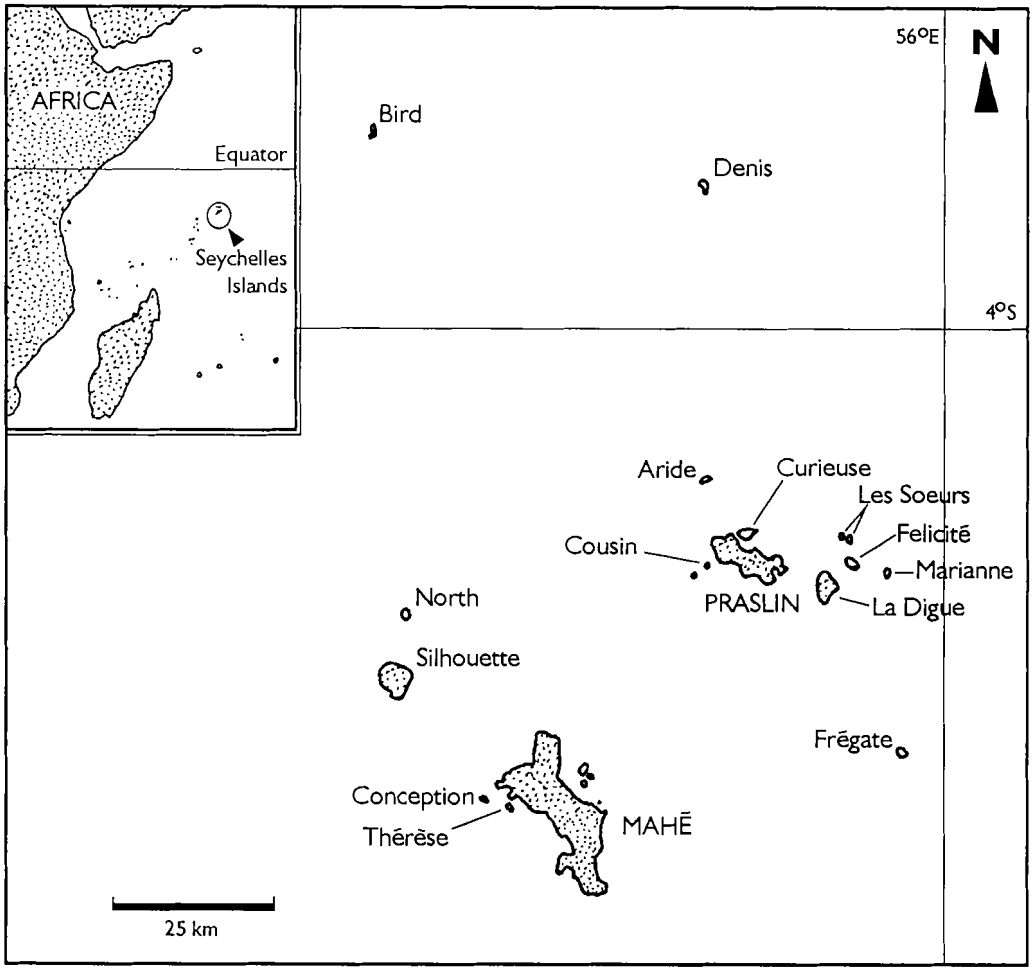


**Figure 1.** The central Seychelles.

# INTRODUCTION AND METHODS

BY

MICHAEL J. HILL[1], TERENCE M. VEL[1], KATHRYN J. HOLM[2], and NIRMAL J. SHAH[1]

## ABSTRACT

The central Seychelles islands support 12 species of endemic land birds, eight of which are regarded as globally threatened. As part of a project to evaluate the islands' potential to support translocated populations of endemic birds, biological surveys were carried out on 10 of the islands ranging from 28 to 286 ha in size. This paper describes the background of the project and the aims and methods of the island assessment survey, the results of which are presented by island in later chapters.

