Predicting Extinction Risks to Landbirds on Tropical Islands: a Western Indian Ocean Model

ALINA LENGYEL

Percy FitzPatrick Institute of African Ornithology
University of Cape Town, Rondebosch 7701

SUPERVISOR:

Prof. Phil Hockey

Percy FitzPatrick Institute of African Ornithology
University of Cape Town

Thesis submitted in partial fulfilment of the requirements for the degree of Master Of Science in Conservation Biology, Faculty of Science, University of Cape Town

April 2001

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Summary

A model of threat and extinction risk to island-dwelling landbirds was developed using parameters that do not require detailed, species-level biological information. The model was based on information collated for the western Indian Ocean islands of the Mascarenes, Seychelles and Comoros and their native landbirds, extant and extinct since 1600. The most important factors identified by the model as predisposing tropical island bird species to extinction and threat were habitat selection, bird mobility, human population size on the island, island area, species range (measured as the number of islands on which a species occurs) and diet. Risk indices predicted by the model for each species were compared to the status ranking of threatened taxa included in the International Red Data Book. The predictions corresponded in 50% of the cases. Model limitations are discussed.

1. INTRODUCTION

Isolated oceanic islands and island groups frequently are centres of endemism (Olson 1989) and sources of insight into evolutionary processes (MacArthur and Wilson 1967). However, many oceanic islands have also experienced disproportionately high rates of extinction, mostly for anthropogenic reasons (Diamond 1989a and 1989b, Olson 1989, Milberg and Tyrberg 1993, Bibby 1994). A total of 128 bird species have become globally extinct in the last 500 years (BirdLife International 2000) and 93% of these were confined to islands (King 1985). Indian Ocean islands, especially the Mascarenes, account for 16% of all island bird extinctions.

Many island birds are currently perceived to be globally threatened (BirdLife International 2000). Whilst many islands (including those of the western Indian Ocean) are fairly well known ornithologically, this is not always the case. Even on the Comoros, a new, and locally common, species of scops-owl was described as recently as 1998 (Lafontaine and Moulaert 1998). In the case of less well-known species there is value in having a model of threat and extinction risk based on parameters that do not require any intimate knowledge of the bird's biology. However, to have any confidence in such a model, it must be calibrated against taxa whose threat statuses are fairly accurately known or whose extinctions have been adequately documented.

The birds of the western Indian Ocean island groups of the Mascarenes, Seychelles, and Comoros satisfy this criterion. Early seafarers to this part of the Indian Ocean left adequate descriptions of the birds they encountered, and the extant avifaunas are fairly well documented (Penny 1974, Staub 1976, Barré and Barau 1982, Stoddart 1984, Diamond 1987, Louette 1988, Sinclair and Langrand 1998).

This study integrates and analyses information on the landbirds of the Mascarenes, Seychelles and Comoros since 1600, and has the following aims:

- to document the extinct and extant landbird avifaunas of the western Indian Ocean islands.
- to identify, using a modelling approach, the environmental and ecological parameters that predispose tropical island bird species to extinction and threat; and
- to compare the independently derived model predictions with the status rankings of threatened taxa (BirdLife International 2000) as a means of testing the power of the model to predict threat in the absence of detailed species-level biological data.

2. STUDY AREAS AND METHODS

2.1 THE ISLANDS

The Mascarene, Seychelles and Comoro islands (4-22°S, 43-64°E) are located in the Indian Ocean, west of the Mid-Indian Ridge (Fig. 1). Madagascar was considered as a source area for colonisation of these islands (as was mainland Africa) and was excluded from analyses.

Mascarenes

In the Mascarene group, the larger islands of Mauritius, Réunion and Rodrigues were included in analyses. They are all relatively young islands, of volcanic origin. Mauritius, at 8 millions years old, is the oldest, followed by Réunion (2.8 million years), and Rodrigues (1.5 million years - Barré and Barau 1982). The climate is tropical oceanic, and temperate at high altitudes on Piton des Neiges on Réunion. The warm season lasts from November to March and is accompanied by heavy rains.

Cyclones occurring during this period have an important influence on the islands' fauna and flora and have been responsible for the extinction of some introduced landbirds that apparently lacked adaptations to these extreme conditions (Staub 1976).

The Mascarenes were discovered by Europeans in the early 16th Century, although they had been visited by Phoenicians 2000 years previously. Malays visited the islands 1500-2000 years ago, and later (7th Century) Arab navigators reached Mauritius (Barnwell and Touissant 1949). The first European visitors were the Portuguese, followed by the Dutch who settled Mauritius in 1638. The island was occupied by the French in 1721 and finally by the English in 1810 (Barnwell and Touissant 1949). Currently, the Mascarenes have a human population exceeding 1.8 million people and an annual population growth rate of 0.89 % on Mauritius and 1.63 % on Réunion (CIA 2000).

Seychelles

The Seychelles archipelago lies between 4 - 10°S, and between 46 - 56°E. It comprises 115 islands with a total land area of 455 km^2 scattered over 1,340,000 km^2 of ocean. Central Seychelles are the only granitic oceanic islands in the world. Included within the Seychelles are also the Aldabras (the reef limestone islands of Aldabra, Astove, Assumption and Cosmoledo), and the Amirante, Providence and Farquhar island groups, which are low sand cays on coral reefs (Braithwaite 1984, Stoddard 1984). The geological age of the Mahé granite is 650 million years (Braithwaite 1984). During Jurassic times the Malagasy – Indian plate (which included the Seychelles Bank) started moving away from Africa in a north-eastern direction. Madagascar separated in the Jurassic or early Cretaceous, and between 75 -

45 million years the Seychelles separated from India, which continued its northward movement (Braithwaite 1984).

Aldabra has been known to Arab sailors since AD 851 (Skerrett and Skerrett 1991), but the first islands to be settled were the granitic Seychelles. A party was sent from Île de France (Mauritius) in 1742 to investigate the islands which were later claimed for France in 1756. The first settlers followed in 1770 (Skerrett and Skerrett 1991). The combined human population of the islands is currently about 75 000 and the annual growth rate is 0.49 % (CIA 2000). Fourteen islands and five island groups were included in the analyses (Appendix A).

Comoros

The Comoros are situated mid-way between Africa and Madagascar in the Mozambique Channel between 11°20' - 13°04' S and 43°13' - 45°19'E (Louette 1988). The islands are volcanic in origin and are fairly recent. The oldest island is Mayotte (8 million years old) and the youngest is Grande Comore (0.01-0.13 million years), home to Mount Karthala, the only active volcano in the region (Nougier *et al.* 1986). The climate is tropical with a warm and humid season between November and April, the period of north-west monsoons, and a dry season between May and October. During the humid season cyclones that form to the east of the Comoros affect the islands. Severe cyclones occur approximately every ten years (Louette 1988).

The islands had already been populated by the 9^{th} - 10^{th} Century by Islamic people (Newitt 1984, Wright 1984) who described themselves as "Shirazi", suggesting an affiliation to the Shirazi families of Kilwa (Tanzania) and Zanzibar (Newitt 1984).

The first Europeans to visit the islands were the Portuguese at the end of the 15th Century. By the end of the 16th Century the islands were at the centre of struggle for maritime supremacy between rival European trading nations, and in the 19th Century they were annexed by the French. In 1975 Grande Comore, Mohéli and Anjouan gained independence from France as the Federal Islamic Republic of the Comoros. In 1997 however, Anjouan and Mohéli declared their (as yet unratified) independence from Comoros. Mayotte is still under French administration (CIA 2000). The four larger islands of Grande Comore, Mohéli, Anjouan and Mayotte were included in the analyses. The combined human population of Grande Comore, Mohéli and Anjouan is approximately 580 000, with a growth rate of 3.05 %, and Mayotte currently has about 160 000 people and a growth rate of 4.76 % (CIA 2000).

2. 2 DATABASE AND ANALYSES

The Database

The database was constructed from 31 literature sources. Information was collated for the following groups: ibises, raptors, guineafowls, francolins, quails and button-quails, rails, pigeons and doves, parrots, owls, and passerines. Species dependent on permanent freshwater were excluded. Native birds were defined as those believed to have reached the islands by means of natural dispersal. These were distinguished from species introduced by man, whether deliberately or accidentally.

Presence/absence data for each species on each of the 26 islands/island groups considered in the study were included and both local and global extinctions were identified. The primary sources used were: Staub (1976) and Diamond (1987) for the Mascarenes, Penny (1974), and Stoddard (1984) for the Seychelles, Louette (1988)

for the Comoros and Sinclair and Langrand (1998) for all island groups (Appendix B). Analyses were all made at the species level.

Island size, maximum altitude, distance from nearest source (Madagascar or Africa), number of islands on which each species occurred, habitat preference and human population size and density were included as "environmental" variables. Biological variables were mobility (volant or flightless), diet and field metabolic rate (FMR, derived from body mass – Nagy *et al.* 1999). The data on island characteristics were extracted primarily from Skerrett and Skerrett (1991) and The Times Atlas of the World (1993). Habitat was classified in three categories; pristine forest only; forest, secondary growth and woodland; and 'other', including marshes, coastal mangroves and heathland. Generalist species were assigned to the third category. The human population size and density were divided into low and high, the differentiating values being, respectively, 500 000 people and 300 individuals km^{-2} (data from CIA 2000). Each bird species was allocated to one of four dietary categories: frugivory, granivory, insectivory and 'other', including nectarivores, birds of prey and species with mixed diets. FMR was calculated using the formula: 10.5 (mass, g) $^{0.681}$ (Nagy *et al.* 1999).

Inter-island Similarity Analyses

In order to assess the level of taxonomic community similarity between the islands, similarity matrices were constructed for the species complements in both 1600 and 2000. Jaccard's index (S_J) was calculated for all possible island pair-wise combinations, using the formula:

$$S_J = \frac{a}{a+b+c}$$

(Anderberg 1973; Moulton and Sanderson 1997) where *a* is the number of species common to both islands, and *b* and *c* represent the number of species unique to each island respectively. The Jaccard's index is calibrated to range between 0, for no similarity between the samples (in this case, zero species shared between the two islands compared), and 1, for maximum similarity (the two islands compared share all their species). The similarity matrices were analysed using the Multidimensional Scaling function in Statistica 5.5 (StatSoft Inc. 2000).

Extinction and Threat Analyses

The numbers of globally and locally extinct species were recorded for each island. Possible undocumented post-1600 extinctions on the Mascarene Islands were estimated from documented extinct species (Appendix C) using the procedure described by Pimm *et al.* (1994). This method is based on the assumption that (for extinct species that left bones), the ratio between species that left both bones and skins and those that left only bones, is the same as that (in the case of species that did not leave bones) between species for which skins exist and those that have not left skins. The formula employed by Pimm *et al.* (1994) is:

$$\frac{\text{'bones but no skins'} \times \text{'skins but no bones'}}{\text{'bones plus skins'}}$$

Threatened species were categorised as critically endangered, endangered, vulnerable or near-threatened (BirdLife International 2000). Criteria used in assigning a species to a threat category are: population reduction, extent of occurrence, population estimates, and probability of extinction based on quantitative analysis (IUCN 2000).

2.3 THE MODELLING APPROACH

The aim of building a model was to identify and rank the importance of a suite of variables that influence the persistence of a species on a particular island within its range. A two-step modelling approach was used: first a Generalized Additive Model (GAM) was constructed and then, based on the results obtained, a Generalized Linear Model (GLM) was built. The reason for this approach was that the GAM is useful for identifying non-linear relationships, which can then be parameterised using the GLM (MathSoft 1997). S-PLUS 4.5 was used to build both the GAM and GLM (MathSoft 1997).

As the persistence (survivorship) of a species is a binary variable (0 for an extinct species and 1 for an extant species), a generalised model with a binomial error distribution was used. The predictors (independent variables) tested in the GAM were island area, maximum altitude of an island, the number of islands on which a bird occurs, mobility, diet, field metabolic rate (FMR), habitat, and the current human population size and density of the islands. Mobility, diet, habitat, human population and population density were treated as categorical variables. For continuous data, a cubic smoothing spline was used to estimate nonparametric functions. Only native species were considered in the analysis.

A forward stepwise model procedure was used to construct the best GAM. Predictors entered the model one at a time and were tested for significance using the χ^2 test. The most significant variable (always $p < 0.05$) was retained, forming the base of the new model, to which each remaining variable was added sequentially. Resulting models

were again tested for significance. The procedure was repeated until there were no significant variables to be added to the model.

The GAM indicated that use of a GLM was suitable, and suggested a log-transformation of island area and a break-point regression for the number of islands on which a species occurred. The GLM is preferred over the GAM because it is more parsimonious as the effective number of parameters is less than that for the GAM, and it also gives an analytical expression for the model, which is not possible with a GAM.

