Continued decline and conservation needs of the Endangered Mauritius olive white-eye *Zosterops chloronothos*

Rina Nichols, Lance Woolaver and Carl Jones

Abstract The Mauritius olive white-eye *Zosterops chloronothos* is the least known of the eight threatened terrestrial bird species remaining on the island of Mauritius. The olive white-eye has declined drastically in numbers and distribution since 1975. Surveys carried out between 1998 and 2001 estimated that 93–148 pairs remained within an area of less than 25 km^2. Most areas that held olive white-eye territories in 1975 supported considerably fewer territories in 2001. This decline is thought to have primarily been the result of deforestation and degradation of native habitat and intense nest predation by introduced mammals. Declines have been more severe in areas dominated by native vegetation than they have been in areas that contained substantial amounts of exotic *Cryptomeria* and *Pinus*. The continued decline of the Mauritius olive white-eye is of critical concern and immediate species-specific conservation management is required for its survival.

Keywords Endangered, distribution, Mauritius olive white-eye, population status, *Zosterops chloronothos*.

Introduction

Mauritius, with an area of 1,865 km^2, is the second largest of the Mascarene Islands in the south-west Indian Ocean, and has been severely degraded ecologically since the arrival of humans in the 1600s. Habitat loss and the introduction of a host of exotic flora and fauna has resulted in the extinction or endangerment of many of the endemic plant and animal species. At best, only 5% of forest with a significant native component remains (Safford, 1997a). Continued degradation of the remaining native forest is occurring rapidly as a result of introduced invasive plants and animals (Lorence & Sussman, 1986). Of 671 native plant species, 46% of which are endemic to Mauritius, 76 are Extinct, 105 are Critically Endangered and 44 are Endangered (Page & D'Argent, 1997; IUCN, 2003). All eight taxa of Mauritian palms are threatened with extinction (Maunder *et al*., 2002; IUCN, 2003).

Mauritian fauna have not fared much better. At least 50% of the endemic Mauritian vertebrate species, including 11 of the 21 endemic terrestrial bird species, have gone extinct since human colonization (Cheke, 1987a). The Mauritius kestrel *Falco punctatus*, the pink pigeon *Columba mayeri* and the echo parakeet *Psittacula echo,* have been, or are currently, the focus of intensive management that has helped to substantially increase population numbers (Jones *et al*., 1992, 1995; Thorsen & Jones, 1998). The remaining seven species are passerines, five of which are considered to be threatened (BirdLife International, 2000). Recent research suggests that some of the passerine species are still declining in distribution (R. Nichols, unpub. data; Nichols *et al*., 2002).

The Mauritius olive white-eye *Zosterops chloronothos*, the least known of all the Mauritian birds, is categorized as Endangered on the IUCN Red List (IUCN, 2003) and has recently been upgraded to Critically Endangered by BirdLife International (J. Ekstrom *in litt*., 2003). Olive white-eyes are monogamous and solitary and range over large areas in search of nectar sources (Cheke, 1987b). Two previous surveys found the olive white-eye to exist in low numbers with a small, localized distribution. During the first survey in 1975, the total population was estimated at 346 pairs, the majority located in south-west Mauritius, with 20 pairs in central Mauritius (Cheke, 1987b). A second survey in 1993 estimated that the total population had declined to 200 pairs with only a few sightings observed outside south–west Mauritius (Safford, 1997b). A third survey was carried out between November 1998 and February 2001. This paper reports the findings of that survey and suggests appropriate species-specific management techniques to prevent a further decline in numbers and distribution.

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Methods

Study area

The surveys were carried out in the same areas of south–west Mauritius that had been surveyed between 1973 and 1975 (Cheke, 1987b) and between 1989 and 1994 (Safford, 1997b). Both of these previous surveys found outlying olive white-eye territories in central Mauritius (Montagne Lagrave and the 'central plateau relicts'). As these areas could not be surveyed during the present study we therefore used the population estimates from the 1993 survey. All other areas that had been surveyed by Cheke and Safford were revisited.

