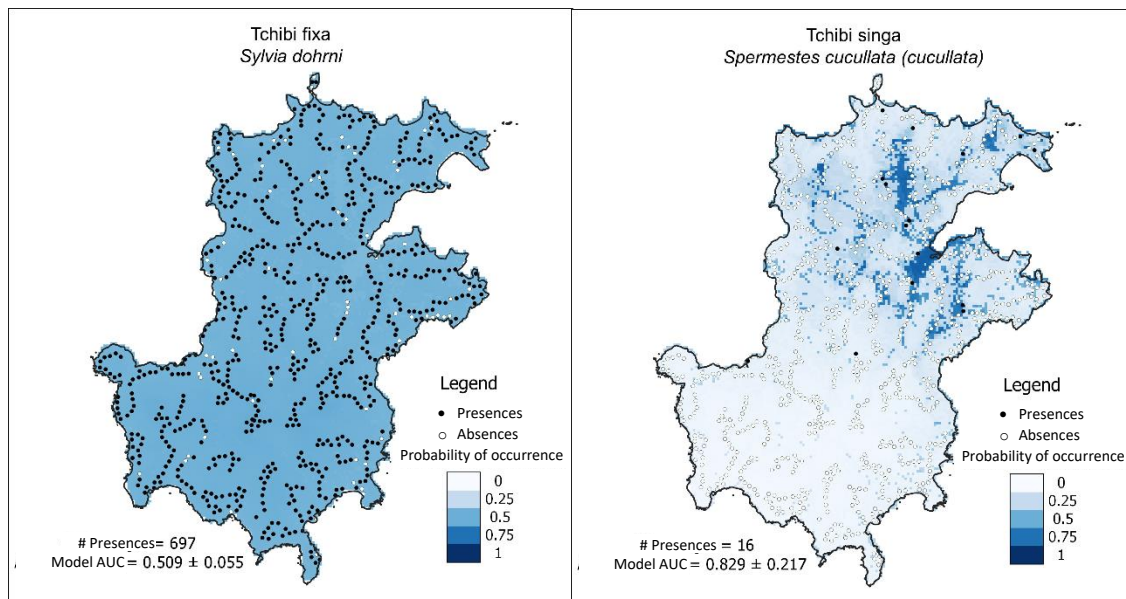


Figure 1. Maps of distribution models for bird species that were present in at least 10 point count locations, showing all point-count locations and indicating presence or absence. Pixels are $\sim 92.5\text{m}^2$ and are coloured to represent the probability of occurrence. Model AUCs are included, with standard deviations.

Príncipe Thrush

During July 2018 to July 2019, a total of 71 Príncipe Thrush were encountered across 59 recording instances. These were combined with a further 87 records, reported from various sources during 2007-2018. The current extent of occurrence for the species was derived by drawing a polygon around all the records and then cropping to remove any areas beyond the coastline of the island. The resulting polygon had an area of 3982.47 Ha (Figure 2).

We modeled distribution based on all records (Figure 2), after pruning so that there was no more than one record per pixel ($\sim 92.5\text{m}^2$). The model's AUC value of 0.835 (± 0.49) indicated good predictive accuracy, with Land-use, Remoteness, and Rainfall as the most important explanatory variables. Occurrence is limited to the south of the island, with the highest probability in areas of remote native forest with high rainfall.

We identified 3 sites where adult thrush were consistently present (Figure 3). Camera trapping at these sites revealed several introduced mammal species (Table 2 and Figure 4), including potential nest predators (black rat *Rattus rattus* and Mona monkey *Cercopithecus mona*), and potential active predators (feral cats *Felis catus*, dogs *Canis lupus familiaris*, and African civets *Civettictis civetta*). The least remote site – Morro de Leste – had all five threat species, followed by João Dias Pai e Filho (rats, monkeys, & cats), and Pico Príncipe (only rats). Other species captured by the traps included the Príncipe Thrush (all sites), the lemon dove (*Aplopelia larvata principalis*, at Morro de Leste & João Dias Pai e Filho), and the endemic Príncipe shrew (*Crociodura fingui*, Pico Príncipe only).

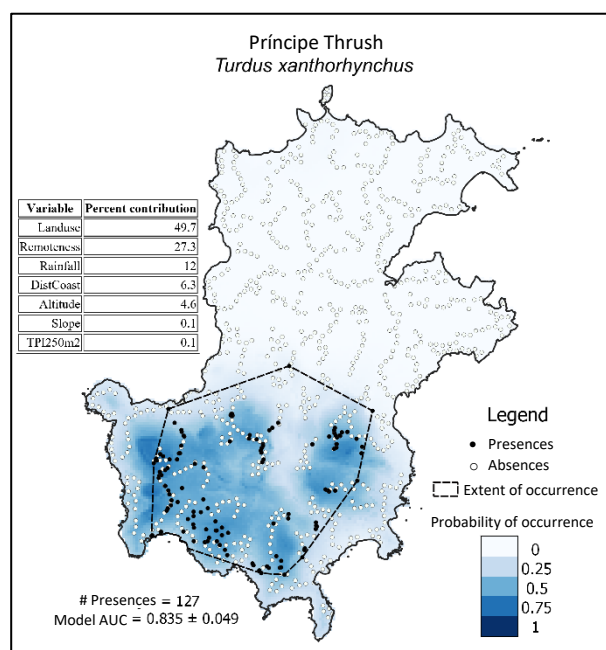


Figure 2. Map of distribution model for the Príncipe Thrush, where presences are based on all known records, and absences are based on point count locations where the species was not recorded. Includes a table with estimates of the relative contribution of environmental variables to the MaxEnt model. Pixel size, colour, and AUC follow figure 1.

Adult thrush were encountered repeatedly at all sites, and several observations of breeding behaviour were recorded (Table 3). Notably, at the João Dias Pai e Filho site, two adult thrush were observed carrying foliage into two holes high in a dead tree during late March, but subsequent inspection of the holes using a drone did not reveal active nests (Figure 5), and no further activity at the holes was observed on numerous subsequent visits. However, at the same site two birds were observed at a nest in late June 2019, approximately 5m from the ground, on a shelf within a shallow depression on a rock-face (Figure 5). It consisted of a wide shallow circular cup, approximately 20cm wide and 3cm deep, woven from moss and plant roots. A further fresh-looking nest cup was found on the ground beneath the ledge (Figure 5). A camera trap was positioned near to the nest using a long pole, and captured images of at least 2 thrushes entering frequently until mid-July, when they appear to have abandoned the nest without laying eggs, returning only occasionally thereafter (Figures 4 & 5). The camera trap was maintained until early September, but the last captured visit was on August 8th.

Table 2. Records of animals appearing at camera traps during March-June 2019. Within the ‘No of camera traps’ column the total number of trapping days is included within parentheses. Introduced mammal species that are potential threats to native biodiversity are shaded grey.

Site	No of camera traps	No of observations							
		Dog	Cat	African Civet	Mona monkey	Rat	Príncipe Thrush	Lemon dove	Príncipe Shrew
Morro de Leste	3 (287)	1	2	3	25	41	8	54	0
João Dias Pai e Filho	2 (180)	0	1	0	5	29	7	11	0
Pico Príncipe	2 (162)	0	0	0	0	10	5	0	8

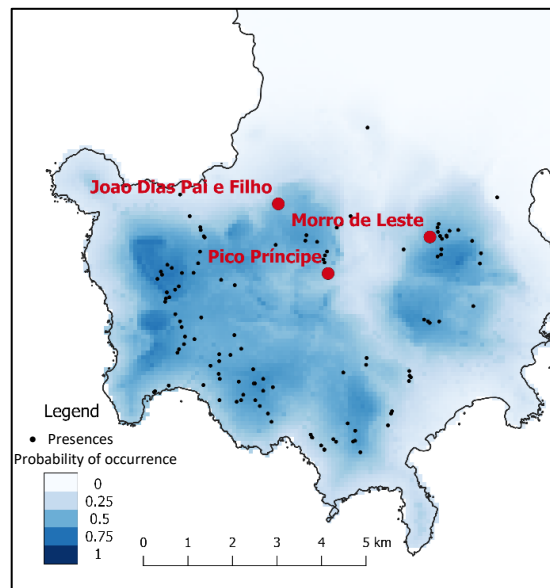


Figure 3. Location of camera trap sites, with all Príncipe Thrush records, and distribution model from Figure 2.

Table 3. Descriptions of Príncipe Thrush breeding behaviour observed in the field during March-August 2019

Site	Date	Time	Description
João Dias Pai e Filho	26/03/2019	~ 17:00	Two adult thrush observed carrying moss and other small foliage into two holes in the trunk of a dead standing tree, approximately 15m above ground.
Morro de Leste	09/04/2019	~13:00	One adult thrush observed during 15 mins collecting mud and roots in its beak, but unable to determine the destination
Pico Príncipe	08/05/2019	~11:00	Group of five adult thrush observed from the trail below pico Príncipe. Two birds chased and fought with each other for nearly 1 hr before the group moved away
João Dias Pai e Filho	21/05/2019	~10:30	Two or three adult thrush observed repeatedly carrying material in beak, but unable to determine the destination. Two thrushes also observed attacking and chasing away a blue breasted kingfisher
João Dias Pai e Filho	25/06/2019	12:16	Adult thrush observed at a nest in a shallow depression on a rock face, approximately 5m above ground. Two other thrushes were seen perching in nearby trees and calling to one another. A camera trap was tied to a long pole and positioned near to the nest.