The model produced a prediction (a survival index) for the survivorship for each species, along with values for the relative importance of each predictor (Appendix D and Table 3). Risk indices were calculated for each bird by subtracting its survival index from 1. Risk indices were compared to the threat categories in the International Red Data Book (BirdLife International 2000). Because the birds of these islands are mostly well known, it was assumed that these threat categories were accurate, most being based on long-term information on bird population sizes. For those species occurring on more than one island a compounded global risk index was calculated as the product of risk indices on each island within its range.

3. RESULTS

3.1 DATABASE ANALYSES

The database contained 135 native and 30 introduced taxa (including subspecies). The birds belong to 35 families, of which 30 families are native. One entire family, the Raphidae (dodos) is now extinct (Appendix B). The original species complement (in 1600) included 103 native species, 82 (80%) being still extant.

The Mascarene Islands have the highest historical level of endemism and have experienced the most extinctions, to the point where endemism has been reduced by 51% (Table 1). Of all extant endemic landbirds of the Mascarene Islands, 12 are included in the Red Data Book, and most of them occur only in pristine forest (as did most of the extinct species – Appendix B).

Post 1600, the Mascarene Islands lost all their native rails, owls and starlings (7 species). Of an initial complement of six pigeons and pigeon-like birds (including the dodo and the solitaires) only one, the Pink Pigeon *Nesoenas mayeri*, still survives (and is critically endangered). Likewise, of the six parrots present in the original avifauna, only the Echo Parakeet *Psittacula echo* of Mauritius has survived (and is also, critically endangered). All flightless birds are now extinct. Applying the formula of Pimm *et al.* (1994), six additional undetected extinctions were predicted for the Mascarenes. The effects of human colonization were severe immediately after settlement, as exemplified by Mauritius (Fig. 2). Early colonisers not only hunted several species to extinction, but also destroyed native vegetation and introduced many alien species, both bird and mammal. The highest number of introduced bird species (20) is also found on Mauritius (Appendix A).

Unlike the Mascarenes, the Seychelles have experienced mostly local, rather than global, extinctions. The only islands (of those included in this study) that have lost no species are Frégate, Cousin, Cousine and Bird Island. Taxa that have undergone major range contractions are the Seychelles Magpie Robin *Copsychus sechellarum*, the Seychelles Black Parrot *Coracopsis nigra barkly*, the Seychelles Black Paradise

Flycatcher *Terpsiphone corvina*, the Seychelles Fody *Foudia sechellarum* and the Seychelles Warbler *Acrocephalus sechellensis*.

All except the Seychelles Black Parrot are included in the Red Data Book (BirdLife International 2000). BirdLife International treat Seychelles Black Parrot as a race of the Lesser Vasa Parrot *Coracopsis nigra* of Madagascar and the Comoros. Sinclair and Langrand (1998) treat the Seychelles form as specifically distinct. If the latter authors are correct, this bird would be included in the RDB.

A small number of native species was present originally on the large island of Mahé (9) relative to the number on the slightly larger island of Aldabra (14) and much smaller islands of Praslin and Marianne (10 and 9). One flightless bird, the Aldabra Rail [*Dryolimnas (cuvieri) aldabranus*], is still extant.

No extinctions of native landbirds have been recorded in the Comoros, despite the fact that of all the islands included in this study, they were the first to be colonised by humans. There is a high level of endemism at both species and subspecies level in the Comoros. These include the endemic monotypic genus *Humblotia*. There are no records of flightless birds on the Comoros.

Introduced birds are present on all islands included in this study except Astove. Analysis of dietary preferences of natives and aliens suggests that competition for food between native and introduced species may not have been an important cause of extinctions (Fig. 3). Fifty percent of introduced taxa are granivorous, a dietary guild rare among the indigenous landbirds (two species), and no native granivores have

become globally extinct. On the other hand, frugivores have accounted for 50% of extinctions, but only two frugivorous species, the Grey-headed Lovebird *Agapornis cana* and the Ring-necked Parakeet *Psittacula krameri*, have been introduced.

The high incidence of single–island endemism is reflected in generally low taxonomic similarity indices between islands. In 1600, the similarity between Providence and Farquhar was 1. At this time the similarity between Félicité and La Digue and between Cousine and Cousin was 0.86. Currently, the only two islands that share all of their landbird species are Astove and Cosmoledo. Subsequent to 1600, both Providence and Farquhar lost the Comoro Blue Pigeon *Alectroenas sganzini,* the only native landbird species they possessed. On average, the similarity between islands in 2000 was slightly less than in 1600 (Figs. 4-5). In 1600, there was much greater similarity between the landbird assemblages of the Comoros and Aldabras than there is now. The main reason for this divergence has been local extinctions on Assumption, Astove and Cosmoledo, resulting in these islands becoming more similar to one other and less similar to the Comoros.

3.2 MODEL RESULTS

The GAM and GLM identified six variables as significant for predicting local survival probabilities of birds (i.e. survival on each of the islands that make up their respective ranges). These were (in order of significance): habitat, mobility, human population, island area, number of islands comprising the range, and diet (Fig. 6). In total, these factors explain approximately one third of the observed variance ($r^2 = 0.32$). Factors rejected as non-significant were: island maximum altitude, distance from source, bird FMR, and human population density. FMR was consistently non-significant ($p >>$

0.05), even after removing outliers (the dodo and solitaires), indicating (unexpectedly) that energy demand is not related to extinction risk.

The profile of a bird facing the highest threat of local extinction included the following: occupancy of only pristine forest, being flightless, living on only a few small islands with high human population and having a diet consisting primarily of fruits or seeds. However, the standard error in the case of granivores is very high (Fig. 7) because so few species are granivorous. The relationship between mobility and species persistence shows that flightless birds stand a very high chance of becoming extinct. Of the six species of flightless birds present on the islands in 1600, only one (the Aldabra Rail) still survives. However, the model also predicts high extinction probabilities among certain mobile taxa. In terms of range size, the same extinction risk is predicted for all species with a range consisting of fewer than eight islands. Once a bird's range includes more than eight islands its chances of survival increase considerably.

The risk indices, calculated from the survival indices predicted by the model on a scale from 0 to 1, were compared to current threat categories (BirdLife International 2000). The highest risk index for extant taxa (mean = 0.14, sd = 0.17) was 0.69 (Seychelles Warbler and Seychelles Fody on Cousine Island) and the lowest was 0 (Comoro Turtle Dove *Streptopelia picturata comorensis* on Grande Comore, Anjouan and Mayotte, and Seychelles Sunbird *Nectarinia dussumieri* on Mahé). The majority (95%) of the extant taxa were assigned risk indices lower than 0.50.

Among observed extinct taxa, the risk index (mean = 0.48, sd = 0.27) ranged from 0.03 (Seychelles Turtle Dove *Streptopelia picturata aldabrana* of Assumption and

Aldabra Brush Warbler *Nesillas aldabrana*) to 0.99 (Dodo *Raphus cucullatus* and Réunion Solitaire *Ornithaptera solitaria*). Approximately 54% of the extinct taxa (30 out of 56) were assigned risk indices greater than 0.50 and some 20% had values higher than 0.71 (Table 2). Single-island endemics (for which local extinction is equivalent to global extinction) included in this category are the dodo, the solitaires, the Mauritian Red Rail *Aphanapteryx bonasia* and the Leguat's Rail *Aphanapteryx leguati*. Twenty-five percent of all extinct taxa had risk indices between 0.51 and 0.60, while only 9% ranged between 0.61-0.70 (Fig. 8, Table 2).

The GLM output is summarized in Table 3 and Appendix D. Large negative values assigned to predictor variables (Table 3) indicate high risk categories. Thus, for example, use of pristine forests and a range size of fewer than eight islands would predispose a species to greater risk than would occupancy of secondary habitats and a larger range size.

Of the extinct taxa with risk indices higher than 0.50, 47% are pristine forest inhabitants, 53% are frugivores, 27% are found on islands with high human population, 97% have ranges comprising fewer than 8 islands and 57% occur on small Seychelles islands. The same pattern is observed for extant species, although in this case the figures are smaller. Those with risk indices greater than 0.50 comprise more pristine forest birds (18%), frugivores (36%), and species inhabiting islands with high human population (18%) than taxa with risk indices below 0.50. The proportion of species with ranges smaller than eight islands is approximately the same (82% and 80% respectively). However, birds found on small islands represent 73% of those included in the upper half of the risk index range, and only 28% of the lower half.

The model identified 25% (21 species) of the total number of extant species as having a global risk index greater than 0.1 (Tables 4-5). These taxa have an average range size of 1.8 islands. The ten birds most at risk are found on Mauritius and Réunion, with one exception, the Aldabra Rail. Nine species not included in the Red Data Book (RDB) were identified by the model as having a risk index greater than 0.1 (Table 4).

Global risk indices generated by the model were grouped into threat categories (Table 6) and were compared to those in the Red Data Book. These indices ranged from very low (<<0.01) to 0.66 (Table 7). Of the 12 Mascarene species included in the RDB, 5 were correctly placed by the model in their respective threat categories, 2 were given a higher threat status and 5 were downlisted. Seychelles species that occur on multiple islands appear as having a very low probability of global extinction, although they have high probabilities of local extinction (Appendix D). Species occurring on Mahé in particular were predicted as having low chances of extinction. Of the Comoran species, only the Comoro Olive Pigeon was predicted as being near – threatened, corresponding to its RDB status. The Mohéli Scops Owl *Otus moheliensis*, was downlisted from critically endangered to endangered. Three species, the Karthala Scops Owl *Otus pauliani*, Humblot's Flycatcher *Humblotia flavirostris* and the Comoro Brush Warbler *Nesillas brevicaudata* were predicted a risk index of 0.1. All other Comoro species were assigned lower values.

4. DISCUSSION

The rich and unique landbird avifauna of the west Indian Ocean, and especially of the Mascarenes, has been impoverished by numerous extinctions. Most global extinctions

occurred on the bigger islands of the Mascarenes, partly because they had a larger species pool, but more probably because they were more attractive to potential human colonists due to their size and resources. This pattern does not hold in the Seychelles, where most taxa have been lost from small islands (mostly local, rather than global extinctions) such as Marianne (6), and Aride, Praslin and Cosmoledo (4). Based on the fossil record Olson (1989) estimates that the diversity of birds on all oceanic islands was reduced by 30 to 50 % since human colonisation. The estimate of six undocumented extinctions for the Mascarene made in this study is considered to be conservative.

On Mauritius, the majority of the 'naïve' species such as flightless dodos were lost very soon after colonisation. The absence of extinctions on the Comoros is surprising and counterintuitive, considering that they were the first of all three island groups to be colonised by humans. Indeed, humans had been resident on the Comoros for at least 700 years prior to 1600. It is possible that a thorough palaeontologic study of the Comoros may reveal significant numbers of currently undocumented extinctions.

Another hypothesis for the apparent lack of Comoran extinctions is provided by the cultural differences between the peoples who colonised the Mascarenes (Europeans) and the Comoros (Muslims). Newitt (1984) mentions that pigs and dogs "are virtually unknown" in the Comoros, that birds have few predators and "with the exception of few luckless pigeons are seldom hunted". On the other hand, the Mascarene birds have been hunted since 1600 regardless of their size or number, bulbuls being officially considered as "game" (Cheke 1987c).

Hunting and over-exploitation of native avifauna is only one of the possible causes of extinction. Others include the effects of habitat destruction and introduced species, as well as the phenomenon of synergisms when one extinction is followed by a cascade of others (Diamond 1989a and 1989b, Myers 1989). Introduced species encompass both predators and competitors. Rats and cats are the most notorious predators and have affected especially, but not only, ground - nesting species. Other predators include mongooses and monkeys on Mauritius. Of the Seychelles islands on which no extinctions have occurred, Cousin and Cousine have been cat and rat free (Diamond 1984). These islands are home to the critically endangered Seychelles Magpie Robin, and the vulnerable Seychelles Warbler and Seychelles Fody (BirdLife International 2000).

Introduced competitors, however, do not invariably result in a high risk of extinction to native taxa. Diamond and Veitch (1981) argue, based on a study conducted in New Zealand, that the extinction of native landbirds was caused by introduced mammalian predators. The decrease in the number of native species subsequently allowed the establishment of introduced birds, some of which may have had several ecological parallels with species extirpated by predators.