The forest in the study area of south-west Mauritius consisted mainly of exotic vegetation, degraded native forest, and softwood tree plantations (Fig. 1). The most common introduced plant species in areas of exotic and degraded native vegetation included *Psidium cattleianum, Ligustrum robustum, Ravenala madagascariensis, Syzigium jambos, Rubus alceifolius* and *Lantana camara*. Monvert, Florin, Pétrin and Bois Sec were small nature reserves containing native forest. Tree plantations consisted mainly of *Pinus elliotti* and to a lesser extent *Eucalyptus robusta* and *Melaleuca quinquenervia*, with smaller patches of *Cryptomeria japonica, Araucaria* spp. and *Callistemon citrinus*.

Survey technique and coverage

Territory mapping followed the methodology of Safford (1997b) and allowed a direct comparison with the 1993 survey. The surveys were carried out during the breeding season (September–March) when olive white-eyes were most conspicuous (Cheke, 1987b). Territorial birds were located and their territories mapped, beginning with the areas of highest density as found by Safford (1997b). Separate territories were determined by locating disputing individuals and pairs and by locating pairs exhibiting nesting behaviour. Distinguishing territorial birds was easiest during the dawn chorus (04.30–06.30).

The survey covered 16 areas of native vegetation. Survey coverage varied due to the patchy distribution of the population (Table 1). The coverage categories

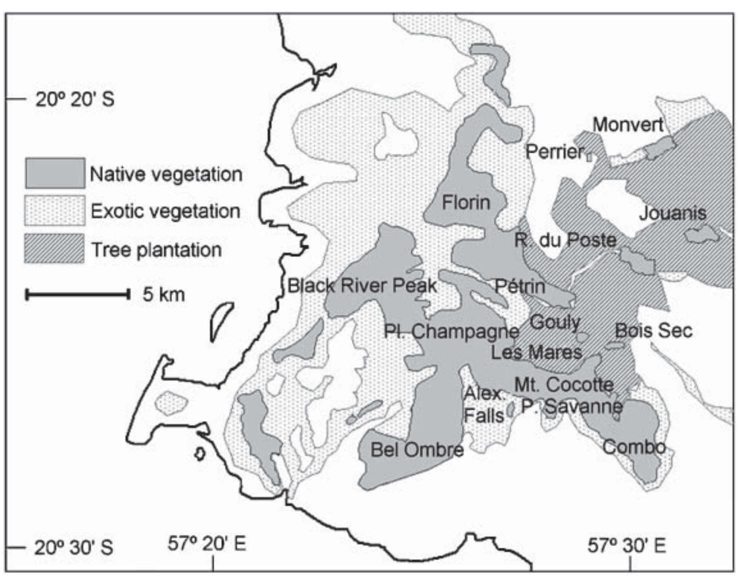

Fig. 1 South-west Mauritius showing vegetation types and area names referred to in the text (adapted from Safford, 1997a). Montagne Lagrave was an isolated 4.0 km² patch of degraded native forest located approximately 6.6 km north-east of Monvert.

Table 1 Coverage of areas surveyed for the Mauritius olive white-eye *Zosterops chloronothos* between 1998 and 2001. Good and Fair coverage are areas that received more or less than 8 h km^{-2}, respectively.