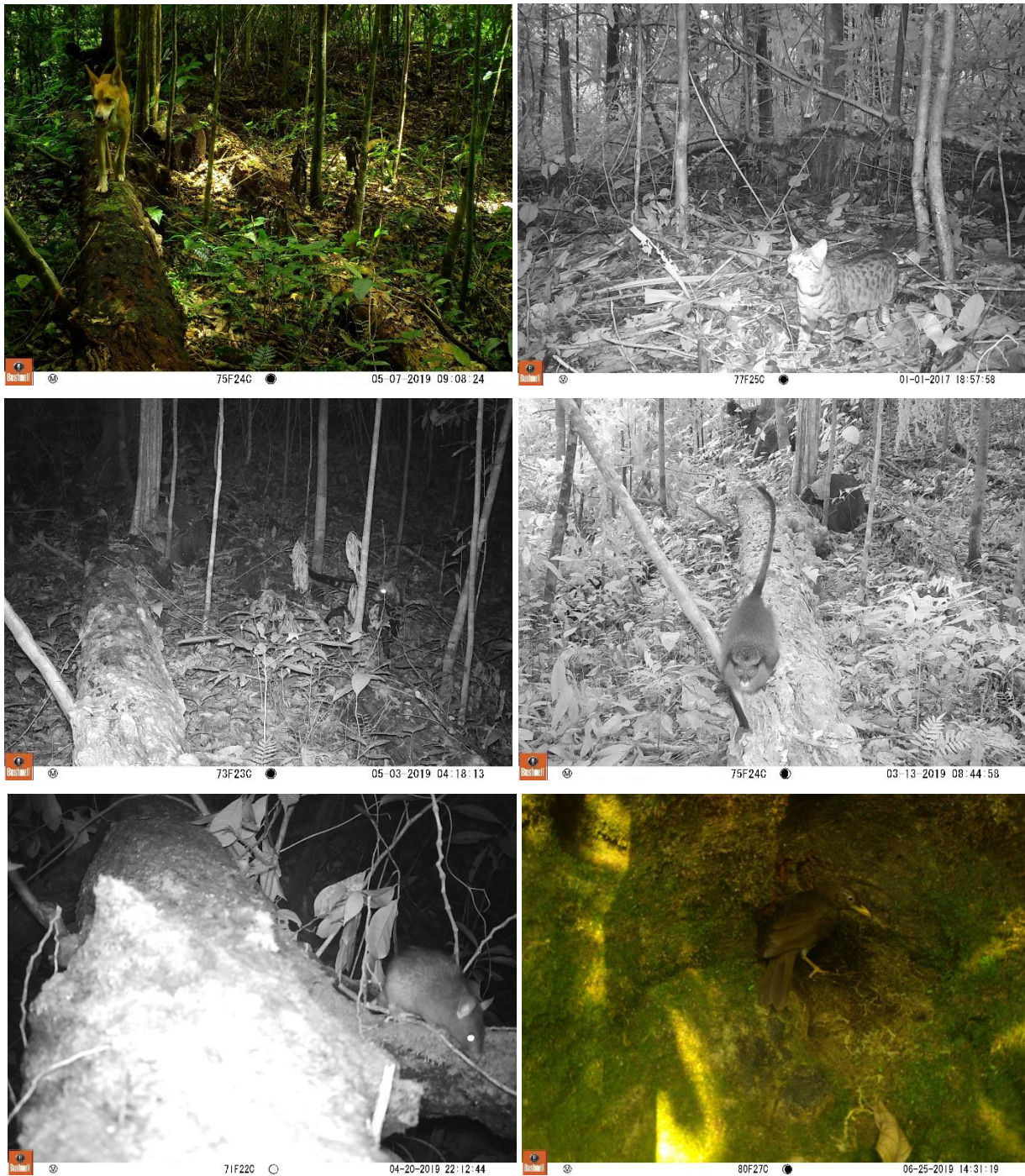


Figure 4. Camera trap images of: feral dog at Morro de Leste (top left); feral cat at João Dias Pai e Filho (top right); African civet at Morro de Leste (middle left); Mona monkey at Morro de Leste (middle right); black rat at Pico Príncipe (bottom left); and Príncipe Thrush on its nest at João Dias Pai e Filho (bottom right). Dates and times are shown at the bottom right of each image.



Figure 5. Images of: a Príncipe Thrush nesting site at João Dias Pai e Filho (left), with a camera trap in place; a Príncipe Thrush nest cup (top right) that was found on the ground beneath the nesting site in late June 2019; & a tree hole that was visited by thrush in late March 2019 (bottom right).

Obô Snail

During July 2018 to May 2019, a total of 598 Obô Snails records were made across 184 separate instances (concurrent records within a 20m radius were considered to be a single instance). Of these, 119 were alive, often occurring in clusters of two or more. In one instance, on a steep ridge in the south of the island, 24 live individuals were recorded together.

The current extent of occurrence for the Obô Snail in Príncipe was derived by drawing a polygon around all known records and then cropping to remove any areas beyond the coastline of the island. The resulting polygon had an area of 4695.57 Ha (Figure 6).

Separate distribution models were produced for all instances (live individuals and empty shells – Figure 6 left), and for instances with one or more live individuals (Figure 6 right). Both models had good predictive accuracy (AUC's of 0.800 ± 0.051 & 0.819 ± 0.074), with Land-use and Rainfall as the most important explanatory variables. Occurrence was restricted to the south of the Island, with the highest probability in native forests with high rainfall.

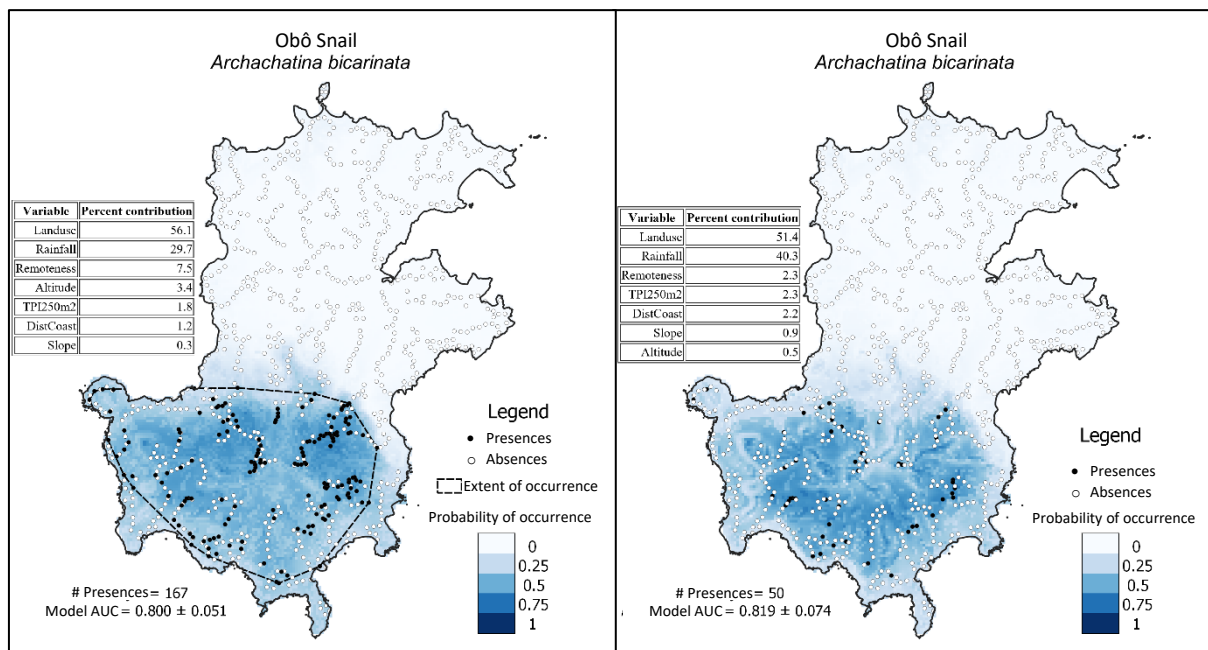


Figure 6. Maps of distribution models for the Obô snail, where presences are based on records (July 2018 to March 2019) of both live individuals and empty shells (left), and only live individuals (right), with absences based on point locations where the species was not recorded. Includes tables with estimates of the relative contribution of environmental variables to the MaxEnt models. Pixel size, colour, and AUC follow figure 1.

Individual questionnaires were conducted with 75 men and 63 women, and recognition of the Obô Snail was high throughout (~93% total, 94% & 93% respectively, Figure 7). The majority of these knowledgeable respondents reported that there were fewer Obô Snails than in the past (76%), and the most popular answers to follow up questions suggest that the decline began 5-10 years ago (46%), that more than 75% of the population has gone (44%), and that collecting by people is the main reason (27%).

Many of the knowledgeable respondents from the individual questionnaires (74%) identified areas where the Obô Snail has disappeared, and this information was compiled and mapped (Figure 8). Only areas that were identified by at least two respondents were retained in the map, and it was cropped to remove areas that overlapped with the current extent of occurrence. The identified area is continuous, covering much of the centre of the island, with an area of 3009.38 Ha. If accurate, this would represent a range reduction of approximately 40%.