## INTRODUCTION

The central Seychelles (Fig. 1) comprises a group of around 40 granitic islands (and two outlying coralline islands) situated approximately 1,600 km from East Africa and 1,700 km from India (Stoddart, 1984). The flora and fauna are derived from the Oriental and African regions but show a high degree of endemicity: Scott (1933) estimated that 51% of the insect fauna were endemic. There are about 76 extant endemic plant species (Carlström, 1996a), which comprise around 9% of the total flora (Procter, 1984). The islands also support a number of endemic land birds (12 extant taxa: see Table 1), and have been classified as an Endemic Bird Area (EBA), one of 218 such regions of global importance for their endemic bird species (Stattersfield *et al.*, 1998).

In common with most oceanic archipelagos, the granitic Seychelles has no native terrestrial mammals, the only non-marine mammals being two endemic species of bat (Racey and Nicoll, 1984). Since human settlement of the islands in 1770, habitat destruction and the introduction of alien animals and plants have lead to the complete extinction of at least three endemic bird taxa and the loss of many island populations (Diamond, 1984).

On smaller islands, habitat destruction accelerated in the nineteenth and early twentieth centuries with the expansion of coconut plantations. Many islands became devoted to the production of coconut together with a few other cash crop species. A few smaller or remote granitic islands remained predator-free despite conversion to plantation agriculture, and these islands offered refugia for endangered endemic avian species lost on other islands. As a result, species such as the Seychelles warbler *Acrocephalus*

[1] Nature Seychelles, PO Box 1310, Victoria, Mahé, Seychelles. Email: birdlife@seychelles.net

[2] 1991 Casa Marcia Crescent Victoria, British Colombia, Canada.

*sechellensis*, Seychelles fody *Foudia sechellarum*, and Seychelles magpie-robin *Copsychus sechellarum* are today found on a few small islands. These three species, together with five other endemic birds, are regarded as globally threatened (Stattersfield *et al.*, 1998). Several of these species have, at some stage, been reduced to single island populations (the Seychelles warbler on Cousin, magpie-robin on Frégate, black paradise flycatcher on La Digue, and scops owl on Mahé). Such small, isolated populations are vulnerable to extinction through stochastic events (Simberloff, 1998), especially when island refugia are small. In such cases, translocation to establish new populations is an important conservation tool.

Table 1. Endemic land bird taxa of the granitic Seychelles.

| Scientific name | English name | Pop. Estimate (individuals)[1] | No. of islands[2] | Status[3] |
|---|---|---|---|---|
| *Coracopsis nigra barklyi* | black parrot | 200-300 | 2 | - |
| *Copsychus sechellarum* | Seychelles magpie-robin | 85 | 4 | Critical |
| *Terpsiphone corvina* | Seychelles black paradise flycatcher | 150-200 | 2 | Critical |
| *Otus insularis* | Seychelles scops owl | 180-360 | 1 | Critical |
| *Zosterops modestus* | Seychelles white-eye | 280-380 | 3* | Critical |
| *Falco araea* | Seychelles kestrel | *c.* 900 | 7 | Vulnerable |
| *Collocalia elaphra* | Seychelles swiftlet | 2,500 – 3,000 | 3 | Vulnerable |
| *Acrocephalus sechellensis* | Seychelles warbler | 2,100 | 3 | Vulnerable |
| *Foudia sechellarum* | Seychelles fody | 3,260 | 3 | Vulnerable |
| *Alectroenas pulcherrima* | Seychelles blue pigeon | > 3,000 pairs | 14+ | Least Concern |
| *Hypsipetes crassirostris* | Seychelles bulbul | > 7,000 pairs | 5 | Least Concern |
| *Nectarinia dussumieri* | Seychelles sunbird | > 8,000 pairs | 15+ | Least Concern |

[1] Population estimates for seven endangered endemics from species action plans (Shah and Nevill, 2002), Seychelles white-eye and black parrot from Skerrett *et al.* (2001); other species from Rocamora (pers. comm.). Estimates for "Least Concern" species are pairs, all other species individuals.