This study indicates little overlap in the diets of native extinct and introduced birds on Indian Ocean islands and therefore competition for food is probably not a significant cause of extinction. Half of the introduced species are granivores, a dietary guild that was almost absent from the native avifauna. However, following an increase in seed supply associated with increasing agriculture, introduced granivorous landbirds can thrive in a habitat that previously was rare or absent. Consequently, other factors, like

competition for nesting sites will probably be important. Cheke (1987b) points to the negative effects of nest–robbing by introduced Common Mynah, *Acridoteres tristis*, and Red–Whiskered Bulbul, *Pycnonotus jocosus*. The introduced Common Mynah and the Ring – Necked Parakeet (also introduced), compete with the critically endangered Echo Parakeet for nest sites (Cheke 1987b).

Causes of past extinctions do not necessarily provide a good indication of the threats facing extant species. Although predation is responsible for most past island extinctions, habitat destruction and degradation are the most important current threats (King 1985), and Diamond (1989a) has emphasised the increasing role that habitat destruction will play in the future as a cause of extinction. This is even more meaningful for island ecosystems because of their small size and limited opportunities for dispersal.

The habitat category identified by this analysis as being at greatest risk is pristine forest; this being the habitat occupied by most threatened birds. Although some species have adapted to secondary growth and plantations (e.g. Mauritius Kestrel *Falco punctatus*, Malagasy Scops-Owl *Otus rutilus capnodes*, Mauritius Bulbul *Hypsipetes olivaceus*, Seychelles Magpie Robin, Seychelles Black Paradise Flycatcher and Seychelles White-eye *Zosterops modestus*), the majority will probably not be able to adjust fast enough. Disturbance and destruction of pristine habitat will therefore have negative consequences for the landbird avifauna. It is also important to note that the occupancy of secondary habitats is not in itself adequate to ensure species' persistence – sufficient and successful reproduction within such habitats is a necessary precursor for species survival.

Tilman *et al.* (1994) show that dominant competitors might not be free of extinction threat from habitat destruction as would be expected because of their abundance. These authors used a modelling approach to conclude that even moderate destruction of previously undisturbed habitat causes time–delayed (extinction debt) loss of dominant species in the remaining patches.

Pristine forest is a threatened habitat on Indian Ocean islands, especially in the Comoros. Between 1973 and 1983 these islands lost 15 % of their forest area (FAO 2000). Seychelles still retains 56 % of its surface covered by "closed canopy forest", although much of it is coconut plantation (FAO 2000). By contrast, Mauritius and the Comoros have only 3% and 7.7% forest cover respectively (plantations on Mauritius are not included in this figure). The high number of forest bird endemics confined to the remaining patches of forest on Mohéli, Anjouan and Mount Karthala on Grande Comore suggests that future extinctions in these forest patches are likely.

The fact that habitat and human population size were significant predictors of species survival suggests that humans will continue to have a large impact on the avifauna of the west Indian Ocean islands. Mauritius, for example, has the highest human population densities in the region. The population growth rates are positive for the Mascarenes and Seychelles but they are the highest in the Comoros (CIA 2000). Increasing human populations will inevitably demand more space for housing and agricultural development - to the detriment of the few pristine areas left.

Bird mobility is a highly significant correlate of past extinctions, flightless birds having been an easy target to the early colonisers. With the exception of the Aldabran

Rail, all other flightless birds of the region are extinct, mostly due do hunting (dodo and solitaires) or because of introduced predators (Cheke 1987a) However, many mobile species have also become extinct and 29 mobile taxa are included in the Red Data Book (BirdLife International 2000).

The effect of island area on the persistence of species is highly significant, although only after adjusting for the three factors mentioned above. This is consistent with the patterns observed by Reed (1985) in a study of landbird populations on British islands, where the number of habitats present on islands explained most of the variance. Regardless of the mathematical elegance of the species–area relationship other environmental and ecological variables need to be considered when investigating parameters responsible for species' survival on islands. The model shows that species on small islands have a higher risk of extinction than those on large islands, in line with Island Biogeography Theory (MacArthur and Wilson 1967). However, the model also indicates that the persistence of species is more influenced by the extent of remaining suitable habitat than by island area.

An increase in range size (measured as the number of islands on which a species occurs) has a significant effect on species survival once it exceeds eight islands. A possible explanation for this is that species with large ranges are good dispersers and may be able to recolonize islands following local extinctions. Such species are habitat generalists or inhabit all forest types. The low taxonomic similarity between islands indicates that relatively few species (n=8) have wide ranges encompassing eight or more islands. Range size alone however, is no guarantee for the existence of species, parameters such as available habitat and island size being more significant.

Nevertheless, it underlines the need for preserving bird populations on as many islands as possible within a species' range and suggests that introduction of threatened species to other islands with similar environmental conditions could be a possible solution for their survival.

Of the factors included in the analyses and found to be non–significant, human population density could be explained by the inclusion in the model of human population size and island area. Similarly, island maximum elevation is generally correlated with island size. Distance from either Africa or Madagascar was also non-significant. Within island archipelagos (especially the Seychelles where distances between many of the islands are short), species pools of neighbouring islands are more likely to determine local diversity than is distance from the ancestral source areas of Africa and Madagascar. However, inclusion in the model of distances between islands is rather difficult, mainly because accurate information is not very easily available and the purpose of building this model was to use minimal necessary information. It is also questionable which distance should be considered: distance to the nearest island regardless of its size or distance to the biggest nearest island (which is, again, disputable – e.g. for Seychelles, should one consider Aldabra/Mahé or Madagascar?). Besides, there are other islands in the area, which were not included in this study, and it is difficult to assess which exactly served as species pool and which was the recipient.

The model predicted on average, relatively low values for the risk indices for both extant and extinct species. Very few extinct species were predicted values between 0.61 and 0.70, while a high proportion was included in the 0.51-0.60 interval. The

apparent lack accuracy of the model in identifying extinct species (46% birds with risk indices less than 0.5) emphasises the need for caution when extrapolating the interpretation of results to extant species.

The results should be seen in perspective. The model placed the highest risk on species with most of the 'disadvantageous' traits (occupancy of only pristine forest, being flightless, living on only a few small islands with high human population and having a diet consisting primarily of fruits or seeds). However, this does not imply that other species are safe, but that comparatively, they face a lower threat.

The model predictions corresponded to RDB rankings in approximately 50% of cases. Most discrepancies affected species of the Comoros. This is probably due to the absence of documented extinctions in the Comoro archipelago, the model using extinctions from other two island groups to infer underlying relationships. Moreover, there were (to the best of our knowledge) no flightless birds on the Comoros and the islands are medium and large in size. Most Comoran species belong to the least vulnerable diet categories, insectivory and "other".

The nine species not included in the RDB for which the model specified global risk indices greater than 0.1 are mainly single-island endemics. The White-eyes of Réunion and Mauritius seem to have been little affected by human transformation of habitats (Cheke 1987b and 1987c). However, the Marianne White-eye *Zosterops mayottensis semiflava* became extinct on Marianne when the native vegetation was replaced with coconut plantation (Watson 1984).

The majority of species included in the RDB are confined to very small habitat fragments. Therefore, species found on large islands may appear as having large ranges when in fact they are restricted to a few isolated patches (Rodrigues Fody *Foudia flavicans* – BirdLife International 2000). Other examples include the Seychelles White-eye and the Seychelles Scops-Owl *Otus insularis*, both with ranges within Morne Sechellois National Park on Mahé (Watson 1984) and the birds of Mauritius following the masive reduction of forest habitat (Temple 1981).

Because the model was specifically developed to operate with limited information, it inevitably has its own limitations. Important factors not included are current population sizes of the different species, threats due to hybridisation (e.g. with *Streptopelia picturata* – Penny 1974), inbreeding depression (e.g. Pink Pigeon, *Nesoenas mayeri* – Jones 1987 - and Seychelles Magpie Robin *Copsychus sechellarum*), genetic bottlenecks (Mauritius Kestrel *Falco punctatus* – Cade and Jones 1993), and threats due to competition with introduced landbirds (which impact among others the Echo Parakeet – Jones 1987).

Were the model to be developed further, some of these factors could be addressed. For example, it would be possible to include a factor accounting for the presence or absence of an alien congener or the presence/absence of alien predatory land mammals. Other factors, however, could not be taken into account. These include species-specific interactions or mutualisms.

A simple model was desired to identify the environmental and ecological parameters predisposing tropical islands landbird species to extinction and threat. The model

underlined important factors that also have biological support. The variables included in the model are generally readily available making application of results to other island situations relatively easy. Moreover, the model predicts the probability of extinction for each species on each island, therefore making it easier to identify conservation priorities. Further investigation into the application of this approach to insular habitats such as tropical African montane forest might also prove useful.

Acknowledgements:

I thank Prof. Phil Hockey, for enticing me into the wonderful world of island birds and for his constant support, patience and invaluable advice. I am grateful to Anthony Richardson for his assistance in developing the model and for sharing his time and knowledge with so much generosity. Adrian Skerrett and Marc Herremans commented on earlier versions of the database. I thank Struik Publishers, Cape Town, for the permission to include the map of the study area. My studies in South Africa were made possible through a grant from Open Society Budapest. My appreciation goes to faculty and staff at the FitzPatrick Institute and especially to my fellow CB-ers for being such wonderful and tireless friends.

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Table 1. Summary statistics for native, endemic and introduced taxa on the Mascarenes, Seychelles and Comoros. Parenthesis indicate the number of species with subspecies

Island group	MASCARENES		SEYCHELLES		COMOROS	
Category	Species	Subspecies	Species	Subspecies	Species	Subspecies
Total number **natives** in 1600	42(3)	3	30(7)	12	40(24)	45
Natives extant	22(2)	2	28(4)	8	40(24)	45
Natives extinct	20(1)	1	2(3)	4	-	-
% extinct	48%	33%	7%	33%	-	-
Total number **endemics** in 1600	39(3)	3	22(7)	12	33(23)	45
Endemics extant	19(2)	2	19(5)	8	33(23)	45
Endemics extinct	20(1)	1	2(4)	4	-	-
% extinct	51%	33%	9%	33%	-	-
Total number **introduced**	27(1)	1	13(1)	1	14	-
Introduced extant	24(1)	1	12(1)	1	12	-
Introduced extinct	3	-	1	-	2	-
% extinct of total introduced	11 %	-	8 %	-	14 %	-

Table 2. Number and percentage of extant and extinct native species in each risk index category

Extant species			Extinct species			
Risk index	**n**	**%**	**Risk index**	**n**	**%**	**% extinct species (of total)**
0.0 - 0.1	131	63.29	0.0 - 0.1	6	10.71	4
0.11-0.2	23	11.11	0.11-0.2	5	8.93	18
0.21-0.3	18	8.70	0.21-0.3	5	8.93	22
0.31-0.4	16	7.73	0.31-0.4	7	12.5	30
0.41-0.5	8	3.86	0.41-0.5	3	5.36	27
0.51-0.6	4	1.93	0.51-0.6	14	25	78
0.61-0.7	7	3.38	0.61-0.7	5	8.93	42
0.71-0.8	0	0	0.71-0.8	4	7.14	100
0.81-0.9	0	0	0.81-0.9	1	1.79	100
0.91-1	0	0	0.91-1	6	10.71	100

Table 3. Values assigned by the GLM to each category of the predictor variables

	Predictor	Value assigned by the GLM
Habitat	Pristine forest	-1.62
	Forest, woodland, secondary growth	0.03
	Other	0.89
Mobility	0	-3.82
	1	0.14
Human population	Low	0.27
	High	-1.9
Area	Mauritius	1.77
	Réunion	1.97
	Rodrigues	0.19
	Mahé	0.4
	Praslin	-0.56
	Silhouette	-0.74
	La Digue	-1.12
	Curieuse	-1.82
	Frégate	-1.97
	Marianne	-2.44
	Félicité	-1.86
	Aride	-2.62
	Cusin	-3.11
	Cusine	-3.17
	Bird Island	-2.4
	Aldabra	0.41
	Astove	-1.45
	Asumption	-1.04
	Cosmoledo	-1.71
	Providence	-2.16
	Farquhar	-2.53
	Amirantes	-2.3
	Grande Comore	1.53
	Mohéli	0.58
	Anjouan	0.97
	Mayotte	0.9
Number of islands	Streptopelia picturata (14)	3.93
	Alectroenas pulcherima (10)	1.01
	Alectroenas sganzini (9)	0.28
	Nectarinia dussumieri (12)	2.47
	All other taxa (8 or less)	-0.45
Diet	Frugivores	-0.58
	Granivores	-2.72
	Insectivores	0.4
	Other	0.37

Table 4. Native extant species for which the GLM predicted a global risk index greater than 0.1