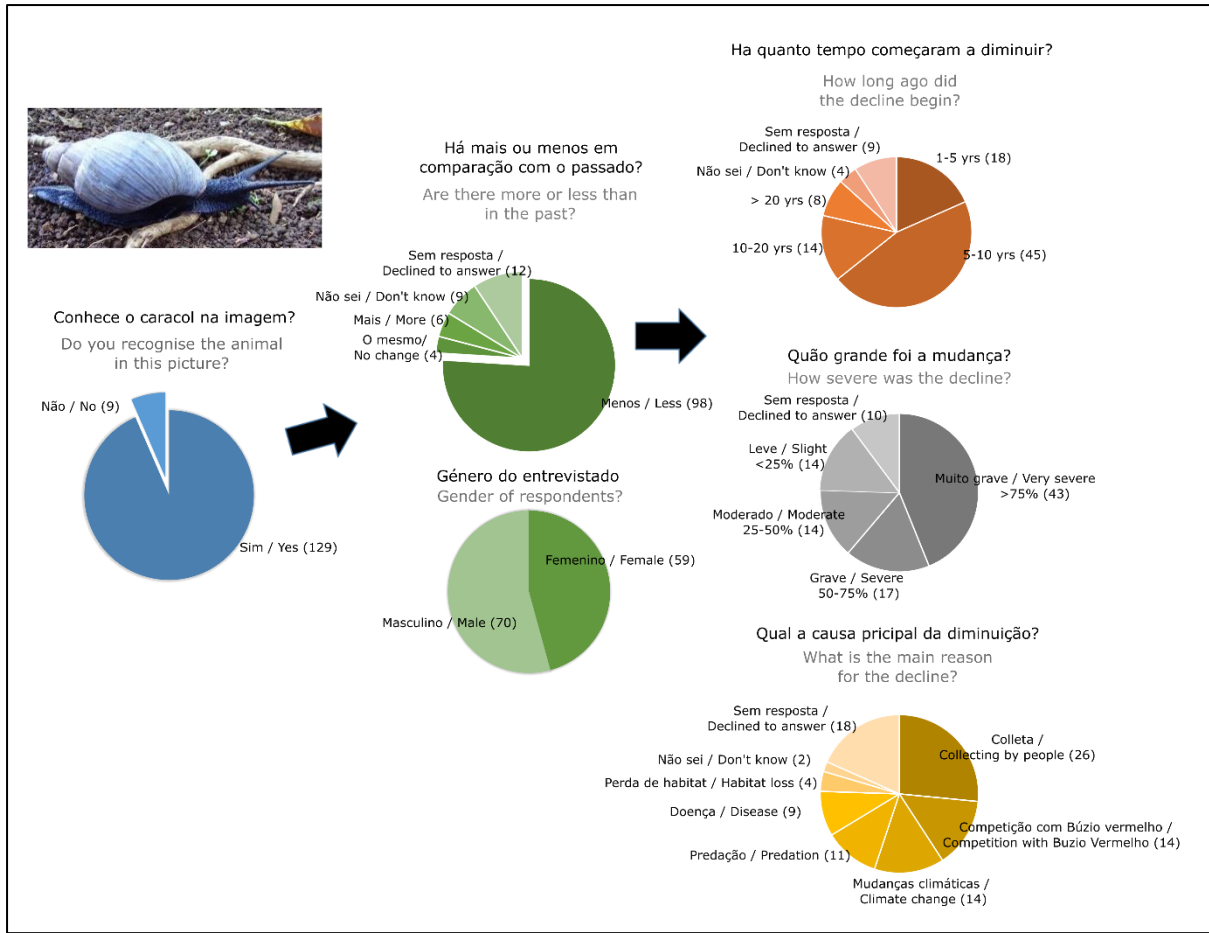


Figure 7. Pie charts indicating the proportions of responses to questions about the Obô snail. The number of respondents that gave each answer is included in parentheses.

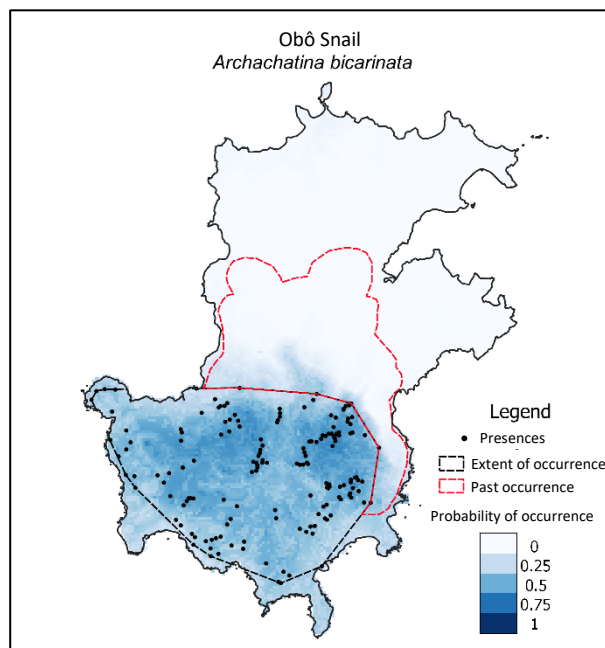


Figure 8. Map indicating the current extent of occurrence for the Obô snail, and the area from which it has disappeared based on responses to individual questionnaires. Includes distribution model and presences/absences from figure 3 (right), with pixel size, etc. following Figure 1.

A little less than half of the individual questionnaire respondents (42%) collected snails from forests. Of these, 60% answered that they would prefer to collect the Obô Snail – due to its larger size and superior flavour. However, all except 3 reported that they currently only collect the African Giant Snail, as it is easier to find. Reported collection sizes for Obô snails were 6, 30-40, & 450 per month, although further questioning revealed that this large number was only obtainable several years ago, and current collections were irregular and much lower. During questionnaires, it was also suggested that collecting of both Obô Snail and the African Giant Snail intensifies on occasions when traders from Nigeria arrive and buy up all available snails for salting and export.

African Giant Snail

African Giant Snails were recorded within 36 of the 152 1km² quadrats, forming a continuous zone through the centre and north of the island (Figure 9). Its recognition rate in individual questionnaires was 99% - slightly higher than for the Obô snail. Of these knowledgeable respondents, 75% reported that there are fewer African Giant Snails now than in the past.

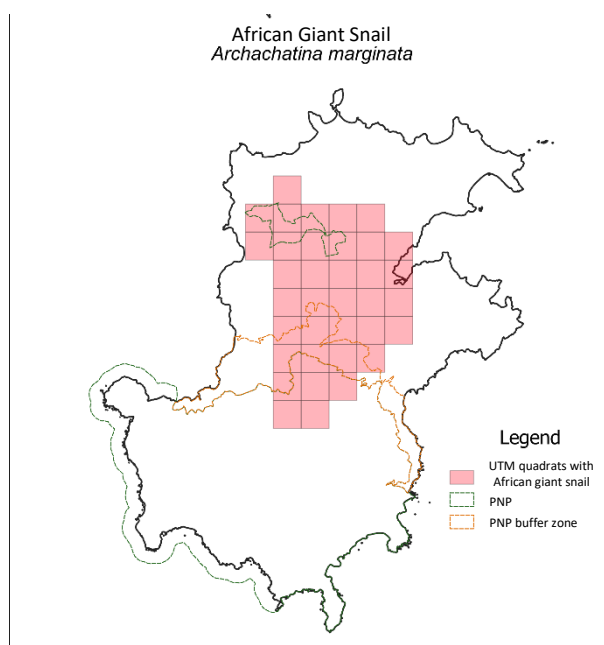


Figure 9. Map of Príncipe, indicating the 1km UTM grid-squares where the African Giant Snail was detected during the point count study (July 2018-March 2019).

Other terrestrial molluscs

Samples of terrestrial molluscs were collected from 10 sites, and a total of 29 species were recorded (Table 3). Of these, 21 were previously known from Príncipe, 2 were new records for the island, and 6 were new species for science. The continued presence of a further 16 previously documented species could not be confirmed. Formal descriptions of new species have been prepared in collaboration with expert taxonomists, and are awaiting publication (Holyoak et al, In prep.).

Table 4. List of the terrestrial mollusc species known from Príncipe, based on (Holyoak et al, In prep.), indicating the species whose presence was confirmed during the project, and the likely level of endemism.

Family	Scientific name	Presence confirmed?	Endemism
Cyclophoridae	Chondrocyclus sp. nov.	Sim / Yes	Príncipe
Truncatellidae	<i>Truncatella princeps</i> Dohrn, 1866		
Assimineidae	<i>Assiminea</i> sp.		
Ellobiidae	<i>Melampus flavus</i> Gmelin, 1791		
Ellobiidae	<i>Melampus pusillus</i> Gmelin, 1791		
Ellobiidae	<i>Pedipes</i> sp.		
Veronicellidae	<i>Laevicaulis alte</i> (A. Férussac, 1821)	Sim / Yes	
Veronicellidae	Pseudoveronicella sp. nov.	Sim / Yes	Príncipe
Veronicellidae	<i>Pseudoveronicella liberiana</i> (Gould, 1850)	Sim / Yes	
Veronicellidae	<i>Archachatina bicarinata</i> (Bruguière, 1792)	Sim / Yes	São Tomé & Príncipe
Veronicellidae	<i>Archachatina marginata</i> (Swainson, 1821)	Sim / Yes	
Veronicellidae	<i>Columna columna</i> (O.F. Müller, 1774)	Sim / Yes	Príncipe
Veronicellidae	<i>Columna hainesi</i> L. Pfeiffer, 1856		Príncipe
Veronicellidae	<i>Columna leai</i> Tryon, 1866	Sim / Yes	Príncipe
Veronicellidae	<i>Lignus alabaster</i> (Rang, 1831)	Sim / Yes	Príncipe
Veronicellidae	<i>Pseudoglessula fuscidula</i> (Morelet, 1858)		
Veronicellidae	<i>Striosubulina striatella</i> (Rang, 1831)	Sim / Yes	
Veronicellidae	<i>Subulina feai</i> Germain, 1912		Príncipe
Veronicellidae	<i>Subulina moreleti</i> Girard, 1893	Sim / Yes	Príncipe
Veronicellidae	<i>Subulina newtoni</i> Girard, 1893	Sim / Yes	Príncipe
Veronicellidae	<i>Bocageia lotophaga</i> (Morelet, 1848)		Príncipe
Veronicellidae	<i>Opeas dohrni</i> (Girard, 1893)		
Veronicellidae	<i>Opeas greeffi</i> (Girard, 1893)	Sim / Yes	Príncipe
Veronicellidae	<i>Opeas pauper</i> (Dohrn, 1866)		São Tomé & Príncipe
Veronicellidae	<i>Opeas subpauper</i> Germain, 1912		Príncipe
Veronicellidae	<i>Pseudopeas crossei</i> (Girard, 1893)	Sim / Yes	
Streptaxidae	Gulella sp. nov.	Sim / Yes	Príncipe
Streptaxidae	<i>Gulella crystallum</i> (Morelet, 1848)	Sim / Yes	Príncipe
Streptaxidae	<i>Gulella joubini</i> (Germain, 1912)		Príncipe
Streptaxidae	<i>Gulella sorghum</i> (Morelet, 1848)	Sim / Yes	Príncipe
Streptaxidae	Streptostele sp. nov.	Sim / Yes	Príncipe
Streptaxidae	<i>Streptostele fastigiata</i> (Morelet, 1848)	Sim / Yes	Príncipe
Streptaxidae	<i>Streptostele</i> (?) <i>feai</i> Germain, 1912		Príncipe
Streptaxidae	<i>Streptostele folini</i> (Morelet, 1858)	Sim / Yes	Príncipe
Streptaxidae	<i>Streptostele</i> (?) <i>moreletiana</i> Dohrn, 1866)		São Tomé & Príncipe
Succineidae	<i>Quickia concisa</i> (Morelet, 1848)	Sim / Yes	
Cerastidae	<i>Rachis burnayi</i> (Dohrn, 1866)	Sim / Yes	
Cerastidae	<i>Rachis eminulus</i> (Morelet, 1848)	Sim / Yes	
Euconulidae	<i>Afropunctum seminium</i> (Morelet, 1873)	Sim / Yes	
Urocyclidae	<i>Dendrolimax heyneimanni</i> Heyneimann, 1868	Sim / Yes	Príncipe
Urocyclidae	<i>Africanion dumeticola</i> (Dohrn, 1866)		
Urocyclidae	Principicochlea sp. nov.	Sim / Yes	Príncipe
Urocyclidae	<i>Principitrochoidea aglypta</i> (Dohrn, 1866)	Sim / Yes	Príncipe
Urocyclidae	Principitrochoidea sp. nov.	Sim / Yes	Príncipe
Urocyclidae	<i>Principitrochoidea folini</i> (Morelet, 1848)	Sim / Yes	