[2] Only islands in the central Seychelles considered: Seychelles fody is also present (as naturalised population) on one outer coralline island.

[3] Global conservation status from BirdLife International (2000).

* Seychelles white-eye recently (2001) introduced to Frégate Island, previously restricted to Mahé and Conception (Rocamora *et al.* in press).

Recent economic changes and developments in the field of wildlife management have allowed an improvement in the status of several species of Seychelles endemic birds. In the late twentieth century, many plantations became uneconomic and were no longer maintained. Two small islands (Cousin and Aride) were purchased and dedicated entirely to conservation. Cats had previously been present on Aride but were eliminated in the 1920s or 30s (Warman and Todd, 1984); Cousin had no alien mammals apart from the black-necked hare *Lepus nigricollis* introduced in the early twentieth century (Racey and Nicoll, 1984). Inter-island transfers of some of the most endangered bird species have led to encouraging results. Following the eradication of cats on Cousine and habitat restoration on Cousine and Aride, the Seychelles warbler has successfully been established on both islands (from Cousin: Komdeur *et al.*, 1995) and the Seychelles magpie-robin has been successfully translocated to Cousin and Cousine (from Frégate: Parr *et al.*, 2000).

In recent years both rats and cats have been eradicated on several islands, including Bird Island (black rats eradicated 1996: Feare, 1999a), Frégate (Norway rats eradicated 2000) and Denis and Curieuse (cats eradicated 2000/2001). The eradication of alien predators and regeneration of broadleaf woodland and scrub in former coconut plantations should facilitate the translocation of endangered endemic bird species to new islands and the establishment of further populations. It was with this opportunity in mind that the project *Management of Avian Ecosystems in Seychelles* was designed, and implemented from 1999. As part of this project an island assessment process was carried out, which involved biological surveys of a selected range of islands in the central Seychelles from 29 ha (Cousin) to 286 ha (Curieuse). The primary aim of the survey was to assess the potential of a number of islands for habitat restoration and the translocation of endangered endemic land birds, in particular five globally threatened species known to survive on relatively small islands: the Seychelles magpie-robin, Seychelles white-eye, Seychelles black paradise flycatcher, Seychelles warbler and Seychelles fody.

For most islands surveyed, assessment visits were carried out in both major seasons, the drier southeast (SE: usually between June and August or September) and the wet northwest monsoon period (NW: approximately November to April). This allowed seasonal differences in (for example) invertebrate activity and freshwater wetlands to be taken into account.

This volume is based on the assessment of biological factors on each of the islands visited, describing each island in turn and including a summary chapter on the comparative values of each island for conservation.

## ISLAND SELECTION

Not all of the 40 granitic islands could be visited in this survey: effort was directed at a smaller number of islands. The initial selection was made on the basis of island size, human population, and land ownership. All the central Seychelles islands are relatively small and within the group, both the smallest and largest were identified as having particular disadvantages. The smallest islands (under 20 ha) were rejected because (in most cases) they would only support small populations of endemic land birds, leaving populations vulnerable to stochastic extinctions. Of 43 named islands, 22 are under 20 ha (and 20 of these under 10 ha). Large islands (over 500 ha), while they support a high diversity of habitats and have great conservation potential, also have a number of disadvantages: most have large human populations with associated introduced animal species, and multiple ownership which complicates management. The only large island under single ownership (of four islands > 500 ha) is Silhouette (1,995 ha). Using size criteria, a list of 18 islands was produced. Of these, several inaccessible islands were not visited, and others (for example, islands in the Ste Anne Marine Park off Mahé with restricted access or multiple ownership) were also excluded from the survey. A total of 10 islands were included in the final study and a further island (Frégate) was also the subject of a short assessment visit. For each of the 10 islands studied, a short report is included in this volume.