No.	Species not included in the Red Data Book	Island	Predicted global risk index	Red Data Book status
1	Pink Pigeon	Mauritius	0.66	Endangered
2	Echo Parakeet	Mauritius	0.66	Critical
3	Aldabra Rail	Aldabra	0.58	N/A
4	Mauritius Olive White-Eye	Mauritius	0.42	Endangered
5	Mauritius Cuckoo Shrike	Mauritius	0.42	Vulnerable
6	Mauritius Fody	Mauritius	0.42	Critical
7	Réunion Bulbul	Réunion	0.38	N/A
8	Réunion Olive White-Eye	Réunion	0.37	N/A
9	Réunion Grey White-Eye	Réunion	0.37	N/A
10	Réunion Cuckoo Shrike	Réunion	0.37	Endangered
11	Seychelles Black Parrot	Praslin	0.30	N/A
12	Seychelles Magpie Robin	Fregate, Cousin	0.27	Critical
13	Seychelles Warbler	Cousin, Cousine, Aride	0.26	Vulnerable
14	Seychelles Scops Owl	Mahé	0.25	Critical
15	Benson's Brush Warbler	Mohéli	0.22	N/A
16	Moheli Scops Owl	Mohéli	0.21	Critical
17	Abbott's Sunbird	Assumption	0.21	N/A
18	Mauritius Kestrel	Mauritius	0.13	Vulnerable
19	Mauritius Bulbul	Mauritius	0.13	Vulnerable
20	Comoro Green Pigeon	Mohéli	0.12	N/A
21	Mauritius Grey White-Eye	Mauritius	0.12	N/A

Table 5. Global risk index, as predicted by the GLM, of native extant species in four threat categories (BirdLife International 2000)

	Model predictions (risk of extinction)								
	1 – 0.71	**0.7 – 0.61**	**0.60 – 0.51**	**0.50 – 0.41**	**0.40 – 0.31**	**0.30 – 0.21**	**0.20 – 0.11**	**0.10 – 0.0**	**Total**
Red Data Book species									
CRITICAL	0	1	0	1	0	3	0	4	9
ENDANGERED	0	1	0	1	1	0	0	5	8
VULNERABLE	0	0	0	1	0	1	2	5	9
NEAR-THREATENED	0	0	0	0	0	0	0	3	3
Species not included in RDB	0	0	1	0	3	3	2	46	55
Total	0	2	1	3	4	7	4	63	84

Table 6. Risk index ranges chosen to group the model predictions into threat categories

Red Data Book category	**Risk index range**
CRITICAL	0.5 – 0.69
ENDANGERED	0.2 – 0.49
VULNERABLE	0.1 – 0.19
NEAR-THREATENED	0.01 – 0.1

Table 7. Predicted global risk indices for species included in the Red Data Book

No.	Species	Island(s) on which extant	Predicted global risk index	Predicted threat status
	Red Data Book Species			
	CRITICAL			
1	Echo Parakeet	Mauritius	0.66	Critical
2	Mauritius Fody	Mauritius	0.42	Endangered
3	Seychelles Magpie Robin	Fregate, Cousin	0.27	Endangered
4	Seychelles Scops Owl	Mahé	0.25	Endangered
5	Moheli Scops Owl	Mohéli	0.21	Endangered
6	Karthala Scops Owl	Grande Comore	0.10	Vulnerable
7	Seychelles Black Paradise Flycatcher	La Digue, Félicité	0.08	Near-threatened
8	Seychelles White-eye	Mahé	0.06	Near-threatened
9	Malagasy Scops Owl	Anjouan, Mayotte	<0.01	Not threatened
	ENDANGERED			
1	Pink Pigeon	Mauritius	0.66	Critical
2	Mauritius Olive White-eye	Mauritius	0.42	Endangered
3	Réunion Cuckoo Shrike	Réunion	0.37	Endangered
4	Humblot's Flycatcher	Grande Comore	0.10	Vulnerable
5	Rodrigues Warbler	Rodrigues	0.07	Near-threatened
6	Mayotte Drongo	Mayotte	0.04	Near-threatened
7	Grande Comore Drongo	Grande Comore	0.02	Near-threatened
8	Madagascar Marsh Harrier	Réunion, Grande Comore, Mohéli, Anjouan, Mayotte	<0.01	Not threatened
	VULNERABLE			
1	Mauritius Cuckoo Shrike	Mauritius	0.42	Endangered
2	Seychelles Warbler	Cousin, Cousine, Aride	0.26	Endangered
3	Mauritius Kestrel	Mauritius	0.13	Vulnerable
4	Mauritius Bulbul	Mauritius	0.13	Vulnerable
5	Seychelles Fody	Frégate, Cousin, Cousine, Amirantes	0.09	Near-threatened
6	Rodrigues Fody	Rodrigues	0.07	Near-threatened
7	Karthala White-Eye	Grande Comore	0.01	Near-threatened
8	Seychelles Kestrel	Mahé, Praslin, Silhouette	<0.01	Not threatened
9	Seychelles Swiftlet	Mahé, Praslin, La Digue, Aride, Cousin, Cousine, Bird Island	<0.01	Not threatened
	NEAR-THREATENED			
1	Aldabra Drongo	Aldabra	0.06	Near-threatened
2	Comoro Olive Pigeon	Grande Comore, Mohéli, Anjouan, Mayotte	0.01	Near-threatened
3	Mascarene Swiftlet	Mauritius, Réunion	<0.01	Not threatened

Fig. 1 Map of study area

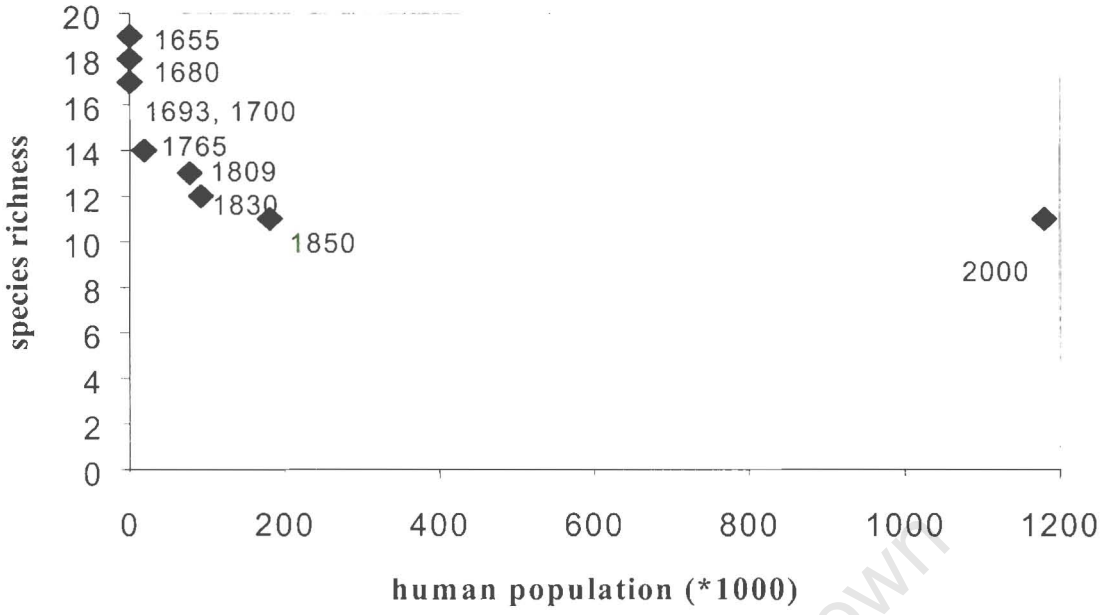

Fig. 2 Species extinction on Mauritius as a function of the increase in human population

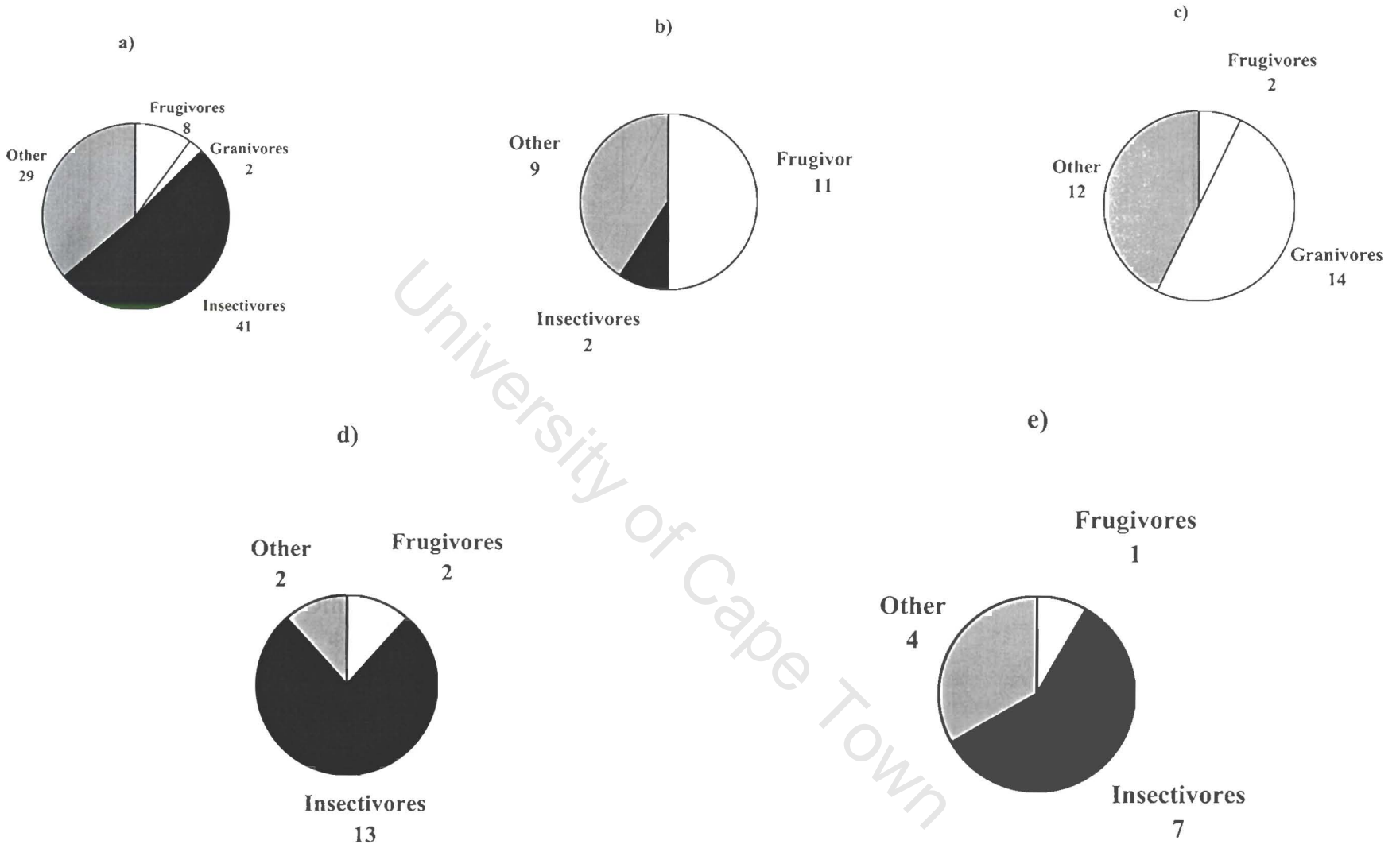

Fig. 3 Proportional representation of dietary guilds among a) all extant native species, b) globally extinct native species, c) extant introduced species, d) critically endangered and endangered species included in the Red Data Book and e) vulnerable and near-threatened species