Areas surveyed	Hours	Effort (h km^{-2})	Assessment of coverage
Bois Sec/Rivière du Poste	50	22.6	Good
Florin/Pétrin/Gouly	64	18.3	Good
Monvert/Jouanis/Perrier	21	7.6	Fair
Black River Peak/Plaine Champagne/Bel Ombre	142	7.8	Fair
Alexandra Falls/Piton Savanne/Montagne Cocotte	201	36.8	Good
Combo	96	24.0	Good
Les Mares	176	58.6	Good

followed those of Safford (1997b). Coverage was considered 'good' when the total effort in an area exceeded 8 h km^{-2}. Any area with effort below this was considered to have received 'fair' coverage. All areas that contained the highest numbers of pairs in the earlier surveys received good coverage in the present study. Fair coverage was considered to be sufficiently intensive to ensure the detection of presence or absence of olive white-eyes within an area (as found by Safford, 1997b). Population estimates are given as the number of territorial pairs. The total number of pairs within an area was estimated by extrapolating the number of territories recorded in surveyed areas to adjacent areas of non-surveyed similar habitat (following Cheke, 1987b, and Safford, 1997b).

Results

Population status and distribution in 2001

We located 67 territories in the 2001 survey, giving a total estimated population of 93–148 pairs (Table 2). The distribution of the Mauritius olive white-eye has contracted significantly (Fig. 2). The entire population was restricted to an area of <25 km^2, with the exception of a few pairs possibly remaining at Montagne Lagrave and the 'central plateau relicts'.

Of the outlying sub-populations, the area of Jouanis has been clear-felled and the two olive white-eye territories found in 1993 no longer exist. The three territories recorded at Florin in 1993 have also disappeared. No olive white-eyes were recorded from areas where single or occasional sightings were reported in 1993. Only a single outlying sub-population remained in 2001, between Pétrin and Rivière du Poste (Fig. 2).

The core sub-population was distributed between Alexandra Falls and Combo and, with the exception of Combo, all areas contained considerably fewer territories in 2001 (Table 2). Nearly all of the 153 territories estimated for the Black River Peak – Bel Ombre area in 1975 have disappeared, with only two territories found in 2001. Four new territories were found in Les Mares representing a slight range expansion into pine plantation.

Olive white-eye territories have declined most notably in areas dominated by native vegetation, including Black River Peak – Bel Ombre, Piton Savanne – Montagne Cocotte and Florin – Gouly. The number of territories in Bois Sec, Rivière du Poste and Combo, which are dominated or surrounded by exotic *C. japonica* and *P. ellioti*, have remained relatively stable.

Discussion

The Mauritius olive white-eye is the most challenging of the Mauritian passerines to accurately census due to the species' elusive and quiet nature (Cheke, 1987a; Safford, 1997b). Although population estimates may be tentative (Safford, 1997b), distribution limits can be determined with greater precision and more accurately compared among surveys (Bibby *et al.*, 1992). Over the past 25 years the population distribution of the olive white-eye has contracted. Three outlying sub-populations have disappeared and the core area has decreased by nearly 50% since 1975. The near-extirpation of olive white-eyes from

Table 2 Distribution and population estimates of the Mauritius olive white-eye *Zosterops chloronothos* in 1975, 1993 and 2001. Data for 1975 and 1993 are from Safford (1991, *in. litt.* 2001).

Area	Pairs estimated 1975	Pairs found 1992/1993	Pairs estimated 1992/1993	Pairs found 2000/2001	Pairs estimated 2000/2001
Outlying sub-populations					
Bois Sec/Rivière du Poste	11	18	20–25	7	10–14
Florin/Pétrin/Gouly	22	5	6–12	2	4–7
Monvert/Jouanis/Perrier/ Montagne Lagrave[1] / 'central plateau relicts'[1]	19	5	15–30	0	5–15
Core sub-populations					
Black River Peak/ Plaine Champagne/Bel Ombre	153	18	30–100	2	5–22
Alexandra Falls/Piton Savanne/ Montagne Cocotte	93	41	51–68	31	40–54
Combo	25	3	15–25	21	25–30
Areas cleared since 1975[2]	23	0	0	4[3]	4–6
Total	346	90	137–260	67	93–148

[1]Area not surveyed in 2001
[2]Areas cleared since 1975 are represented by 'Tree plantation' in Fig. 1
[3]Found in the pine plantation of Les Mares