Species richness was greatest at sites that had a variety of forest types – e.g. native & secondary forest at Morro de Leste and Trilho de Santa Joquima; and secondary, agro, and non-forest at Estrada de Bela Vista (Figure 10). The proportions of non-native species within samples were highest at the more disturbed sites around the city and within the PNP buffer zone. The three most remote sites within the PNP – Pico Mesa, Pico Príncipe, and João Dias Pai e Filho – had few species, but these were all

endemics and included several new for science. The Floresta de Azeitona site also had a high proportion of endemic species, and included the sole record for one of the new species.

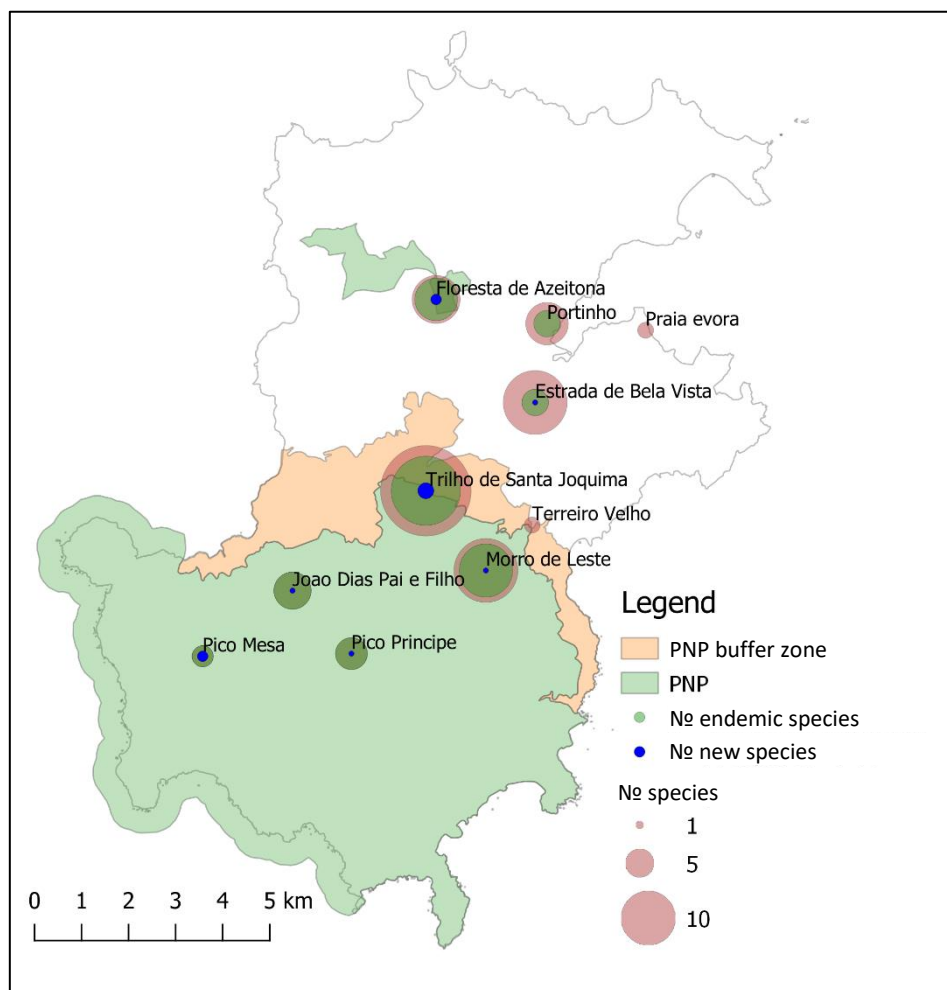


Figure 10. Map of mollusc sampling locations. The circles around sampling points are proportional in size to the total number of recorded species (red), the number of species that were country endemics (green), and the number of species that were new to science (blue).

Forest Resource Activities

Focal groups ranged in size from 8 to 19 people, and all except one included both men and women (Figure 11). Collecting fruit, collecting firewood, and extracting timber were identified as important activities for all communities (i.e. were scored as either essential, very important, or important – Figure 12). Snail collecting and hunting - which may directly impact the Obô Snail and/or Príncipe Thrush – were not scored as essential by any communities, and were of intermediate overall importance. In several cases, activities with intermediate or low overall importance were essential for particular communities – e.g. charcoal production was essential for São Joaquim; collecting rocks and gravel was essential for Abade, Monta Alegre, and Porto Real; river fishing was essential for Bela Vista; & collecting Pau Estera (*Pandanus thomensis*) was essential for Abade and Praia Seca.

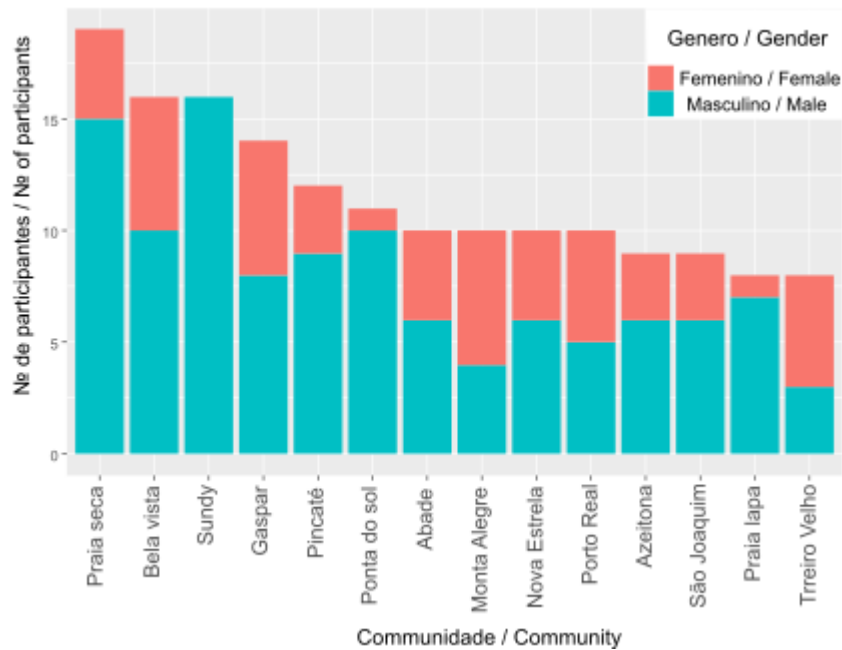


Figure 11. Number of men and women that participated in community focal groups about forest resource use.