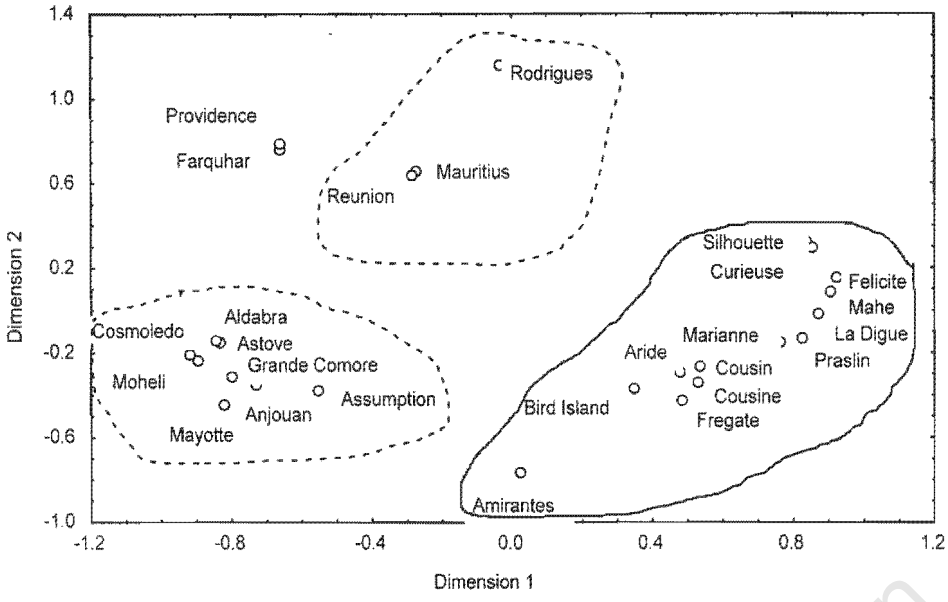

Fig. 4 Original (1600) taxonomic similarity between islands

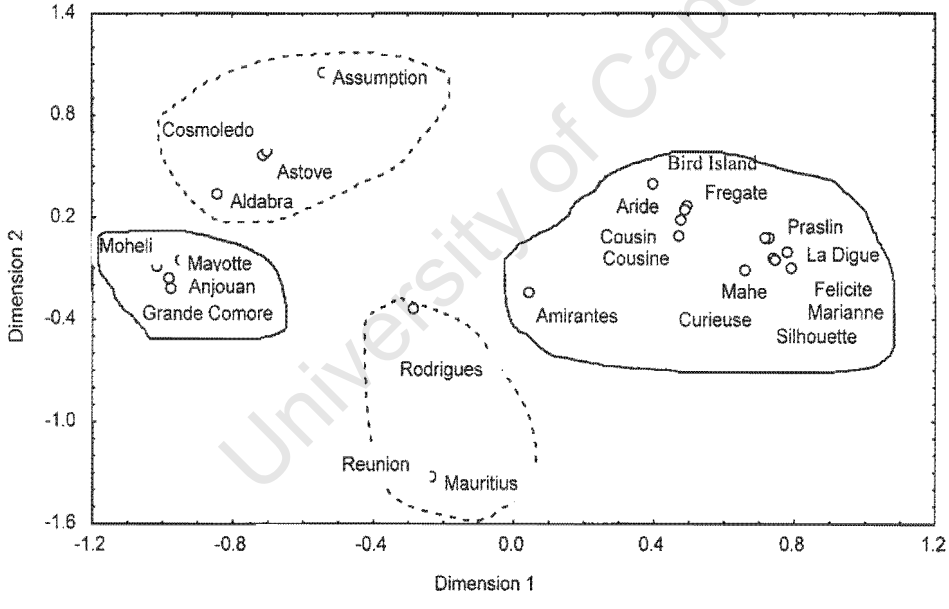

Fig. 5 Taxonomic similarity between islands now

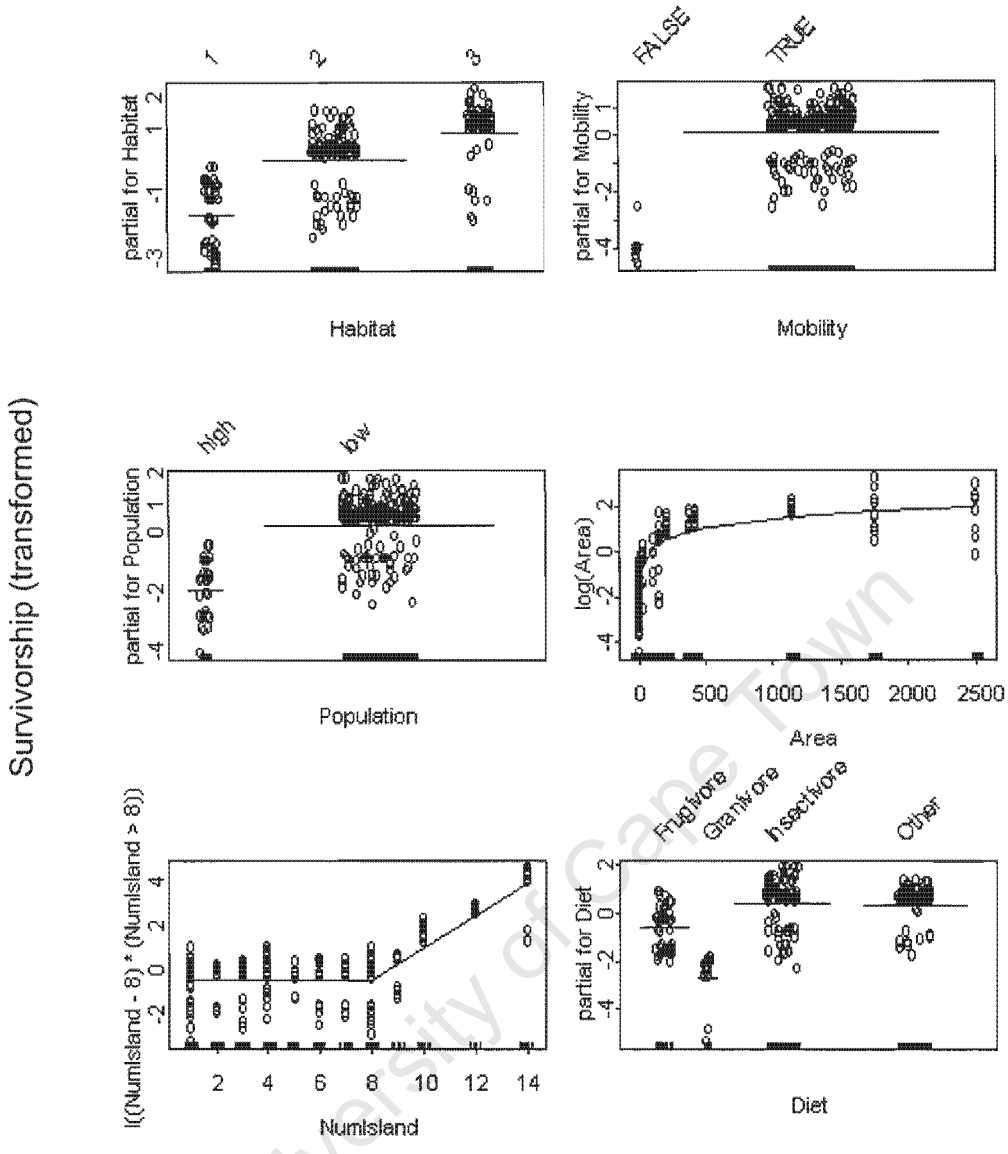

Fig. 6 Relationship between species' survival and significant predictor variables identified by the model. Residuals of the response (survivorship) are shown for each predictor. Habitat: 1 = pristine forest, 2 = forest, woodland, secondary growth, 3 = other; Mobility: false = flightless, true = volant; Population: high = high human population size, low = low human population size; Area: area of island in km^2; NumIsland: number of islands on which a species had occurred.

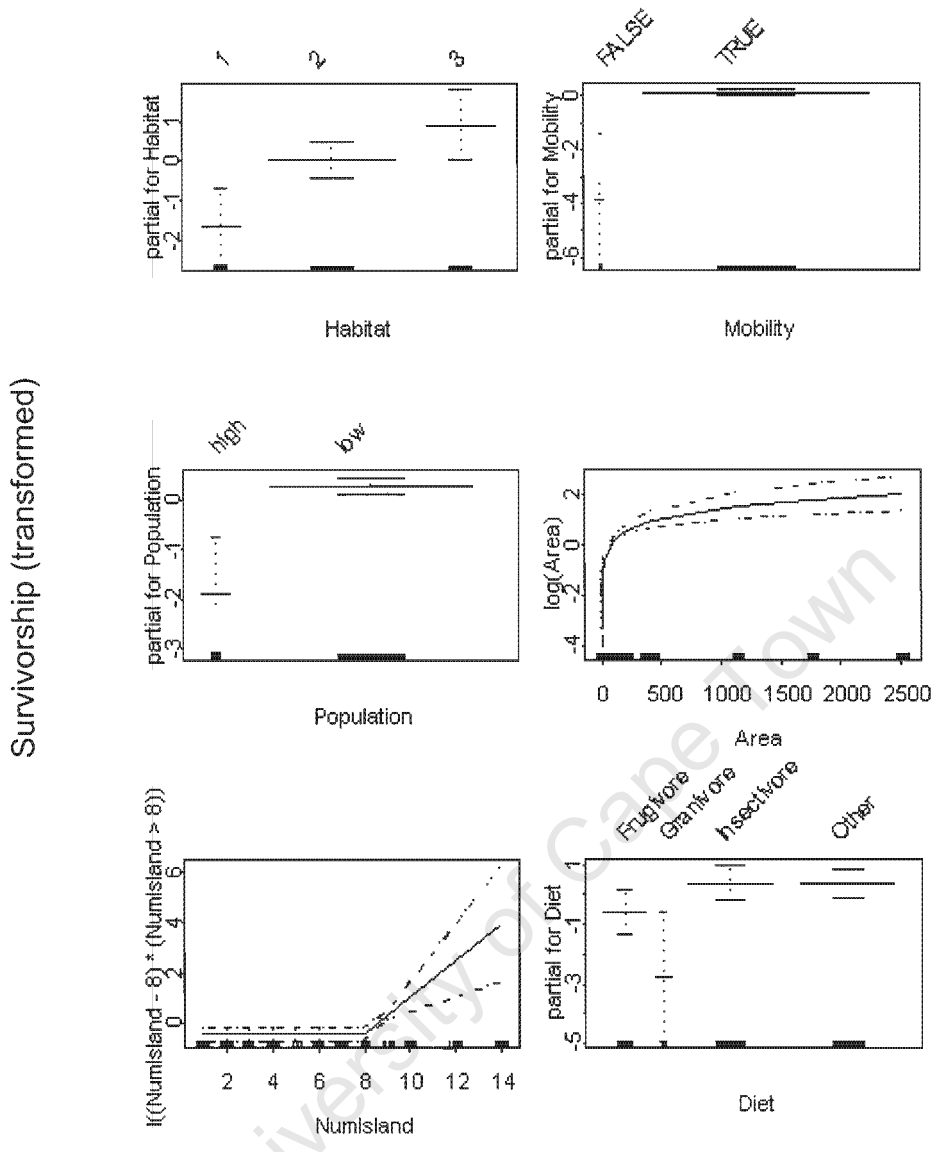

Fig. 7 Relationship between species' survival and significant predictor variables identified by the model. Standard error for the response (survivorship) is shown for each predictor. Habitat: 1 = pristine forest, 2 = forest, woodland, secondary growth, 3 = other; Mobility: false = flightless, true = volant; Population: high = high human population size, low = low human population size; Area: area of island in km^2; NumIsland: number of islands on which a species had occurred.

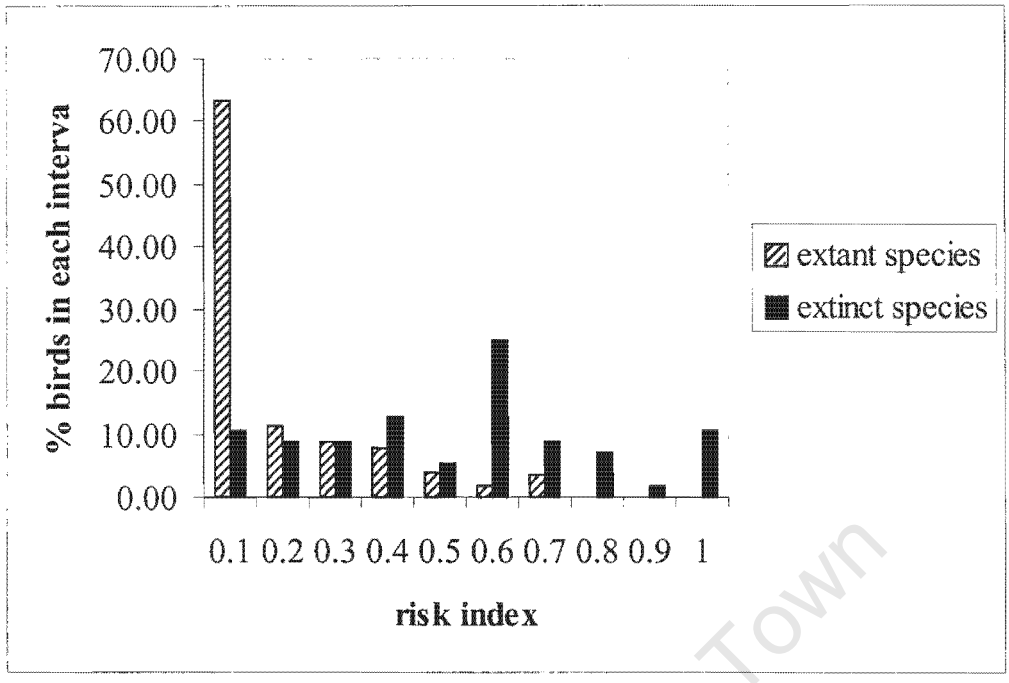

Fig. 8 Distribution of native extant and extinct species in risk index categories (risk index was calculated as 1-GLM predicted survival index)

