

Status and Conservation of the Norfolk Island Boobook *Ninox novaeseelandiae undulata*

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ABSTRACT

During a survey of Norfolk Island, 12th to 20th October 1986, only one female Norfolk Island Boobook *Ninox novaeseelandiae undulata* was found. She is almost certainly the last surviving specimen and recommendations were made for maximising her chances of survival. A re-establishment programme using males of the closely related New Zealand Boobook *N. n. novaeseelandiae*, to breed back a population selected by phenotype, has been proposed to the Australian National Parks and Wildlife Service; it must be commenced immediately if it is to succeed. A severe scarcity of tree hollows for nesting appears to be the main environmental problem at present. Future hazards include continued logging of the forest.

INTRODUCTION

Norfolk Island, an Australian territory 1,367 km east of the mainland, is a small, isolated volcanic island in the south-west Pacific (Fig. 1). It is about 8 km long by 5 km wide and 3,450 ha in area. The highest points are Mt. Bates and Mt. Pitt, reaching 318 and 316 m respectively. Rolling hills, separated by gullies, lead to a mostly precipitous coastline. Two smaller islands, the larger being Philip Island 5 km distant and ca. 2 km² in area, and several islets, form the Norfolk Island Group.

When Cook found the subtropical island in 1774, it was covered in rainforest. Between 1788 and 1814, when the British used it as a convict prison, one-quarter of this was cleared. Disturbance to the native vegetation continued during the second, most infamous, penal settlement of 1825 to 1856. By the early 1900s, three-quarters of the island had been cleared and the remaining forest was depleted by logging of mature trees, infestation with weeds and degeneration due to exposure (Lane-Poole 1926; Smithers & Disney 1969; Schodde *et al.* 1983). In early 1986 the Norfolk Island National Park was proclaimed: it covers about 12% of the island, including the two mountains. The management plan for the park allows for continued logging of both mature native trees and plantations of exotics.

Extensive clearing, deliberate introductions, and self-introductions of exotic species have resulted in several extinctions. Since settlement, six of the island's fourteen endemic land birds

have become extinct, a seventh species has not been seen for several years despite efforts to find it, and only about twenty of an eighth species, the Red-fronted Parakeet (Green Parrot) *Cyanoramphus novaeseelandiae cooki* remain (Schodde *et al.* 1983; McKean *et al.* 1976; Rooke 1986).

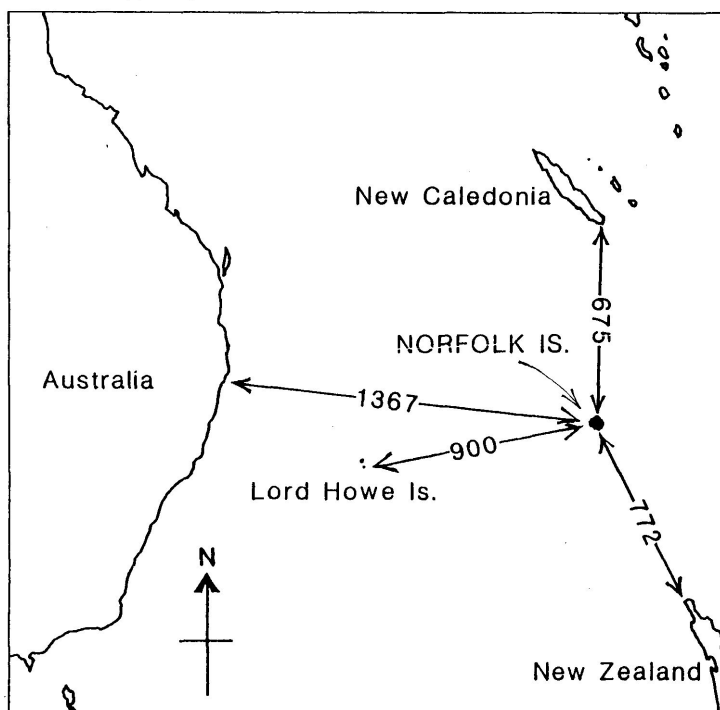


Figure 1 Location of Norfolk Island in the South-west Pacific.