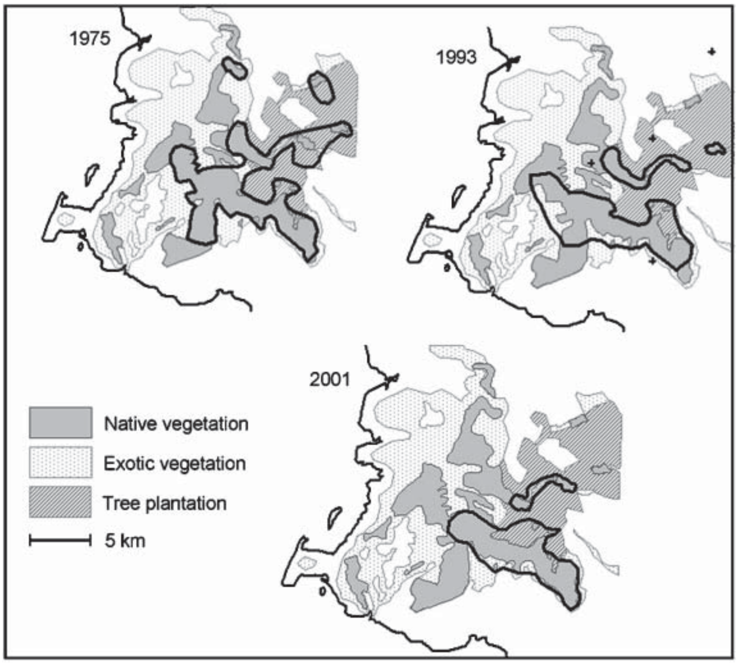

Fig. 2 The population ranges of the Mauritius olive white-eye *Zosterops chloronothos* (within solid black line) in 1975, 1993 and 2001. Data for 1975 and 1993 were reproduced from Cheke (1987b) and Safford (1997b). The small patch of native vegetation at Rivière du Poste was not surveyed in 1975. The + symbol refers to single sightings. Outlier sightings of olive white-eyes were further east during the 1975 and 1993 surveys. These sightings are not shown on this map but are reported in Table 2.

large areas is indicative of a continued severe decline in the species and is similar to the pattern of decline of the Mauritius fody *Foudia rubra* (Nichols *et al*., 2002; R.Safford unpubl. data).

Continued habitat loss and degradation and high levels of nest predation by introduced species appear to be the main factors in the continued decline of the Mauritius olive white-eye. Approximately 3,000 ha of endemic *Pandanus* marsh forest in south-west Mauritius were clear-felled between 1970 and 1975 and replaced with tree plantations. This was an important source area of endemic birds for much of the high plateau (Cheke, 1987a). Although major forest clearances of the same scale have not occurred since, native forest continues to be clear-felled on a smaller scale (e.g. the loss of Jouanis) and to rapidly degrade as a result of introduced invasive species, primarily *P. cattleianum* and *L. robustum* (Lorence & Sussman, 1986). Forest communities dominated by these exotics generally provide poorer habitat, with less choice of foraging opportunities for nectarivores, than that of the more diverse native forest (Cheke 1987b; Safford, 1997b). Nest predation by introduced mammals has been a major factor in the decline of Mascarene passerines (Cheke, 1987b). Predation by the introduced ship rat *Rattus rattus* and the crab-eating macaque *Macaca fascicularis* was responsible for 83–95% of nesting failures in the Mauritius fody (Safford, 1997c). Nest predation by the ship rat and Indian myna *Acridotheres tristis* has also been identified as the main reason for the decline of the Seychelles white-eye *Zosterops modestus* on the island of Mahé (Rocamora & François, 2000).