APPENDIX A

Ecological, environmental and biological data for islands included in the analyses

Island	Geological origin	Area (Km^2)	Maximum altitude (m)	Minimum distance to source (Km)	Number of species					
					Native extant	Native extinct	Total natives	Introduced extant	Introduced extinct	Total introduced
Mauritius	volcanic	1761	828	704	11	8	19	20	5	25
Reunion	volcanic	2512	3069	563	9	6	15	19	2	21
Rodrigues	volcanic	104	396	1086	2	8	10	7	3	10
Mahe	granitic	152.52	905	825	7	2	9	8	1	9
Praslin	granitic	27.56	367	925	6	4	10	6	0	6
La Digue	granitic	10.1	333	965	5	3	8	7	0	7
Silhouette	granitic	19.95	740	844	4	1	5	6	1	7
Curieuse	granitic	2.86	172	926	3	1	4	5	0	5
Fregate	granitic	2.19	125	880	5	0	5	5	0	5
Marianne	granitic	0.947	N/A	885	3	6	9	5	0	5
Felicite	granitic	2.68	231	880	3	2	5	5	0	5
Aride	granitic	0.683	134	985	5	4	9	4	1	5
Cousin	granitic	0.286	58	869	6	0	6	5	0	5
Cousine	granitic	0.257	5	869	5	0	5	5	0	5
Bird Island	low sand cays on coral reef	1.01	5	1066	3	0	3	4	0	4

Island	Geological origin	Area (Km^2)	Maximum altitude (m)	Minimum distance to source (Km)	Number of species					
					Native extant	Native extinct	Total natives	Introduced extant	Introduced extinct	Total introduced
Aldabra	reef limestone	155	8	322	13	1	14	1	1	2
Astove	reef limestone	5.6	8	161	5	3	8	0	0	0
Assumption	reef limestone	11.5	8	241	2	3	5	4	0	4
Cosmoledo	reef limestone	3.5	8	201	5	4	9	1	0	1
Providence	low sand cays on coral reef	1.57	5	342	0	1	1	1	0	1
Farquhar	low sand cays on coral reef	0.08	5	221	0	1	1	2	0	2
Amirantes	low sand cays on coral reef	0	5	595	0	1	1	5	0	5
Grande Comore	volcanic	1148	2361	241	32	0	32	10	1	11
Mohcli	volcanic	211	790	302	27	0	27	10	1	11
Anjouan	volcanic	424	1595	342	24	0	24	9	0	9
Mayotte	volcanic	374	660	201	20	0	20	12	1	13

APPENDIX B

Summary information for all taxa of breeding landbirds on the Mascarenes, Seychelles and Comoros

Author key:

1. Barré and Barau (1982)
2. BirdLife International (2000)
3. Cheke (1987a)
4. Cheke (1987b)
5. Cheke (1987c)
6. Cheke (1987d)
7. Day (1989)
8. Dunning (1993)
9. Fuller (1987)
10. del Hoyo *et al*. (1994)
11. Jones (1987)
12. Lafontaine and Moulaert (1998)
13. Lionet (1984)
14. Long (1981)
15. Louette (1988)
16. Monroe and Sibley (1993)
17. Mortimer and Constance (2000)
18. Penny (1974)
19. Prŷs-Jones and Diamond (1984)
20. Sinclair and Langrand (1998)
21. Skerret and Skerret (1991)
22. Staub (1967)
23. Taylor (1998)

Habitat key:

1 = pristine forest
2 = forest, woodland, secondary growth
3 = other

NATIVE SPECIES

No	Family	Species	Subspecies	Common name	Red Data Book status[2]	Mass (g)	Diet	Habitat[20]	Island (s) on which extant	Island (s) on which extinct	Reference
1	Threskiornithidae	Threskiornis bernieri		Madagascar Sacred Ibis		1500[8]	Other[8]	3	Ald		2, 8, 18, 20
2	Accipitridae	Circus maillardi	macrosceles	Malagasy Harrier	Endangered	600[10]	Other[10]	3	GC, Mo, Anj, May		2, 10, 15, 20
3			maillardi	Réunion Harrier	Endangered	600[10]	Other[10]	3	Ré		1, 2, 10, 20
4		Milvus migrans	aegyptius[16]	Yellow-Billed Kite		750[10]	Other[10]	3	GC, Mo, Anj, May		2, 10, 15, 16, 20
5		Accipiter francesiae	griveaudi	Frances's Sparrowhawk		120[10]	Other[10]	2	Gc		2, 10, 15, 20
6			pusillus			120[10]	Other[10]	2	Anj		
7			brutus			120[10]	Other[10]	2	May		

No	Family	Species	Subspecies	Common name	Red Data Book status[2]	Mass (g)	Diet	Habitat[20]	Island (s) on which extant	Island (s) on which extinct	Reference
8	Falconidae	Falco peregrinus		Peregrine Falcon		782[10]	Other[10]	3	GC, Mo, Anj, May		10, 15,
9		Falco araea		Seychelles Kestrel	Vulnerable	80[10]	Other[10]	2	Mah, Pra, LaD, Sil		2, 10, 18,
10		Falco newtoni		Madagascar Kestrel		123[10]	Other[10]	3	Ald		10, 18,
11		Falco punctatus		Mauritius Kestrel	Vulnerable	205[10]	Other[10]	2	Mau		2, 10, 11
12		Falco sp.		?	Globally extinct	250[10]	Other[10]		Ré		3, 10
13	Rallidae	Dryolimnas cuvieri	aldabranus	Aldabra Rail		267[10]	Insectivore[10]	3	Ald		10, 18,
14			cuvieri	White-Throated Rail		267[10]	Insectivore[10]	3		Mau	3, 10
15			abbotti		Globally extinct	267[10]	Insectivore[10]	3		Ast, Ass Cos	10, 13, 18,
16		Aphanapteryx bonasia		Mauritian Red Rail	Globally extinct	850[23]	Other	1		Mau	3, 7, 9, 23
17		Aphanapteryx leguati		Leguat's Rail	Globally extinct	850[23]	Other	1		Ro	3, 7, 9, 23
18	Columbidae	Columba polleni		Comoro Olive Pigeon	Near-threatened	381[8]	Frugivore	1	GC, Moh, Anj, May		2, 8, 15
19		Columba rodericana			Globally extinct	350[8]	Frugivore	1		Ro	3, 8, 9,
20		Streptopelia picturata	rostrata	Seychelles Turtle Dove		167[10]	Granivore[10]	3	Fre, Ari, Cn, Cne		10, 18,
21			coppingeri			167	Granivore	3	Ald, Ast, Cos	Ass	
22			aldabrana		Globally extinct	167	Granivore	3		Ami	
23			comorensis			167	Granivore	3	GC, Moh, Anj, May		15

No	Family	Species	Subspecies	Common name	Red Data Book status[2]	Mass (g)	Diet	Habitat[20]	Island (s) on which extant	Island (s) on which extinct	Reference
37		Psittacula exsul		Rodrigues Ring-Necked Parakeet	Globally extinct	115	Frugivore	1		Ro	3, 7, 8, 9,
38		Lophopsittacus bensoni		Mauritius Grey Parrot	Globally extinct	250	Frugivore	1		Mau	3, 7, 8, 9
39		Lophopsittacus mauritanus		Broad-Billed Parrot	Globally extinct	800	Frugivore	1		Mau	3, 7, 8, 9
40		Necropsittacus rodericanus		Rodriguez Parrot	Globally extinct	200	Frugivore	1		Ro	3, 7, 8, 9
41		Mascarinus mascarinus		Mascarene Parrot	Globally extinct	160	Frugivore	1		Re	3, 7, 8, 9
42	Centropodidae	Centropus toulou		Madagascar Coucal		124[8]	Frugivore[8]	3	Ald	Ass, Cos	8, 18,
43	Tytonidae	Tyto sauzieri		Mauritian Barn Owl	Globally extinct	550	Insectivore	1		Mau, Re	3, 8, 9
44	Strigidae	Otus insularis		Seychelles Scops Owl	Critical	100[10]	Insectivore[10]	1	Mah		2, 10, 18,
45		Otus pauliani		Karthala Scops Owl	Critical	70[10]	Insectivore[10]	1	GC		2, 10, 15,
46		Otus rutilus	capnodes	Malagasy Scops Owl	Critical	104[10]	Insectivore[10]	2	Anj		2, 10, 15, 16,
47			mayottensis			104[10]	Insectivore[10]	2	May		10, 15,
48		Otus moheliensis		Moheli Owl	Critical	106	Insectivore	1	Moh		2, 12
49		Scops commersoni		Commerson's Scops Owl	Globally extinct	120	Other	1		Mau	3, 8
50		Ninox murivora		Rodrigues Little Owl	Globally extinct	160	Other	1		Ro	8,
51	Caprimulgidae	Caprimulgus madagascariensis		Madagascar Nightjar		44[10]	Insectivore[10]	3	Ald		10, 18,
52	Apodidae	Apus barbatus	mayottensis	Madagascar Black Swift		42[10]	Insectivore[10]	3	GC, Moh, Anj, May		10, 15,

No	Family	Species	Subspecies	Common name	Red Data Book status[2]	Mass (g)	Diet	Habitat[20]	Island (s) on which extant	Island (s) on which extinct	Reference
24	Alectroenas pulcherrima			Seychelles Blue Pigeon		163[10]	Frugivore[10]	2	Mah, Pra,LaD,Sil, Cu, Fre, Mar, Ari, Cn, Cne		10, 18,
25	Alectroenas sganzini			Comoro Blue Pigeon		159[10]	Frugivore[10]	2	Ald, GC, Moh, Anj, May	Ast, Cos, Pro, Far	10, 15, 17, 18,
26	Alectroenus nitidissima			Dutch Pigeon	Globally extinct	150	Frugivore	1		Mau	3, 7, 9
27	Treron australis		griveaudi	Comoro Green Pigeon		210[10]	Frugivore[10]	2	Moh		10, 15,
28		Nesoenas mayeri		Pink Pigeon	Endangered	303[10]	Frugivore[10]	1	Mau		2, 10, 11,
29	Raphidae	Raphus cucullatus		Dodo	Globally extinct	25000	Frugivore	1		Mau	3, 7, 8, 9
30		Ornithaptera solitaria		Reunion Dodo or Reunion Solitaire	Globally extinct	25000	Frugivore	1		Re	3, 8, 9
31		Pezophaps solitarius		Rodrigues Solitaire	Globally extinct	20000	Frugivore	1		Ro	3, 7, 8, 9
32	Psittacidae	Coracopsis vasa	comorensis	Greater Vasa Parrot		200[10]	Frugivore[10]	2	GC, Moh, Anj		10, 15,
33		Coracopsis nigra	sibilans	Lesser Vasa Parrot		143[10]	Frugivore[10]	2	GC, Anj		10, 15,
34			barklyi	Seychelles Black Parrot		143[10]	Frugivore[10]	2	Pra	Mar, Ari	10, 18, 21,
35		Psittacula echo		Echo Parakeet	Critical	180[10]	Frugivore[10]	1	Mau		2, 10, 11,
36		Psittacula eupatria	wardi	Seychelles Parrot	Globally extinct	115	Frugivore	1		Mah, Pra, Sil	7, 8, 9, 13, 18,

No	Family	Species	Subspecies	Common name	Red Data Book status[2]	Mass (g)	Diet	Habitat[20]	Island (s) on which extant	Island (s) on which extinct	Reference
53		Zoonavena grandidieri	mariae	Madagascar Spine-Tailed Swift		15[10]	Insectivore[10]	2	GC		10, 15,
54		Cypsiurus parvus	griveaudi	African Palm Swift		14[10]	Insectivore[10]	2	GC, Moh, Anj, May		10, 15,
55		Collocalia elaphra		Seychelles Swiftlet	Vulnerable	10.5[10]	Insectivore[10]	3	Mah, Pra, LaD, Ari, Cn, Cne, Brd	Fel	2, 10, 18,
56		Collocalia francica		Mascarene Swiftlet	Near-threatened	9.3[10]	Insectivore[10]	3	Mau, Re		1, 2, 4, 5, 10,
57	Hirundinidae	Phedina borbonica	borbonica	Mascarene Martin		23.9[8]	Insectivore	3	Mau, Re		1, 4, 5, 8,
58	Meropidae	Merops superciliosus		Madagascar Bee-Eater		48.3[8]	Insectivore	3	GC, Moh, Anj, May		8, 15,
59	Leptosomatidae	Leptosomus discolor	gracilis	Madagascar Cuckoo-Roller		220[8]	Other	2	GC		8, 15,
60			intermedius	Comoro Cuckoo-Roller		220	Other	2	Anj		
61			discolor			220		2	Moh, May		
62	Pycnonotidae	Hypsipetes madagascariensis		Madagascar Bulbul		42.9[8]	Other	2	Ald, GC, Moh, Anj, May	Ast, Cos	8, 15,
63		Hypsipetes parvirostris	parvirostris	Comoro Bulbul		80[8]	Other	2	GC		8, 15,
64			moheliensis			80	Other	2	Moh		
65		Hypsipetes borbonicus		Reunion Bulbul		54.7[8]	Other	1	Re		1, 8,
66		Hypsipetes crassirostris		Seychelles Bulbul		79.5[8]	Other	2	Mah, Pra, LaD, Cu, Fel	Mar	8, 18,