The Norfolk Island Boobook *Ninox novaeseelandiae undulata* was first recorded by King (1786-90), and later described by Latham (1801) and painted by Stuart (1834-40, Iredale 1955). It was reported as present on the island between 1851 and 1888 (Iredale 1911). Originally, the owl almost certainly occurred throughout the then forested island, but since 1909 is said to have been confined to the gullies surrounding Mt. Pitt (Bassett-Hull 1910; Turner *et al.* 1968; Smithers & Disney 1969). In 1912 and 1913 Bell took about 30 specimens for a Sydney collector, Bassett-Hull (Bell 1912-13). During the 1960s the owl was neither seen nor heard by a party of visiting biologists (King 1979) but was still heard occasionally by locals in the Mt. Pitt area (Wakelin 1968). De Ravin (1975) also heard an owl calling from Mt. Pitt in 1973, and in 1978 it was recorded in four 0.5 km² sections of the island, probably representing three individuals (Schodde *et al.* 1983; Rooke 1986). Rooke was unable to see or hear the owl during his survey in 1985 and, because the locals still heard it at one location, concluded that "only one Norfolk Island Boobook is known to exist with certainty".

Although the Norfolk Island Boobook was considered rare and endangered during the 1960s and the main reason for the continuing decline in numbers was thought to be a lack of nest sites (Turner *et al.* 1968; King 1979), no action was taken to remedy the situation until 1985, when ten nest boxes were erected by the Australian National Parks and Wildlife Service (ANPWS). The bird is now fully protected. It is one of twenty-six owl species in the world considered to be endangered (Clark *et al.* 1978; King 1981).

Concerned by its rarity and the lack of a vigorous, informed conservation effort, we organised a survey of Norfolk Island. This paper reports the findings and recommendations of that survey.

METHODS

A party of five experienced ornithologists visited Norfolk Island for 8 days between 12th and 20th October 1986. The visit was timed around a full moon on the 18th. Boobooks are said to be more active during this time. By night all forested areas on Norfolk Island (the other islands in the group, being almost treeless, have no suitable habitat) were visited and amplified owl calls were broadcast through a speaker on and off for at least 15 minutes at each location. Small areas were visited by car, larger areas were traversed on foot and calls broadcast at several points. Each forested area was visited at least twice, on different nights. Locations where owls had been heard in the past ten years were visited three times. By day, the forest where the owl was located, and its fringes, were searched for suitable hollows, daytime roosts, excreta, castings and other signs of the owl. Adjoining forest was also searched. All trees with hollows which, from the ground, appeared suitable for owls were scaled, both around the eucalypt plantation and elsewhere on the island (approx. 40). A total of 324 man hours was spent in the field; additional time was spent examining aerial photographs and talking to people with knowledge of the owl. The weather was fine with the exception of part of one night and one day, when it was heavily overcast and rained.

The only owl located was caught in a mist net. It was weighed and measured and a detailed description was taken. A blood sample was taken from the brachial vein and a faecal sample collected from the ground beneath the perched owl. Photographs were taken of the bird both in the hand and in the wild. A band was placed on the left leg and a dot of iridescent nail polish applied to the upper surface of one inner rectrix and to the underside of each outer rectrix as an aid to recognition.

RESULTS AND DISCUSSION

The Owl

Only one owl was found. It was trapped and marked on the second night of the survey and it alone was seen on subsequent nights, always within a particular area, the same area from which the only owl heard on the island in the past eight years called. It therefore seems almost certain that this was the last remaining Norfolk Island Boobook.

We were able to call the owl in to a clearing on the 12th and 13th October. On the 14th and 15th we waited for its first call of the evening or last call in the morning in an attempt to locate its roost (or nest), and it called spontaneously. On the 16th and 17th we were unsuccessful in calling it to the clearing. We walked through the forest on the 18th and found the owl, and on the 19th it again came to the clearing.

Its measurements (Table 1) and the deep, croaky tone of the bird's voice indicated that it was probably a female. A papal examination of its pelvic girdle indicated that it was either a male, or a female that had never laid eggs. It responded to our broadcast calls and to calls made by one of our party by returning the call and making its way to the area from which we called. On arrival it perched in the canopy near us, body feathers raised and wings held slightly open and drooped at its sides. It uttered the well-known disyllabic 'boobook' territorial call, a more rapid 'bukbukbuk' threat call, and a low 'churr' usually associated with breeding. Its flight was at times rapid, sometimes slightly undulating, with deep wing beats, while the wings appeared very short and rounded.

The description which follows differs from the original one given in Mathews (1912, 1928) in only minor details, most notably in the colour of the iris which he describes as bright brass-yellow and which we found to be pale. He did not note the pale midline of the beak, which was, however, recorded by Bell (1912, 1913).