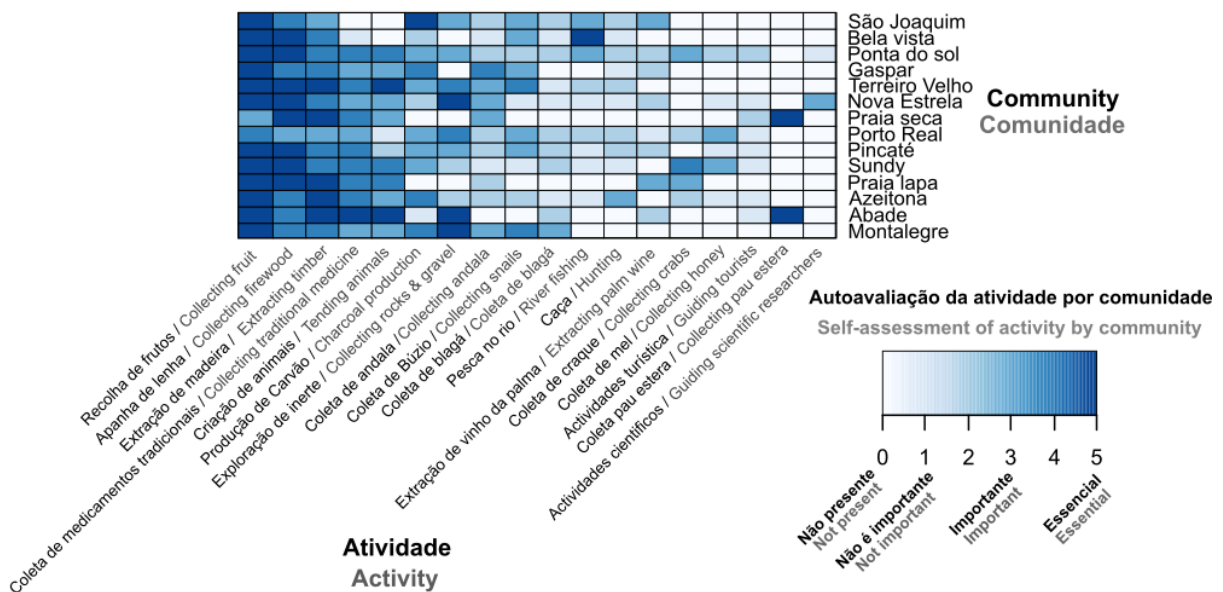
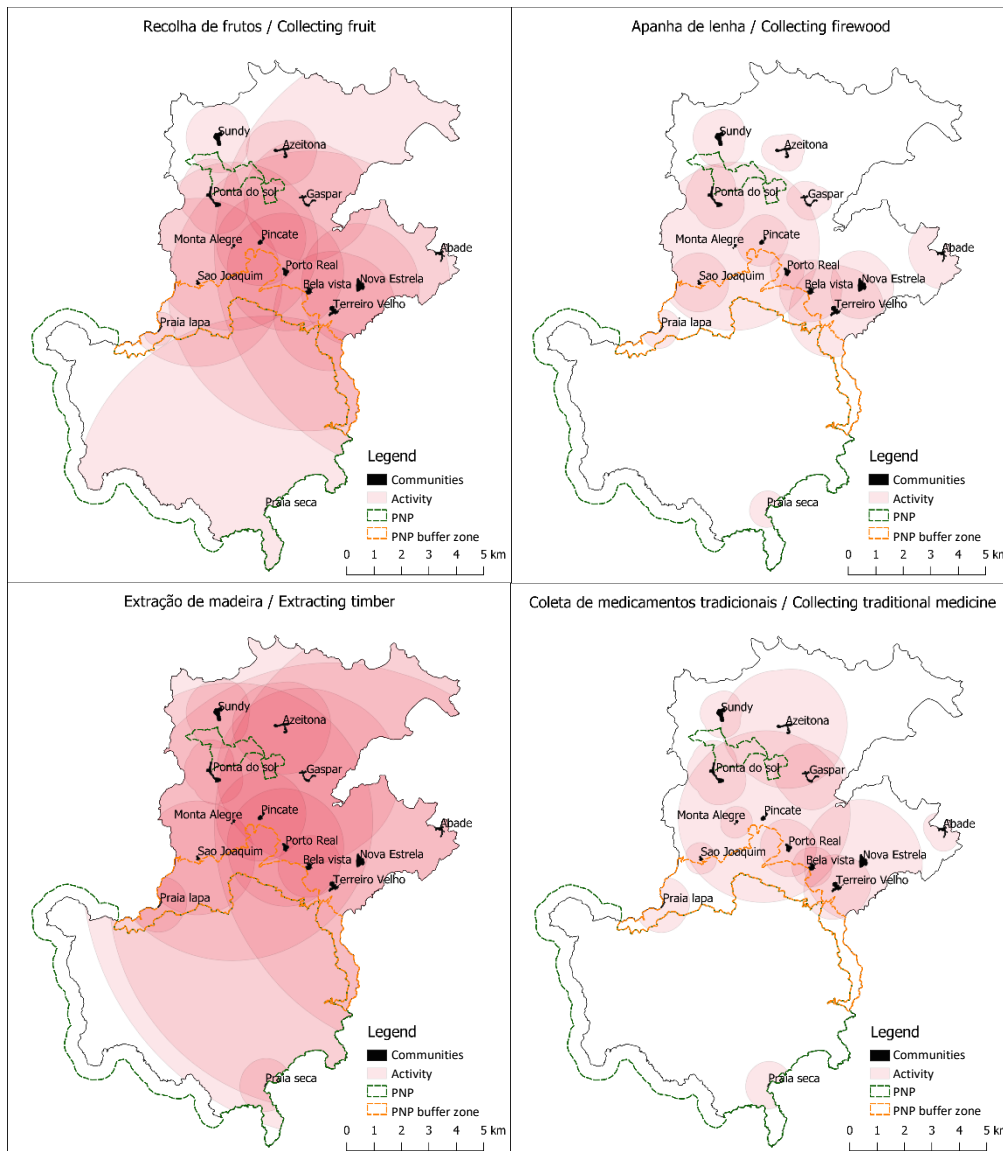
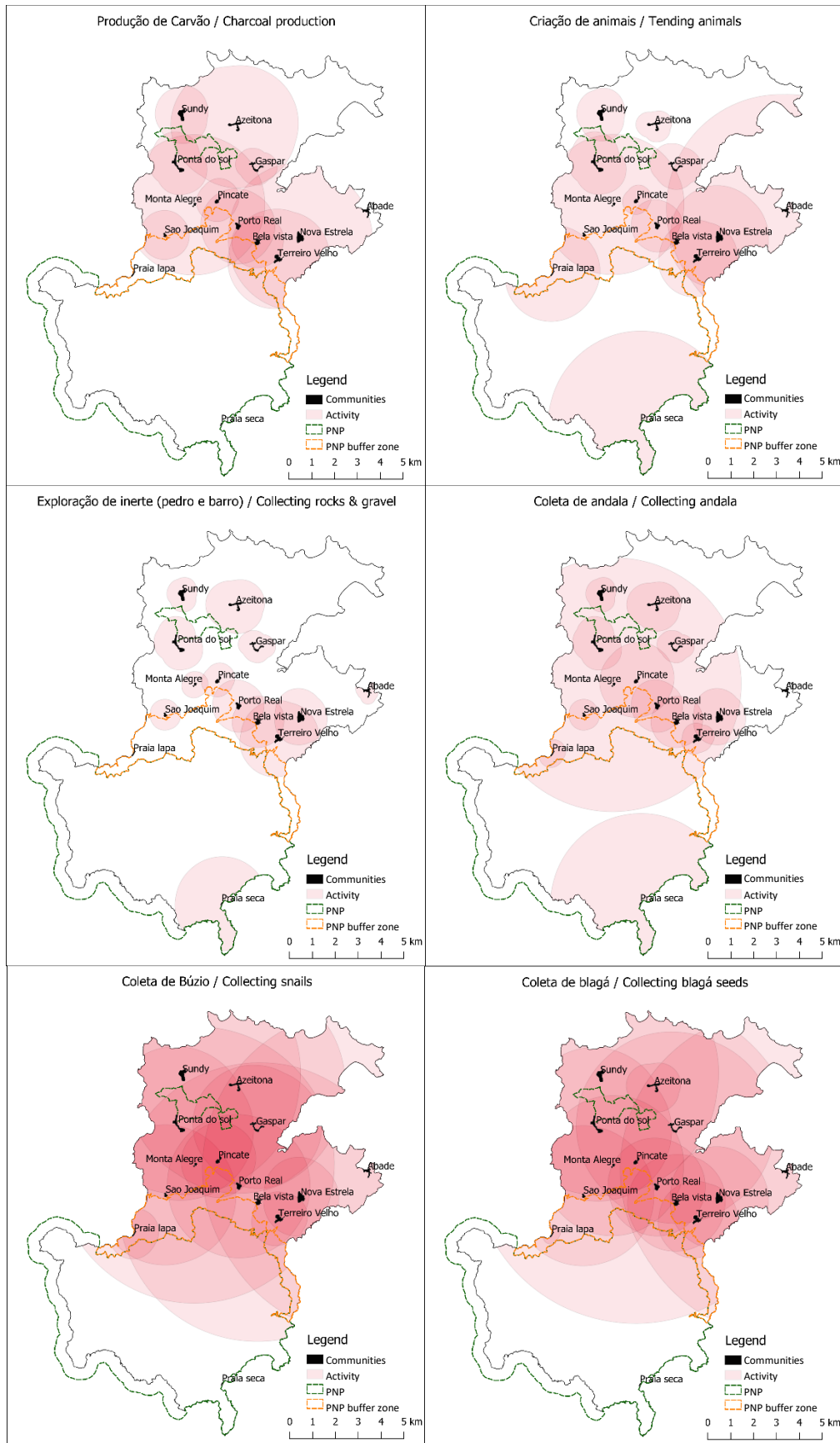