## METHODS

The islands listed in Table 2 were each visited at least once during the survey period. While temperature and humidity vary little through the year, rainfall is seasonal in the central Seychelles islands: dry months between about May and October are dominated by the SE trade winds. The rainy season (NW monsoon) lasts from November to April (Walsh, 1984).

Variations in rainfall (especially, the water stress of the driest months) are likely to have a profound effect on invertebrates (McCulloch and Norris, 1997) and plants in particular. Thus, two sampling periods were carried out, the first predominantly in the dry SE season and the second in the NW monsoon. Most islands were visited twice, once in each season.

Table 2. Islands studied and dates of survey.
(Island names generally follow map DOS 604: Seychelles, produced by the UK Directorate of Overseas Surveys in 1983, with the exception of Île aux Vaches, now generally known as Bird Island, and Île du Nord, North Island).

| Island | Area (ha) | Geology | Survey time (days) | Survey dates | |
|---|---|---|---|---|---|
| | | | | SE season | NW season |
| Curieuse | 285 | Granitic | 23 | 2/8 - 14/8/99 | 5/1 - 18/1/00 |
| Félicité | 268 | Granitic | 6 | 8/11 - 14/11/99 | - |
| North | 210 | Granitic | 17 | 19/8 - 29/8/99 | 24/1 - 3/2/00 |
| Denis | 143 | Sand cay | 17 | 3/10 - 13/10/99 | 4/4 - 13/4/00 |
| Bird | 101 | Sand cay | 6 | - | 21/3 - 27/3/00 |
| Marianne | 95 | Granitic | 16 | 18/10 - 28/10/99 | 6/3 - 14/3/00 |
| Grande Soeur | 84 | Granitic | 9 | 17/7 - 27/7/99 | - |
| Thérèse | 74 | Granitic | 15 | 6/9 - 15/9/99 | 7/2 - 15/2/00 |
| Conception | 60 | Granitic | 15 | 22/9 - 28/9/99 | 21/2 - 28/2/00 |
| Cousin | 29 | Granitic | 16 | 14/6 - 25/6/99 | 1/12 - 8/12/99 |

For each island, vegetation and physical maps were produced using data from a variety of sources. Physical data came from existing physical maps (prepared by the UK Directorate of Overseas Surveys and the Seychelles Government; Series Y851[DOS 204]). Vegetation maps were prepared using field observations and data from recent (1998) colour aerial photographs of the islands (provided by the Ministry of Land Use and Habitat, Seychelles Government, for all islands except Thérèse).

Vegetation maps were based on a simple classification of habitats according to topography (whether on coastal lowland or "plateau", or granite hill >10 m above sea level) and the dominant plant forms and species. Major habitats included beach crest scrub (native), coconut plantations, plateau woodland (native or exotic), hill woodland (native or exotic), hill scrub (native or exotic) and vegetation of open, rocky places (locally known as "glacis"). Inhabited islands often had significant areas of open grassland and gardens.

Of these habitats, those of greatest importance to Seychelles endemic birds are woodland and scrub; many of the endemic species are particularly associated with woodland while anthropogenic habitats are more heavily utilised by introduced bird

species. In order to measure island quality for endemic birds, further sampling of vegetation and invertebrate numbers was carried out concentrated in woodland and scrub areas. Using the vegetation map for each island, random point locations were found within woodland/scrub habitats (15-20 points on each island visit). At each point, vegetation and invertebrate survey techniques were applied within a 10 m x 10 m plot.

## Vegetation Survey

A number of measures were recorded to provide details of the structural and biological diversity of vegetation within each 10 m x 10 m plot. Only flowering plants and ferns were recorded; algae, lichens and mosses were excluded. Vegetation was recorded in three strata: canopy (woody plants and palms over 5m tall), shrub (woody plants and palms less than 5 m tall), and herb layers (herbaceous plants and seedlings under 0.5 m tall). In the canopy layer all individual plants were identified and height and DBH (Diameter at Breast Height: 1.3 m above ground) recorded. In the shrub and herb layers, all species present were recorded, and the percentage cover of each within the layer estimated. In addition, for the herb layer the percentage of the 10 m x 10 m plot with no vegetation was estimated. A measure of the quantity of dead wood (tree stumps, standing and fallen dead wood) was made for each plot.