No	Family	Species	Subspecies	Common name	Red Data Book status[2]	Mass (g)	Diet	Habitat[20]	Island (s) on which extant	Island (s) on which extinct	Reference
67		Hypsipetes olivaceus		Mauritius Bulbul	Vulnerable	55[8]	Other	2	Mau		2, 4, 8,
68		Hypsipetes sp.		? Rodrigues Bulbul	Globally extinct		Other			Ro	3,
69	Turdidae	Turdus bewsheri	bewsheri	Comoro Thrush		63.3[8]	Other	1	Anj		8, 15,
70			comorensis			63.3	Other	1	GC		
71			moheliensis			63.3	Other	1	Moh		
72	Muscicapidae	Copsychus sechellarum		Seychelles Magpie Robin	Critical	26[8]	Insectivore	2	Fre, Cn	Mah, Pra, LaD, Mar, Fel, Ari	2, 8, 18, 19,
73		Saxicola tectes		Reunion Stonechat		12.65[8]	Insectivore	3	Re		1, 5, 8,
74		Saxicola torquata	voeltzkowi	Common Stonechat		11.2[8]	Insectivore	3	GC		8, 15,
75		Humblotia flavirostris		Humblot's Flycatcher	Endangered	14.5[8]	Other	1	GC		2, 8, 15,
76	Monarchidae	Terpsiphone mutata	comorensis	Madagascar Paradise Flycatcher		12.8[8]	Insectivore	2	GC		8, 15,
77			voeltzkowiana			12.8	Insectivore	2	Moh		
78			vulpina			12.8	Insectivore	2	Anj		
79			pretiosa			12.8	Insectivore	2	May		
80		Terpsiphone corvina		Seychelles Black Paradise Flycatcher	Critical	11.5[8]	Insectivore	2	LaD, Fel	Pra, Cu, Mar, Ari	2, 8, 18, 21
81		Terpsiphone bourbonnensis		Mascarene Paradise Flycatcher		11.5[8]	Insectivore	2	Re		1, 5, 8,
82	Sylviidae	Nesillas aldabrana		Aldabra Brush Warbler	Globally extinct	24[8]	Insectivore	3		Ald	8, 18,

No	Family	Species	Subspecies	Common name	Red Data Book status[2]	Mass (g)	Diet	Habitat[20]	Island (s) on which extant	Island (s) on which extinct	Reference
83		Nesillas typica	moheliensis	Madagascar Brush Warbler		24.2[8]	Other	2	Moh		8, 15,
84			longicaudata			24.2	Other	2	Anj		
85		Nesillas brevicaudata		Comoro Brush Warbler		24[8]	Other	1	GC		8, 15,
86		Nesillas mariae		Benson's Brush Warbler		24[8]	Other	1	Moh		8, 15,
87	Cisticolidae	Cisticola cherina		Madagascar Cisticola		10[8]	Insectivore	3	Ast, Cos		8, 17, 18,
88		Acrocephalus rodericanus		Rodrigues Warbler	Endangered	11.4[8]	Insectivore	2	Ro		2, 6, 8,
89		Acrocephalus sechellensis		Seychelles Warbler	Vulnerable	16[8]	Insectivore	2	Ari, Cn, Cne	Mar	2, 8, 18, 19,
90	Zosteropidae	Zosterops maderaspatanus	aldabrensis	Madagascar White-Eye		10[8]	Other	2	Ald, Ast		8, 18,
91			menaiensis			10[8]	Other	2	Cos		8, 17, 18,
92			kirki			10[8]	Other	2	GC		15,
93			comorensis			10[8]	Other	2	Moh		15,
94			anjouanensis			10[8]	Other	2	Anj		15,
95		Zosterops mouroniensis		Karthala White-Eye	Vulnerable	10[8]	Other	3	GC		2, 8, 15,
96		Zosterops chloronotus		Mauritius Olive White-Eye	Endangered	8.1[8]	Insectivore	1	Mau		2, 4, 8,
97		Zosterops olivaceus		Reunion Olive White-Eye		8.1[8]	Insectivore	1	Re		1, 5, 8,
98		Zosterops modestus		Seychelles White-Eye	Critical	9.15[8]	Insectivore	2	Mah		2, 8, 18,
99		Zosterops mauritianus		Mauritius Grey White-Eye		9[8]	Insectivore	2	Mau		8,
100		Zosterops borbonicus		Reunion Grey White-Eye		9[8]	Insectivore	1	Re		5, 8,

No	Family	Species	Subspecies	Common name	Red Data Book status[2]	Mass (g)	Diet	Habitat[20]	Island (s) on which extant	Island (s) on which extinct	Reference
101		Zosterops mayottensis	semiflava	Marianne White-Eye	Globally extinct	8.2[8]	Insectivore	2		Mar	8, 13, 16,
102			mayottensis			8.2[8]	Other	2	May		8, 15, 16,
103	Nectariniidae	Nectarinia notata	moebii	Madagascar Green Sunbird		17.25[8]	Other	2	GC		8, 15,
104			voeltzkowi			17.25	Other	2	Moh		
105		Nectarinia dussumieri		Seychelles Sunbird		10.8[8]	Other	2	Mah, Pra, LaD, Sil, Cu, Fre, Mar, Fel, Ari, Cn, Cne, Brd		8, 18,
106		Nectarinia humbloti	humbloti	Humblot's Sunbird		8[8]	Other	2	GC		8, 15,
107			mohelica			8[8]	Other	2	Moh		
108		Nectarinia souimanga	aldabrensis	Suimanga Sunbird		6.9[8]	Other	2	Ald		8, 18,
109			buchenorum			6.9[8]	Other	2	Ast, Cos		8, 17, 18,
110		Nectarinia abbotti		Abbott's Sunbird		6.9[8]	Other	2	Ass		8, 20
111		Nectarinia comorensis				6.9[8]	Other	2	Anj		8, 16, 20,
112		Nectarinia coquerellii		Mayotte Sunbird		7[8]	Other	2	May		8, 16, 20,
113	Vangidae	Cyanolanius madagascarinus	bensoni	Comoro Blue Vanga		21.8[8]	Insectivore	2	GC		8, 15,
114			comorensis			21.8	Insectivore	2	Moh		
115	Campephagidae	Coracina newtoni		Reunion Cuckoo Shrike	Endangered	43[8]	Insectivore	1	Re		1, 2, 5, 8,
116		Coracina typica		Mauritius Cuckoo Shrike	Vulnerable	42.9[8]	Insectivore	1	Mau		2, 4, 8,

No	Family	Species	Subspecies	Common name	Red Data Book status[2]	Mass (g)	Diet	Habitat[20]	Island (s) on which extant	Island (s) on which extinct	Reference
117		Coracina cinerea	cucullata	Comoro Cuckoo Shrike		43.2[8]	Other	1	GC		8, 15,
118			moheliensis			43.2	Other	1	Moh		
119	Sturnidae	Fregilupus varius		Bourbon/Reunion Crested Starling	Globally extinct	80[8]	Other	1		Re	3, 8,
120		Necropsar rodericanus		Rodrigues Starling	Globally extinct	80[8]	Other			Ro	3, 8,
121	Corvidae	Corvus albus		Pied Crow		529[8]	Other	3	Ald, Ast, Ass, Cos, GC, Moh, Anj, May		8, 15, 17, 18,
122	Dicruridae	Dicrurus forficatus	potior	Crested Drongo		43.8[8]	Insectivore	2	Anj		8, 15,
123		Dicrurus waldenii		Mayotte Drongo	Endangered	55[8]	Insectivore	2	May		2, 8, 15,
124		Dicrurus aldabranus		Aldabra Drongo	Near-threatened	48.5[8]	Insectivore	2	Ald		2, 8, 18,
125		Dicrurus fuscipennis		Grande Comore Drongo	Endangered	48[8]	Insectivore	2	GC		2, 8, 15,
126	Ploceidae	Foudia aldabrana		Aldabra Fody		18[8]	Insectivore	3	Ald		8, 20,
127		Foudia rubra		Mauritius Fody	Critical	17.7[8]	Insectivore	1	Mau		2, 4, 8,
128		Foudia eminentissima	consobrina	Comoro Fody		24.55[8]	Insectivore	2	GC		8, 15,
129			eminentissima			24.55	Insectivore	2	Moh		
130			anjouanensis			24.55	Insectivore	2	Anj		
131			algondae			24.55	Insectivore	2	May		
132		Foudia flavicans		Rodrigues Fody	Vulnerable	15.35[8]	Insectivore	2	Ro		2, 6, 8,
133		Foudia sechellarum		Seychelles Fody	Vulnerable	17.1[8]	Insectivore	2	Fre, Cn, Cne, Ami	Pra, LaD, Mar, Ari	2, 8, 18,
134		Foudia sp.		? Reunion Fody		17[8]	Insectivore	2		Re	3, 8,
135	Estrildidae	Lonchura cucullata		Bronze Mannikin		9.2[8]	Granivore	3	GC, Moh, Anj, May		8, 15,

INTRODUCED SPECIES

No.	Family	Species	Subspecies	Common name	Diet	Island(s) on which extant	Island(s) on which extinct	Reference
1	Numididae	Numida meleagris		Helmeted Guineafowl	Other	Mau, GC, Anj, May	Re	14, 20, 22
2	Phasianidae	Francolinus pintadeanus			Other		Mau	14, 22
3		Francolinus pondicerianus		Grey Francolin	Other	Mau, Ro, Ami		14, 18, 20, 22
4		Margaroperdix madagascariensis		Madagascar Partridge	Other	Mau, Re		14, 20, 22
5		Coturnix coturnix		Common Quail	Other	Mau, Re, GC, Moh, Anj, May		14, 20, 22
6		Coturnix chinensis		Blue-brested Quail	Other	Re	Mau	14, 20, 22
7		Gallus gallus			Other	Re		22
8	Turnicidae	Turnix nigricollis		Madagascar Button-quail	Granivore	Mau, Re		20, 22
9	Columbidae	Columba livia		Feral Pigeon	Granivore	Mau, Re, Ro, Mah, Pra, LaD, Sil, GC, Moh, Anj, May		18, 20
10		Streptopelia chinensis		Spotted (ground) Dove	Granivore	Mau		20
11		Streptopelia capicola		Cape Turtle Dove	Granivore	GC, Moh, Anj, May		14, 20

No.	Family	Species	Subspecies	Common name	Diet	Island(s) on which extant	Island(s) on which extinct	Reference
12		Streptopelia picturata	picturata	Madagascar Turtle Dove	Granivore	Mau, Re, Mah, Pra, LaD, Sil, Cu, Fre, Mar, Fe, Ari, Cn, Cne, Brd, Ald, Ami		14, 18, 20, 22
13		Geopelia striata		Zebra (barred ground) Dove	Granivore	Mau, Re, Ro, Mah, Pra, LaD, Sil,Cu, Fre, Mar, fe, Ari, Cn, Cne, Brd, Ass, Pro, Far,		14, 18, 20, 22
14		Turtur tympanistria		Tambourine Dove	Granivore	GC, Moh, Anj, May		20
15	Psittacidae	Agapornis cana		Grey-headed Lovebird	Frugivore	GC, Moh, Anj, May	Mau, Re, Ro, Mah, Sil	14, 18, 20, 22
16		Psittacula krameri		Ring-necked Parakeet	Frugivore	Mau, Re, Mah		14, 18, 20, 22
17	Tytonidae	Tyto alba		Barn Owl	Other	Mah, Pra, LaD, Sil, Cu, Fre, Mar, Fe, Ari, Cn, Cne,	Ald	14, 18, 20
18	Pycnonotidae	Pycnonotus jocosus		Red-Whiskered Bulbul	Other	Mau, Re, Ass		1, 14, 18, 20
19	Sturnidae	Acridotheres tristis		Common Mynah	Other	Mau, Re, Ro, Mah, Pra, LaD, Sil, Cu, Fre, Mar, Fe, Cn, Cne, Brd, Gc, Moh, Anj, May	Ari	1, 14, 18, 20, 22
20	Corvidae	Corvus splendens		House Crow	Other	Mau		14, 20, 22