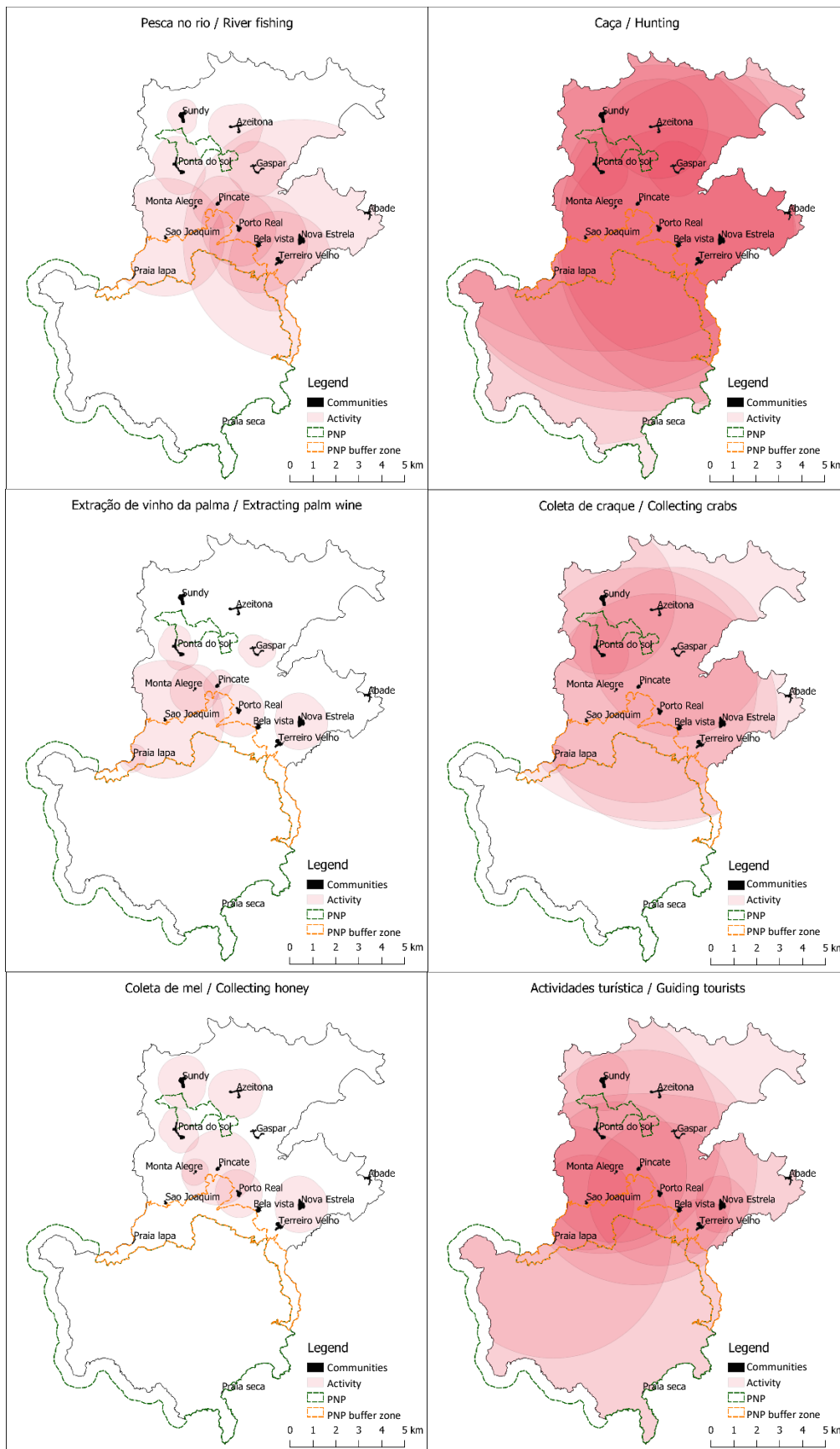
Figure 12. Heatmap illustrating the importance of forest resource use activities for 14 communities in Príncipe, based on self-assessment during group questionnaires. The depth of colour represents the level of importance assigned by the community, with darker colours indicating greater importance. Activities are ordered from left (highest) to right (lowest) by their average score.

The maximum distances travelled for each activity were compiled where possible from the focus groups and individual questionnaires, and were mapped by drawing semi-opaque circles around communities with radiuses equal to their reported maximum distances (Figure 13). These maps can give an indication of the relative ranges and areas that may be impacted/used for the various activities. For example, collecting firewood, producing charcoal, and extracting palm wine, all appear to have

quite localised ranges that do not overlap with the main body of the PNP, but could impact the buffer zone and Azeitona compartment. However, activity maps should be interpreted with caution, as they don't take into account the spatial variation in resource availability or any barriers that may prevent resource access. For example, hunting and guiding tourists both had large distances for several communities, resulting in ranges that covered the entire island, but legal restrictions on these activities within the PNP should in principle substantially limit these ranges.







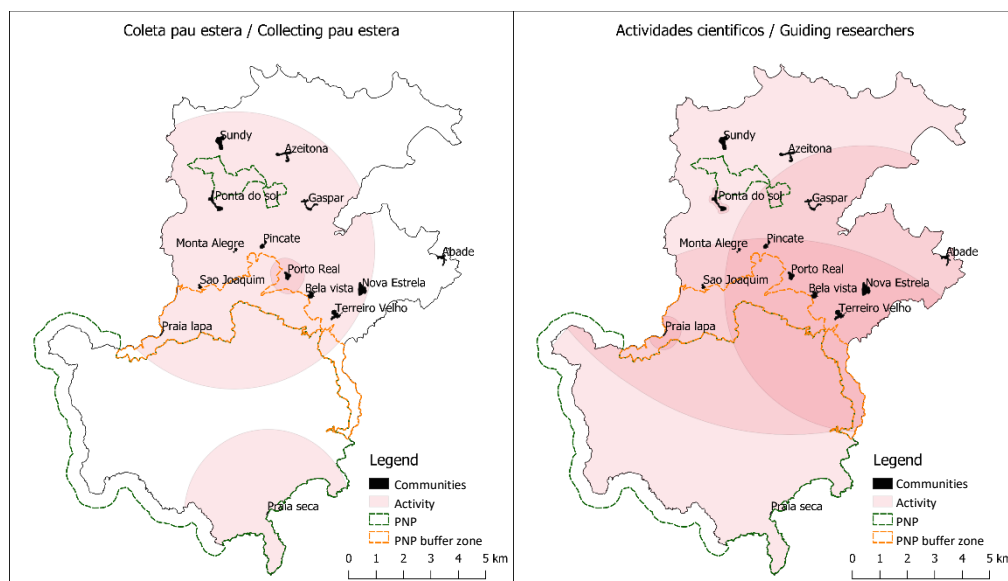


Figure 13. Maps of possible resource use areas. Circles (red) extend from each community based on the maximum reported distance that community members travel for each activity, as obtained from the group and/or individual questionnaires. Circles are semi-opaque, such that overlapping regions appear darker – i.e. increasingly dark regions indicate that multiple communities may be using the same area.

Discussion:

Threatened species:

The Príncipe Thrush

As the only terrestrial species with a dedicated Conservation Action Plan, the Critically Endangered Príncipe Thrush is a flagship for conservation in Príncipe. We directly contribute to the implementation of the Thrush Action Plan by presenting new information on its distribution, ecology, and potential threats. Based on compiled records since 2007, its extent of occurrence is approximately 40km², restricted to forests in the south of Príncipe. It occurs between sea-level and the Island's highest peak (~950m), with distribution models suggesting a higher probability of occurrence in remote areas of native forest with high rainfall. Although no nests with eggs or chicks were directly observed, breeding behaviours were documented on numerous occasions across sites during March-July, and we consider this to confirm that the Thrush is breeding during this period. Further targeted surveys during October-December are required to confirm whether the Thrush has two breeding periods. The current Red Listing (BirdLife International, 2018c) includes the following threats: ongoing habitat loss (low impact: 5); ongoing opportunistic hunting (low impact: 5); and future effects of non-native species, particularly black rat (medium impact: 7). Our results are concordant with this assessment – we encountered no evidence of habitat loss or hunting of the Thrush within its current range, but did confirm the presence of several non-native mammal species. Black rats were numerous at all study sites, but more worrying was the presence of feral cats at two of the three sites. We consider that these active predators are already a serious threat to this naïve ground-feeding bird, and a priority for further research should be to quantify their impact and identify possible mitigation measures.

The Obô Snail

Conservation planning exercises have identified this culturally significant species as a priority for both Príncipe and São Tome, and workshops to develop a formal Conservation Action Plan took place during late October 2019. It is currently Red Listed as Vulnerable, but this assessment is more than 20 years old and in urgent need of an update. We support both these processes by presenting new information on its current distribution (from direct observation), and recent changes in its population size and range (from questionnaires with forest users).

Its extent of occurrence within Príncipe is approximately 46km², and similarly to the Príncipe Thrush, it is restricted to forests in the south of the Island. Distribution models suggest a higher probability of occurrence in areas of native forest with high rainfall. Population size was not estimated directly, but interviews with forest users indicate a recent population decline of >75% and a range decrease of ~40%. Many interviewees indicated that the decline commenced in the past 5-10 years, but Dallimer & Melo (2010) reported that the species was already in rapid decline by 2007. Reports from the late 1990s (e.g. Baillie, 2001; Baillie & Stevart, 2000) indicate that the species was still abundant at this time, and so we consider it likely that the decline has taken place over the past 20 years. Interviewees identified collecting by people as the primary cause for the decline, and this is supported by the large deposits of collected shells observed by Baillie (2001), and Dallimer & Melo (2010). However, disease transmission from the non-native African Giant Snail has also been suggested as a potential threat, as its arrival and spread on the island corresponded with the decline in the Obô Snail (Dallimer & Melo, 2010). Our data indicates that the current distribution of the African Giant Snail in Príncipe (Figure 9) is similar to the decline in range of the Obô Snail (Figure 8), providing further support for this theory.

Other Threatened Species

The Endangered Grey Parrot (*Psittacus erithacus*) continues to do well in Príncipe, occurring in more than 50% of point counts throughout the island (Figure 1). Population estimates were not possible from our data, but in the absence of an increase in threats (e.g. from the live pet trade) we consider that it is unlikely to have declined substantially since the estimate of 6000-8000 individuals in 2014 (Valle et al, 2017).

The Endangered Príncipe White-Eye was infrequently encountered during initial point counts, and modeling of its distribution was not attempted. Exact distances were recorded for 18 birds during the second phase of point counts, and its population was estimated by applying a detection function from the closely related Principe Spierops (*Zosterops leucophaeus*). The resulting estimate of 3052 individuals is substantially higher than the estimate of 350-1,500 individuals from the recent Red Listing (BirdLife International, 2018), but should be interpreted with caution due to the low number of actual observations, and the use of a function from a separate species. Our records do slightly increase the known extent of occurrence for the species, relative to the records from Hering et al (2018) and the eBird database (Figure 14), and will be submitted to eBird to support future assessments.