The number of olive white-eye territories have remained stable in forest dominated or surrounded by exotic *C. japonica* and *P. elliotti*, but have declined in areas with a dominant native component. This pattern appears to be strongly associated with lower levels of nest predation by introduced predators in these exotic conifers. Nesting success was found to be significantly higher for Mauritius fody in *C. japonica* (46%) than in other tree species (6%), including native species (Safford, 1997c). Several species of Mauritian birds including the pink pigeon, the Mauritius fody, the Mascarene paradise flycatcher *Terpsiphone bourbonnensis* and the Mauritius black bulbul *Hypsipetes olivaceous* nest in exotic trees even when native trees are readily available (Safford, 1997c; Nichols, 2001). Stands of exotic conifers, such as *C. japonica* and *P. elliotti*, may be avoided as foraging areas by the ship rat and crab-eating macaque due to the relatively poor food availability. The role of exotic trees in the productivity and nestling survival of the Mauritius olive white-eye should be investigated further as it undoubtedly has important implications for future conservation.

Conservation needs

The following species-specific recommendations should be viewed in the context of conservation of the Mauritian ecosystem as a whole. Methodologies for rehabilitation of the native forest and large-scale predator control using predator-proof fences are currently being tested in Mauritius. However, without active management, the Mauritius olive white-eye will continue to decline and may go extinct before these long-term measures are successful. We make the following species-specific recommendations:

Protect existing wild breeding populations
Important known breeding areas of the olive white-eye need to be intensively protected from introduced nest predators by using predator-specific methods of control such as live-trapping or poisoning (Jones *et al*., 1992) and by predator-proofing individual nest sites (Harper *et al*., 1999) to provide source areas for the species.

Improve food sources in the wild
In the absence of management, continued habitat degradation will reduce the already limited nectar sources available to the olive white-eye. This can be addressed immediately by planting appropriate fast growing native flora and/or non-invasive exotics within the current range of the olive white-eye. Several species have previously been suggested including the native *Trochetia uniflora* and *T. blackburniana* and the exotic *C. citrinus* (Cheke, 1987b; Safford, 1991). Planting of exotics for conservation purposes should only be undertaken after a risk assessment to address the potential of each species to be invasive. Artificial nectar feeders should also be developed and provided in the short-term and in areas where planting nectar sources would not be possible. Supplemental feeding has been a successful conservation tool in significantly increasing the population numbers and distribution of the endemic kestrel, pigeon and parakeet and should be adapted for the olive white-eye.

Establish new wild populations
The translocation of breeding pairs to areas outside the core population, such as offshore islands, has been suggested by Safford & Jones (1998). Inter-island translocations of the Seychelles white-eye have been successful, with translocated birds establishing breeding territories and producing fledglings within 6 months of translocation (Rocamora *et al*., 2002). Adult olive white-eyes range over large areas and may not remain after translocation, unless the new area can meet all the white-eyes' requirements (A. Cheke unpubl. data), although the use of artificial nectar feeders and/or planted nectar sources may help ensure site fidelity to new areas. Avian diseases appear to be more prevalent in lowland species in Mauritius (Peirce *et al*., 1977) and translocation of upland species to offshore islands may expose birds to new pathogens (Cheke, 1987b; Safford & Jones, 1998). Potential disease risks must be assessed before translocations are carried out.

The use of breeding enclosures situated within the upland forest would be the most cost effective and productive method of re-establishing wild populations in areas of their historic range. Field enclosures have been developed and successfully used for captive breeding and release of passerines (Woolaver & Nichols, 2002) and could easily be adapted for the olive white-eye in Mauritius. This would allow captive, parent-raised individuals to be released in their natal area, increasing site fidelity. Releases would need to be done in conjunction with predator control and the provision of additional food sources, or within predator-proof restored areas.

Establish captive population
Small, localized populations are at a high risk of extinction (Simberloff, 1995). Establishment of several pairs in captivity should be a priority in the near future, particularly at this point in time when the wild population can still support the removal of a few pairs to captivity. Although a large-scale *ex-situ* captive breeding programme is not recommended for this species at the moment, a safeguard population should be established in captivity because a stochastic event could potentially have a dramatic effect on the remaining wild population.

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Biographical sketches

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