## Invertebrate Survey

Within each plot the following measures of invertebrate abundance were carried out: pitfall trapping, leaf insect counts, beating and sweeping. In a subset of plots, Malaise trapping was used. Pitfall traps were made of plastic cups with a diameter of 7 cm at the mouth. Traps were set about 2 m apart on a diagonal line across the plot and each trap was given a 'lid' of wire mesh (approx. mesh gauge 1.5 cm) to exclude land hermit crabs. Ethylene glycol was used as a preservative. Traps were in place for three nights, after which the invertebrate catch was preserved in 70% ethanol. Invertebrates were later counted and sorted to species or morphospecies.

Leaf-insect counts were developed as a measure of food supply for the insectivorous Seychelles warbler which mainly feeds by gleaning from the underside of leaves (Komdeur, 1994). Counts were made at, or around, each plot for each of the four most abundant tree species at the plot. For each tree species, five trees were selected. On each of the five trees invertebrates were counted on the underside of 10 leaves. Invertebrates were classified to order, suborder or family. In addition, two leaves were removed from each tree sampled in order to estimate the mean leaf size for each tree species. Leaf sizes were used to calculate the density of invertebrates per square metre of leaf. Since insect activity varies with time of day, temperature etc., counts were completed between 8 a. m. and 11 a. m. No invertebrate specimens were collected.

Beating and sweep-sampling were used to collect invertebrate specimens on abundant tree species and in herbaceous vegetation within the plot. Methods were standardised to ensure that sampling effort was standardised between plots and islands (see Hill, 2001).

Flight-intercept (Malaise) traps were used to collect flying invertebrates. Ethanol (70%) was used as a preservative in trap heads and the traps left in place for three nights.

All invertebrate specimens collected were stored in 70% ethanol and sorted to family or (for pitfall catches) morphospecies. Specimens were retained by Nature Seychelles with the exception of spiders (Araneae) and wasps (Hymenoptera). Spiders were sent for identification by Dr Michael Saaristo of the Zoological Museum, University of Turku, Finland, and remain in the collection of the museum; wasps for identification by Dr. John Noyes of the Natural History Museum, London.

Other Survey Methods

In addition to the vegetation and invertebrate survey methods carried out within plots, a number of further measures were made at the island level. Freshwater habitats occurred on many of the islands surveyed. These habitats have importance as they support a number of Seychelles endemic species including invertebrates and amphibians (Stevenson *et al.,* 1987), and have been implicated in the survival of the endemic black paradise flycatcher on La Digue (Watson, 1981). Wherever freshwater marsh, ponds or streams occurred they were surveyed physically and biologically. In most cases, the area of marsh was calculated, vegetation was sampled on a transect across the water body and aquatic invertebrates sampled using a hand net and, in some cases, a submerged aquatic light trap run overnight.

A complete list of plant species observed was compiled for each island. Species lists were compiled by one observer (MJH), mainly from sight records. Identifications were made using Beaver (1995), Friedmann (1994), Procter (1974), Robertson (1989), and Wise (1998). Species that could not be identified in the field (particularly grasses and sedges) were collected, and many of these were identified by comparison with specimens in the Seychelles National Herbarium (Natural History Museum, Victoria). Pressed specimens from the project are now held by Nature Seychelles. Plant species lists are included in each island account, where the taxonomy follows Robertson (1989) for monocotyledons, and Friedmann (1994) for dicotyledons. The tree *Ochrosia oppositifolia* (Lam.) Schum. should more properly be referred to as *Neisosperma oppositifolia* (Lam.) Fosberg & Sachet (D. Stoddart, pers. comm..), but the name *Ochrosia* (used in Fraidmann, 1994) is used here for purposes of uniformity.