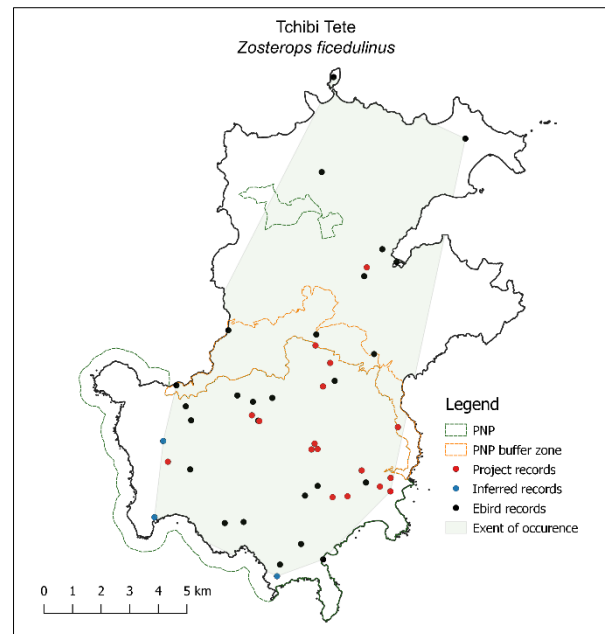


Figure 14. Map of extent of occurrence for Príncipe White-eye, based on records from the current project (red dots), records from the eBird database (black dots), and any further out-lying records inferred from figure 7 of Hering et al 2018.

The Príncipe Spierops (*Zosterops leucophaeus*) is currently Red Listed as Near Threatened (BirdLife International, 2016), but we found it to be one of the island's most common species. It was encountered in point-counts throughout, but particularly in secondary forest, agroforest, and non-forest areas in the north of the Island. Our population estimates of 35907 / 34494 individuals were second only to Dohrn's thrush-babbler (*Sylvia dohrni*). Based on these findings, we submitted an assessment to BirdLife's Globally Threatened Bird Forum in June 2019, recommending that the species be down-listed to Least Concern.

The São Tomé Bronze-naped Pigeon (*Columba malherbii*) is currently Red Listed as Near Threatened due to a suspected moderately rapid decline owing to hunting pressure (BirdLife International, 2018a). Hunting has been assessed in detail for São Tomé (Carvalho, Fa, et al., 2015; Carvalho, Palmeirim, et al., 2015), and although comparable data from Príncipe is currently lacking the pressures may be similar - hunting pigeons and other medium-sized birds is a common pastime for youths, and various signs (e.g. snares) were observed near to communities during fieldwork. The species was encountered in approximately 20% of points, and the distribution model indicates a higher probability of occurrence in modified habitats in the north of the island (Figure 1). The population estimate of 884 was the lowest for any species that was attempted but should be interpreted with caution as it used a detection function from a separate species, and is low relative to the 363 individuals recorded during the first phase of point counts. Further study of hunting pressure, and population size and trends for this species would be useful for supporting future assessments of its Red List status.

Protected areas

The Parque Natural do Príncipe (PNP) was established in 2006, and includes a southern block of native and maturing secondary forests (~6903 Ha), a northern 'Azeitona' block of mature secondary forest (~226 Ha), and a buffer zone of secondary forests and shade plantations (~1157 Ha, see Figure 14 and Table 5 for further details of zonation and characteristics). Our data on the distributions of threatened species clearly highlight the conservation importance of the PNP - the Príncipe Thrush and Obô Snail

are almost entirely restricted to the PNP's southern block (Figures 2 & 6), records of the Príncipe White-Eye are predominantly from within the southern block, and the Grey Parrot is abundant throughout the southern block, Azeitona, and buffer zone (Figure 1, although it is also common outside these areas). Furthermore, recent fieldwork has confirmed the existence of an endemic species of scops owl that is restricted to the PNPs southern block and will likely merit classification as Critically Endangered (Martim Melo, personal communication). Our data for terrestrial molluscs also highlight the significance of the PNP as habitat for some endemic and yet undiscovered taxa, with sampling sites from within the Azeitona and southern blocks having the highest proportions of endemic species, and 5 of the 6 newly discovered species occurring only within the PNP (Figure 10).

The current zonation of the PNP (Figure 15 & Table 5) emerged through its first management plan (Albuquerque, Cesarini, & Tagliabue, 2009), based on previous designations and estimations of biodiversity value and historic disturbance. Our distribution models for the Príncipe Thrush and Obô Snail indicate that they occur throughout the Total Protection zone, but they don't appear to show any differences between the Type I and II zones, and some areas with high probabilities of occurrence extend into the Partial Protection Type I zone around the Rio Papagaio valley and to the north and east of Morro de Leste. In future management plans, it may be appropriate to extend the Total Protection zones to include all areas where there is a high (e.g. >50%) probability of occurrence for these priority species.

Table 5. Characteristics and activities permitted within PNP zones (adapted from Albuquerque, Cesarini, & Tagliabue, 2009)

Zone	Characteristics	Permitted Activities
Total Protection – Type 1	<ul style="list-style-type: none"> • Flora and vegetation of exceptional value/endemism • Avifauna of exceptional value/endemism 	<ul style="list-style-type: none"> • Scientific research • Monitoring of ecosystems
Total Protection – Type 2	<ul style="list-style-type: none"> • Flora and Fauna of very high value and average sensitivity • Areas of native forest or maturing secondary forest • Areas of potential exceptional value but lacking more studies (birds, fish, other biological groups) 	<ul style="list-style-type: none"> • Intensive biological / ecological studies • Controlled tourism (e.g. Accompanied by Park guides, with restrictions on routes, numbers of people, time of year) • Construction of small non-permanent structures to support visitation
Partial Protection – Type 1	<ul style="list-style-type: none"> • Ecosystems that have been or are currently used by communities in activities conflicting with the protection of biodiversity, but whose recovery is critical to the management objectives of the most important areas of the park. 	<ul style="list-style-type: none"> • Controlled use of medicinal species • Environmental tourism excursions with accredited guides or authorized by the Park • Construction of small structures to support visitors
Partial Protection – Type 2	<ul style="list-style-type: none"> • Ecosystems that are currently used sustainably by communities, but with significant interest for the conservation of nature, biodiversity, and landscape. 	<ul style="list-style-type: none"> • Construction of small infrastructure to support visitors or other activities permitted in the park, or as a factor of cultural heritage restoration (e.g. Roças) • Agriculture, forestry, and livestock, as approved by the Board of Management • Traditional local activities

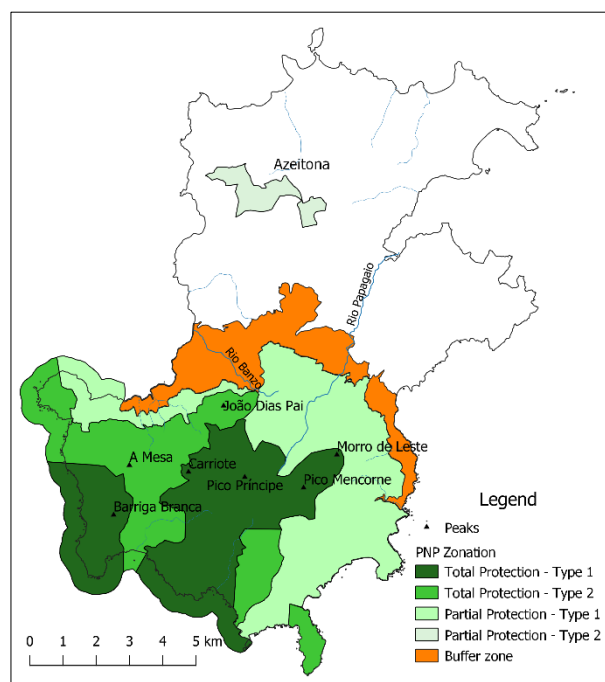


Figure 15. Zonation of the PNP, with major rivers and peaks.

Apart from the ubiquitous Grey Parrot, none of Príncipe’s other Threatened animal species were recorded from the PNP’s Azeitona block in the north of the island. However, we found that many bird species – including non-threatened endemics such as the Príncipe Malachite Kingfisher, Príncipe Golden Weaver, Príncipe Speirops, & Príncipe Sunbird - occur primarily in the north (Figure 1), utilising secondary forest, agro-forest, and non-forest areas. This is somewhat surprising but may reflect a greater variety and abundance of food such as seeds, fruits, and insects within these modified habitats. This pattern bodes well for the persistence of these endemic bird species, although there may be future impacts from the increasing human population. In particular, any weakening of the current pesticide restrictions could be damaging for birds in the proximity of agricultural areas, and increasing demand for agricultural products may lead to the conversion of secondary forest, which likely represents important nesting and/or foraging habitat. As the only area of secondary forest with formal protection, the conservation importance of the Azeitona block should not be overlooked.

Our data on forest resource use activities can provide some insight into how protected areas in Príncipe are being used, and help identify potential issues. The Azeitona block is within the range of several communities for important activities such as fruit, firewood, and traditional medicine collection, timber extraction, and charcoal production (Figure 13). These activities are generally aligned with those permitted through the zonation (Table 5), but they do have the potential to degrade the forest if conducted excessively, and so further quantification and monitoring of impact may be useful for supporting management. In the south, the buffer zone is within range for many activities, but most of these do not appear to extend much further into to park e.g. firewood and traditional medicine collection, charcoal production, tending animals, collecting rocks and gravel, and extracting palm wine (Figure 13). However, the ranges for both snail collecting and hunting do extend into the partial and total protection areas of the PNP, which would be prohibited under the current

zoning, and would likely represent a threat to priority species such as the Príncipe Thrush and Obô Snail. Because the data collection was not spatially explicit – i.e. participants were asked about distances without directions – this is not conclusive evidence that these activities are taking place in the PNP, but does highlight the possibility. For snail collecting, our individual questionnaire data suggest that most collectors currently use only the African Giant Snail that occurs primarily outside of the PNP (Figure 9), but it is possible that participants under reported collection of the Obô Snail. Further interviews with hunters and snail collectors - coupled with awareness raising about Príncipe's threatened species – are scheduled for early 2020, and are expected to help better understand and address these issues. It may also be informative that both snail collecting and hunting were only considered to be of intermediate importance for the wellbeing of most communities (Figure 12.), suggesting that interventions aimed at these activities may be less problematic – i.e. cause less conflict – than those involving more essential activities such as collecting firewood and traditional medicine, and timber extraction.