No.	Family	Species	Subspecies	Common name	Diet	Island(s) on which extant	Island(s) on which extinct	Reference
21	Passeridae	Passer domesticus		House Sparrow	Other	Mau, Re, Ro, Ami, Gc, Moh, May		1, 14, 18, 20, 22
22	Ploceidae	Ploceus cucullatus		Village (spotted-backed) Weaver	Other	Mau, Re		1, 14, 20, 22
23		Foudia madagascariensis		Madagascar Fody	Granivore	Mau, Re, Ro, Mah, Pra, LaD, Sil, Cu, Fre, Mar, Fe, Ari, Cn, Cne, Brd, Ass, Far, Ami, Gc, Moh, Anj, May		1, 14, 18, 20, 22
24	Fringillidae	Serinus canicollis		Cape Canary	Granivore	Re	Mau	1, 14, 20, 22
25		Serinus mozambicus		Yellow-eyed Canary	Granivore	Mau, Re, Ass		1, 14, 20, 22
26	Estrildidae	Lonchura punctulata		Spice Finch	Granivore	Mau, Re		1, 14, 20, 22
27		Vidua macroura		Pin-tailed Whydah	Granivore		GC, May	14, 15
28		Amandava amandava		Red Avadavat	Granivore	Re, Moh, May	Mau	14, 15, 20
29		Padda oryzivora		Java Sparrow	Granivore	Mau, May	Re, Ro	1, 14, 15, 20
30		Estrilda astrild		Common Waxbill	Granivore	Mau, Re, Ro, Mah, LaD, Ami	Moh	1, 14, 15, 20, 22

APPENDIX C

Mascarene species used to estimate the number of possible undocumented extinctions

No.	Common name	bones	skins
1	? Falco sp.	x	
2	Mauritian Red Rail	x	x
3	Leguat's Rail	x	x
4	Rodrigues Pigeon	x	
5	Dutch Pigeon		x
6	Dodo	x	x
7	Réunion Solitaire		x
8	Rodrigues Solitaire	x	x
9	Rodrigues Ring-Necked Parakeet		x
10	Mauritius Grey Parrot	x	
11	Broad-Billed Parrot	x	x
12	Rodriguez Parrot	x	
13	Mascarene Parrot		x
14	Mauritian Barn Owl	x	
15	Commerson's Scops-Owl	x	x
16	Rodrigues Little Owl	x	x
17	? Rodrigues Bulbul	x	
18	Bourbon/Réunion Crested Starling		x
19	Rodrigues Starling	x	
20	Réunion Fody	x	

NOTE:

The information was obtained from Checke (1987a) and Cowles (1987).

APPENDIX D

Risk indices predicted by the GLM

No	Common name	Risk index on each island within a species' range																										Global risk index (extant species)
		Mau	Re	Ro	Mah	Pra	LaD	Sil	Cu	Fre	Mar	Fe	Ari	Cn	Cne	Brd	Ald	Ast	Ass	Cos	Pro	Far	Ami	GC	Moh	Anj	May	
1	Madagascar Sacred Ibis																0.03											
2	Malagasy Harrier																							0.01	0.02	0.02	0.02	<<0.01
3	Reunion Harrier		0.05																									
4	Yellow-Billed Kite																							0.01	0.02	0.02	0.02	<<0.01
5	Frances's Sparrowhawk																							0.02		0.04	0.04	<<0.01
6	Peregrine Falcon																							0.01	0.02	0.02	0.02	<<0.01
7	Seychelles Kestrel				0.06	0.14	0.23	0.17																				<<0.01
8	Madagascar Kestrel																0.03											0.03
9	Mauritius Kestrel	0.13																										0.13
10	White-Throated Rail	0.75															0.58		0.85	0.92								0.58

No	Common name	Risk index on each island within a species' range																									Global risk index (extant species)
		Mau	Re	Ro	Mah	Pra	LaD	Sil	Cu	Fre	Mar	Fe	Ari	Cn	Cne	Brd	Ald	Ast	Ass	Cos	Pro	Far	Ami	GC	Moh	Anj	May	
11	Mauritian red rail	0.98																									
12	Leguat's rail			0.96																							
13	Comoro olive pigeon																							0.22	0.42	0.33	0.34	0.01
14	Rodrigues Pigeon			0.52																								
15	Seychelles Turtle Dove									0.07			0.13	0.20	0.21	0.11	0.01	0.05	0.03	0.06			0.10					<<0.01
16	Comoro Turtle Dove																							0	0.01	0	0	
17	Seychelles Blue Pigeon				0.04	0.09	0.15	0.11	0.26	0.29	0.4	0	0.44	0.56	0.58													<<0.01
18	Comoro Blue Pigeon																0.07	0.34		0.40	0.51	0.60		0.03	0.06	0.04	0.05	<<0.01
19	Dutch Pigeon	0.66																										
20	Comoro Green Pigeon																								0.12			0.12
21	Pink Pigeon	0.66																										0.66
22	Dodo	0.99																										
23	Reunion Solitaire		0.99																									
24	Rodrigues Solitaire			0.98																								
25	Greater Vasa Parrot																							0.05	0.12	0.09		<<0.01
26	Lesser Vasa Parrot																							0.05		0.09		<<0.01

No	Common name	Risk index on each island within a species' range																										Global risk index (extant species)
		Mau	Re	Ro	Mah	Pra	LaD	Sil	Cu	Fre	Mar	Fe	Ari	Cn	Cne	Brd	Ald	Ast	Ass	Cos	Pro	Far	Ami	GC	Moh	Anj	May	
27	Seychelles Black Parrot					0.30					0.74		0.77															0.30
28	Echo Parakeet	0.66																										0.66
29	Seychelles Parrot				0.46	0.69		0.73																				
30	Rodrigues Ring-necked Parakeet			0.52																								
31	Mauritius Grey Parrot	0.66																										
32	Broad-Billed Parrot	0.66																										
33	Rodriguez Parrot			0.52																								
34	Mascarene Parrot		0.61																									
35	Madagascar Coucal																0.03		0.10	0.18								0.03
36	Mauritian Barn Owl	0.43	0.38																									
37	Seychelles Scops Owl				0.25																							0.25
38	Karthala Scops Owl																							0.10				0.10
39	Malagasy Scops Owl																									0.03	0.04	<0.01
40	Mohéli Scops Owl																								0.21			0.21
41	Commerson's Scops Owl	0.43																										

No	Common name	Risk index on each island within a species' range																										Global risk index (extant species)
		Mau	Re	Ro	Mah	Pra	LaD	Sil	Cu	Fre	Mar	Fe	Ari	Cn	Cne	Brd	Ald	Ast	Ass	Cos	Pro	Far	Ami	GC	Moh	Anj	May	
42	Rodrigues Little Owl			0.29																								
43	Madagascar Nightjar																0.03											0.03
44	Madagascar Black Swift																							0.01	0.02	0.01	0.02	<<0.01
45	Madagascar Spine-Tailed Swift																							0.02				0.02
46	African Palm Swift																							0.02	0.05	0.03	0.04	<<0.01
47	Seychelles Swiftlet				0.03	0.06	0.11					0.20	0.35	0.47	0.48	0.30												<<0.01
48	Mascarene Swiftlet	0.06	0.05																									<0.01
49	Mascarene Martin	0.06	0.05																									<0.01
50	Madagascar Bee-eater																							0.01	0.02	0.01	0.02	<<0.01
51	Comoro Cuckoo-roller																							0.02	0.05	0.04	0.04	<<0.01
52	Madagascar Bulbul																0.06	0.29		0.35				0.02	0.05	0.04	0.04	<<0.01
53	Comoro Bulbul																							0.02	0.05			<0.01
54	Reunion Bulbul		0.38																									0.38
55	Seychelles Bulbul				0.06	0.14	0.23	0.17	0.37		0.52	0.38																<<0.01
56	Mauritius Bulbul	0.13																										0.13

No	Common name	Risk index on each island within a species' range																										Global risk index (extant species)
		Mau	Re	Ro	Mah	Pra	LaD	Sil	Cu	Fre	Mar	Fe	Ari	Cn	Cne	Brd	Ald	Ast	Ass	Cos	Pro	Far	Ami	GC	Moh	Anj	May	
57	Comoro Thrush																							0.10	0.22	0.16		<0.01
58	Seychelles Magpie Robin				0.06	0.14	0.22			0.4	0.52	0.38	0.56	0.68															0.27
59	Reunion Stonechat		0.05																									0.05
60	Common Stonechat																							0.01				0.01
61	Humblot's Flycatcher																							0.10				0.10
62	Madagascar Paradise Flycatcher																							0.02	0.05	0.03	0.04	<<0.01
63	Seychelles Black Paradise Flycatcher					0.14	0.22		0.37		0.52	0.38	0.56															0.08
64	Mascarene Paradise Flycatcher	0.12	0.10																									0.01
65	Aldabra Brush Warbler																0.03											
66	Madagascar Brush Warbler																							0.05	0.04			<0.01
67	Comoro Brush Warbler																							0.10				0.10
68	Benson's Brush Warbler																								0.22			0.22
69	Madagascar Cisticola																	0.14		0.18								0.03

No	Common name	Risk index on each island within a species' range																									Global risk index (extant species)
		Mau	Re	Ro	Mah	Pra	LaD	Sil	Cu	Fre	Mar	Fe	Ari	Cn	Cne	Brd	Ald	Ast	Ass	Cos	Pro	Far	Ami	GC	Moh	Anj	May	
70	Rodrigues Warbler			0.07																							0.07
71	Seychelles Warbler										0.52		0.56	0.68	0.69												0.26
72	Madagascar White-eye																0.06	0.29		0.35				0.02	0.05	0.04		<<0.01
73	Karthala White-eye																							0.01				0.01
74	Mauritius Olive White-eye	0.42																										0.42
75	Reunion Olive White-eye		0.37																									0.37
76	Seychelles White-eye				0.06																							0.06
77	Mauritius Grey White-eye	0.12																										0.12
78	Reunion Grey White-eye		0.37																									0.37
79	Marianne White-eye										0.52																	
80	Mayotte White-eye																										0.04	0.04
81	Madagascar Green Sunbird																							0.02	0.05			<0.01
82	Seychelles Sunbird				0	0.01	0.02	0.01	0.03	0.04	0.06	0.03	0.07	0.10	0.11	0.05												<<0.01
83	Humblot's Sunbird																							0.02	0.05			<0.01

No	Common name	Risk index on each island within a species' range																										Global risk index (extant species)
		Mau	Re	Ro	Mah	Pra	LaD	Sil	Cu	Fre	Mar	Fe	Ari	Cn	Cne	Brd	Ald	Ast	Ass	Cos	Pro	Far	Ami	GC	Moh	Anj	May	
84	Suimanga Sunbird																0.06	0.29		0.35								<0.01
85	Abbott's Sunbird																		0.21									0.21
86	Anjouan Sunbird																									0.04		0.04
87	Mayotte Sunbird																										0.04	0.04
88	Comoro Blue Vanga																							0.02	0.05			<0.01
89	Reunion Cuckoo-shrike		0.37																									0.37
90	Mauritius Cuckoo-shrike	0.42																										0.42
91	Comoro Cuckoo--shrike																							0.10	0.22			0.02
92	Reunion Crested Starling		0.38																									
93	Pied Crow																0.03	0.15	0.10	0.18				0.01	0.02	0.02	0.02	<<0.01
94	Crested Drongo																									0.03		0.03
95	Mayotte Drongo																										0.04	0.04
96	Aldabra Drongo																0.06											0.06
97	Grande Comore Drongo																							0.02				0.02
98	Aldabra Fody																0.03											0.03
99	Mauritius Fody	0.42																										0.42
100	Comoro Fody																							0.02	0.05	0.03	0.04	<<0.01

No	Common name	Risk index on each island within a species' range																										Global risk index (extant species)
		Mau	Re	Ro	Mah	Pra	LaD	Sil	Cu	Fre	Mar	Fe	Ari	Cn	Cne	Brd	Ald	Ast	Ass	Cos	Pro	Far	Ami	GC	Moh	Anj	May	
101	Rodrigues Fody			0.07																								0.07
102	Seychelles Fody					0.14	0.22			0.40	0.52		0.56	0.68	0.69								0.48						0.09
103	? Reunion Fody		0.10																									
104	Bronze Mannikin																							0.16	0.33	0.25	0.27	<0.01