Observation and opportunistic collection were used to identify members of certain invertebrate groups, including day-flying Lepidoptera (identified from Larsen, 1996), Odonata (identified using Blackman and Pinhey, 1967), and Phasmatoptera (identified using a key provided by P. Matyot). Vertebrates were identified by observation; no vertebrates were collected, with the exception of rats. For identification of bird species, Penny (1974) and Sinclair and Langrand (1998) were used, although taxonomic order in species lists follows that in Skerrett *et al.* (2001).

Introduced predators are of prime importance in determining the current restricted distribution of several endangered endemic birds in Seychelles. While the Seychelles has a relatively small number of introduced bird and mammal species, several introduced species are known or presumed to negatively affect native land birds. These include two *Rattus* species (*R. rattus* and *R. norvegicus*), domestic (feral) cat *Felis catus,* barn owl *Tyto alba* and common mynah *Acridotheres tristis* On each island, lists of all bird and mammal species observed were compiled and, in addition, tape playback methods were

used to confirm the presence of barn owls and trapping was used to identify rat species present. Lists of all birds and mammals observed were compiled.

Tape playback used recordings of barn owls from India and Britain played between 7 p.m. and 9 p.m. in at least three locations on each island. Recordings were played for a total of 20 minutes in each location.

Rodent trapping followed "index trapping" methods developed in New Zealand by the Ecology Division of the Department of Scientific and Industrial Research (Cunningham and Moors, 1983; Nelson and Clark, 1973). The methodology used differed in some respects from index trapping; live rat traps were used rather than snap traps (to reduce the inadvertent killing of land crabs, birds, etc.) and numbers of trap-nights were rather lower than the recommended minimum of 150 for each habitat type. The traps were in place for five nights with coconut flesh as bait. The trapline consisted of pairs of traps (with 1m between the pair) at 30 m intervals. Two traplines were laid on each island to sample major habitats represented. On each morning of trapping the number of rats trapped was recorded, together with other animals caught and the number of traps that had closed without trapping anything. These data were used to calculate an index of rats trapped per 100 trap-nights, corrected for traps closed (D. Merton, *in litt.*).

Tape playback was also used to give presence/absence data for three endemic bird species: Seychelles scops owl, Seychelles black paradise flycatcher and Seychelles white-eye. All three of these species may respond to taped calls of their own species by moving closer to the source of the calls and (sometimes) calling, although responses differ between the species and with time of year. Scops owls usually call in response to the tape and fly to perches close to the player, where they can be observed by torchlight (D. Currie, *pers. comm.*). Paradise flycatchers do not usually sing back to taped song but both males and females move close to taped sources. They tend to gather quickly but disperse again rapidly, at least when constant-loop tapes are used (D. Currie, *pers. comm.*). White-eyes sometimes respond to taped sources but may ignore them altogether (G. Rocamora *pers. comm.*).

Tape playback was carried out at sample points on walked transects (for example, existing paths). For all species, 60-second constant-loop cassettes were used. Location of playback sites and duration of playback differed, depending on target species:

- For scops owl, transects were located within hill forest habitat, or on the plateau adjacent to areas of hill forest. Tapes were played for 20 minutes at three points on each transect, at least 200 m apart. Playback was between 7 p. m. and 9 p. m.
- For the paradise flycatcher and white-eye, transects were located in all major habitats represented on an island. Tapes were played at five points on each transect, at least 100 m apart, for five minutes at each point. Playback occurred between 5.30 a.m. and 6.30 a.m. (Rocamora, 1997).

For each species, as many sampling events (mornings/evenings of playback) as possible were carried out. The date, time, habitat, and any responses were recorded.

## RESULTS

Results are presented here by island, each of the following 10 reports giving the data gathered on each island and a final summary report discussing the implications of these island studies for the conservation of Seychelles native flora and fauna, and endemic birds in particular. Species lists for each island are given in the text of each island report (most taxa) or as an Appendix (in the case of plants). References are given at the end of the volume.