Future priorities:

The potential for introduced mammal species to threaten Príncipe's endemic biodiversity has long been recognised (Dutton, 1994), but focussed study has so far been lacking. We confirm that a predatory mammal – the feral cat – is present within the high-value area of the PNP, and likely represents a major threat to ground feeding forest birds such as the Príncipe Thrush. Interventions to address this and related threats – e.g. trapping of cats, civets, & dogs - would likely be challenging and costly, and we consider that further research is required to better understand the issues and options. This could include further camera trap surveys to examine the numbers and distributions of threat species, and diet studies (e.g. fecal analysis) to examine the prey species most at risk. Results could then inform a thorough assessment of potential interventions.

Our attempts to examine threats to the Príncipe Thrush by camera trap monitoring of nests was largely unsuccessful, due to the difficulty in locating and accessing nests. We were similarly unable to identify many nests of other comparable species, and this general difficulty has also been encountered by researchers in São Tomé (Ricardo Lima, personal communication). We consequently feel that further attempts to obtain quantitative data on nest predation would require excessive efforts and resources, without much likelihood of success, although opportunistic identification and observation of nests would still provide useful information on nesting behaviours and habitat requirements. Upcoming work on the thrush will focus on breeding phenology (i.e. testing for a 2nd nesting period during Oct-December), examining habitat associations, monitoring population trends (e.g. Fauna & Flora International, 2019), and education/awareness raising in Príncipe. Future priorities will be set through the revision of the Conservation Action Plan in 2020 and may involve further study and interventions relating to threat species (see above).

For the Obô Snail, our data provide evidence of a severe ongoing decline in population and range within Príncipe. An immediate priority will be to use this – together with comparable data from São Tomé – to update its Red List status (an entry on the IUCN Species Information Service has recently been initiated). Future priorities will be set through the development of a conservation action plan following workshops in both Príncipe and São Tomé, and will likely include: further research on the interaction with the African Giant Snail; awareness-raising / behavioural change campaigns to reduce collecting; and new/strengthened legislation.

Our work on terrestrial molluscs has built local capacity for relevant field and laboratory methods (e.g. specimen curation), and highlighted the high levels of novelty and endemism of this group in Príncipe. The establishment of productive relationships with taxonomic experts that can assist with identifying

samples and describing new species makes this an appealing group for further study. Options include: further sampling of native forest areas within the PNP - particularly at higher elevations around Pico Príncipe, Pico Mesa, and Pico Mencorne that are likely to reveal additional novel endemic species; further sampling across the island to confirm/exclude the presence of previously documented species and review their taxonomic placement (e.g. *Bocageia lotophaga* and *Africanion dumeticola*); ecological study to compare communities across habitat/forest types, with the potential for using molluscs as an indicator taxon for forest health/quality; detailed assessment of the ecology and distribution of particular taxa – such as the endemic *Columna* genus – to facilitate Red List assessments and conservation planning.

Forests and the services they provide are integral to the wellbeing of communities in Príncipe, but a lack of information on forest resource use and its ecological impacts is currently a major barrier to the effective management and sustainable use of forests. Our study contributes useful information on the relative importance of different forest resource activities, and their spatial ranges, but more detailed assessment is required to identify and address resource-use threats - i.e. species, populations, or materials with a high current risk of extirpation. We feel that further community level assessments, involving more detailed mapping and quantification of resource use, would be a useful next step, and could be coupled with the facilitation of land use planning by civil society groups, and/or sustainable enterprise development.

Acknowledgements

The project – Understanding the Remarkable Biodiversity of Príncipe Island (2018-19) - was funded by a Le Fonds Français pour l'Environnement Mondial (FFEM) grant, awarded to Fundação Príncipe. Match funding and complementary activities were supported by the Critical Ecosystem Partnership Fund (project CEPF-103778), HBD Príncipe, and Fauna & Flora International. The project benefited greatly from the partnership between Fundação Príncipe and the Príncipe Regional Government - particularly the Departamento da Biosfera e Parque Natural do Príncipe. Field training and support for developing survey protocols were provided by Hugo Sampaio from the Portuguese Society for the Study of Birds (SPEA); David and Geraldine Holyoak; & Ricardo Lima, Martina Panisi, and Filipa Soares from the University of Lisbon. The project staff from Fundação Príncipe were joined in the field by technicians from the Parque Natural do Príncipe, and volunteers from the Príncipe Tourist Guides Association.



Grievance Mechanism

The work described herein was implemented by Fundação Príncipe, who operate the following grievance procedure:

Fundação Príncipe is committed to hearing and resolving any grievances raised by its stakeholders, and we have developed a specific mechanism to help us with this. A document describing the mechanism is available on our website and on request from our office in Santo Antonio. If you have any concerns about Fundação Príncipe's actions or activities, then please get in touch in the following ways:

- *By telephone – The Fundação Príncipe telephone number is +239 9803640*
- *By Email - An electronic copy of our grievance lodgement form is available online at www.fundacaoprincipe.org and completed forms or messages can be sent to info@fundacaoprincipe.org.*
- *Face to face - Stakeholders can voice their grievance to any Fundação Príncipe employee who will then escalate using the correct process.*
- *Through mediating organisations – If you prefer not to directly contact the Fundação Príncipe, or are unhappy with how your grievance was handled, then you can speak to any staff member from the Department of Environment and Nature Conservation – either at their offices in Santo Antonio or by telephone on +239 2251142.*

References

- Albuquerque, C., & Carvalho, A. (2015). Plano de Manejo 2015/2020 do Parque Natural do Príncipe. RAPAC, ECOFAC V, São Tomé, São Tomé e Príncipe.
- Albuquerque, C., Cesarini, D., & Tagliabue, L. C. (2009). Plano de Gestão do Parque Natural do Príncipe. Republica Democratica de São Tomé e Príncipe.
- Baillie, J. (2001). *One month in the forest of Príncipe*. Gulf of Guinea Conservation Group.
- Baillie, J., & Stevart, T. (2000). Exploration du Pico de Príncipe. *Canopee*, 16.
- BirdLife International. (2014). *Single Species Action Plan for the Conservation of the Príncipe Thrush Turdus xanthorhynchus 2014-2018*. BirdLife International, Cambridge.
- BirdLife International. (2016). *Zosterops leucophaeus, Principe Speirops*. Retrieved from <http://dx.doi.org/10.2305/IUCN.UK.2016-3.RLTS.T22713919A94394313.en>
- BirdLife International. (2018a). *Columba malherbii, Sao Tome Bronze-naped Pigeon*. Retrieved from <http://dx.doi.org/10.2305/IUCN.UK.2018-2.RLTS.T22690351A131459979.en>
- BirdLife International. (2018b). *Psittacus erithacus, Grey Parrot*. Retrieved from <http://dx.doi.org/10.2305/IUCN.UK.2018-2.RLTS.T22724813A129879439.en>
- BirdLife International. (2018c). *Turdus xanthorhynchus, Principe Thrush, The IUCN Red List of Threatened Species*. Retrieved from <http://dx.doi.org/10.2305/IUCN.UK.2018-2.RLTS.T22736414A131458830.en>
- BirdLife International. (2018). *Zosterops ficedulinus, Principe White-eye*. Retrieved from <http://dx.doi.org/10.2305/IUCN.UK.2018-2.RLTS.T103890694A131796574.en>
- Carvalho, M., Fa, J. E., Rego, F. C., Lima, R. F. D., Santos, G., & Palmeirim, J. M. (2015). Factors influencing the distribution and abundance of endemic pigeons on São Tomé Island (Gulf of Guinea). *Bird Conservation International*, 25(1), 71–86. <https://doi.org/10.1017/S0959270914000288>
- Carvalho, M., Palmeirim, J. M., Rego, F. C., Sole, N., Santana, A., & Fa, J. E. (2015). What motivates hunters to target exotic or endemic species on the island of São Tomé, Gulf of Guinea? *Oryx*, 49(02), 278–286. <https://doi.org/10.1017/S0030605313000550>
- Clarke, D., & Naggs, F. (1996). *Archachatina bicarinata, The IUCN Red List of Threatened Species*. <https://doi.org/10.2305/IUCN.UK.1996.RLTS.T2039A9194771.en>

- Dallimer, M., & Melo, M. (2010). Rapid decline of the endemic giant land snail *Archachatina bicarinata* on the island of Príncipe, Gulf of Guinea. *Oryx*, 44(2), 213–218. <https://doi.org/10.1017/S0030605309990834>
- Dallimer, M., Melo, M., Collar, N. J., & Jones, P. J. (2010). The Príncipe Thrush *Turdus xanthorhynchus*: A newly split, 'Critically Endangered', forest flagship species. *Bird Conservation International*, 20(4), 375–381. <https://doi.org/10.1017/S0959270910000390>
- Dutton, J. (1994). Introduced mammals in São Tomé and Príncipe: Possible threats to biodiversity. *Biodiversity and Conservation*, 3, 927–938.
- Fauna & Flora International. (2019). *Príncipe Thrush and Obô Snail Monitoring Protocol*. FFI, Cambridge, UK.
- Hering, J., Hering, H., de Lima, R. F., & Melo, M. (2018). Príncipe White-eye *Zosterops ficedulinus*—A rare island endemic. *The Bulletin of the African Bird Club*, 25(1), 8.
- Holyoak, D., Holyoak, G., Lima, R. F. D., Panisi, M., & Sinclair, F. (In prep.). Undescribed species and genera and new island records of land snails (Gastropoda) from the islands of São Tomé and Príncipe.
- Phillips, S. J, Dudík, M., & Schapire, R. E. (n.d.). Maxent software for modeling species niches and distributions (Version 3.4.1). Retrieved from http://biodiversityinformatics.amnh.org/open_source/maxent/
- Valle, S., Collar, N. J., Harris, W. E., & Marsden, S. J. (2017). Spatial and seasonal variation in abundance within an insular grey parrot population. *African Journal of Ecology*, 55(4), 433–442. <https://doi.org/10.1111/aje.12367>