Feathers of forehead chocolate brown; head, neck and ear coverts uniform dark brown; mantle and lower back dull chocolate brown; scapulars and rump of the same colour as the back, barred with dull white, scapulars with six pale brown, indistinct spots; primaries, secondaries and tail dull earth brown, obscurely barred with brownish buff; feathers at the base of the bill black, long and bristle-like; lores and chin buff; bread, chest, belly, sides and flanks rich chocolate brown, spotted and barred with white; belly and flanks more strongly barred, some feathers having twin spots of white; undertail coverts rich buffish white, with a large spot of chocolate brown towards

the extremity; underwing coverts rich rufous brown, indistinctly barred brown; eyes pale buff yellow; bill dark blue-grey with a lighter stripe down the length of the midline of the upper surface; cere dirty greenish yellow; feet bright yellow. Weight 213 g; wingspan 650 mm.

Table 1. Measurements of the captured Norfolk Island Boobook *Ninox novaeseelandiae undulata* compared with those from skins of *undulata* in museum collections (AMNH & BMNH) and the description in Mathews (1912, 1928). Also the New Zealand Boobook *N. n. novaeseelandiae* (calculated from Mees 1964) and the smallest *Ninox boobook*, *N. b. leucopsis*, from Tasmania (from Schodde & Mason 1980). Mean \pm S.D.(n, range) given where appropriate.

FEMALE			
	Wing (mm)	Tail (mm)	Exposed Culmen (mm)
Norfolk	204	126	26
Mathews	200	127	22
Museums	201.8 \pm 3.8 (17,197-209)	129.9 \pm 5.4 (14,115-137)	24.6 \pm 1.1 (17,23.5-27)
N.Z.	192.3 \pm 5.8 (19,183-202)	114	26
Tas.	213.0 \pm 2.6 (10)	126.0 \pm 3.0 (10)	-
MALE			
Mathews	201	123	20
Museums	198.0 \pm 4.1 (11,189-203)	125.1 \pm 6.6 (9,124-132)	24.0 \pm 0.9 (11,23-26)
N.Z.	192.3 \pm 4.0 (10,186-199)	100	24
Tas.	204.0 \pm 4.8 (18)	119.9 \pm 3.1 (18)	-

Habitat and Territory

All recent locations from which an owl had been heard calling, and those where we saw the owl, encompassed an area of forest less than 2 km², mostly within the National Park, encircling some gullies in the foothills of Mt. Pitt, and could be the home range of a single owl. The Norfolk Island Boobook is said to prefer gullies (e.g. Smithers & Disney 1969) and Boobooks in general tend to prefer gullies, although by day they may roost on nearby hillsides.

Norfolk Island Boobooks have been seen outside the forest at night in the past; one perched on the roof of a building (B. Evans, pers. comm.). The owl may have flown across a field of vegetables adjoining the eucalypt plantation during this survey but it was too dark for the observer to be certain. However, it is mostly heard and seen in forested areas and its morphology indicates that it is adapted to life in the forest.

Nest Hollows

No hollows considered suitable were found within the area thought to be the owl's territory, with one possible exception. All other hollows inspected were too small and many faced into the prevailing weather and were full of water. The ten nest boxes erected in 1985 were found to be unsuitable for owls. Birds could have entered but been unable to leave five boxes of the chimney type. It was strongly suggested that these be removed immediately and this was quickly acted upon by the ANPWS. The remaining boxes were of quite a good design but were too small to be ideal for the owl.

Elsewhere on the island the scarcity of hollows and of trees with the potential to form hollows in the near future was striking. Small hollows were found in Norfolk Island Pines *Araucaria heterophylla* and White Oaks *Lagunaria patersonia*. Ironwoods *Nestegis apetala* formed particularly good hollows but were usually not very large trees, so the cavities were correspondingly small. No hollows considered adequate for nesting Boobooks were found anywhere on the island.

The literature contains no reports of nesting owls. Lyle Tavener (pers. comm.) remembers his father pointing out the hollow where he believed Boobooks nested. It was in a Norfolk Pine and its entrance was about the size of the ring formed by a man's arms.

Food

Only one possible owl pellet was found, under a White Oak in the plantation. It contained the fur of the Polynesian Rat *Rattus exulans*. Insects were the only food recovered from the stomachs of four owls collected by Bell (1912, 1913). Moore (1981) found a feeding table, thought possibly to be

that of the Boobook, with the remains of a White Tern *Gygis alba*.

Possible Reasons for the Decline

The reason for such a drastic decline in Boobook numbers is almost impossible to determine in retrospect. While habitat alteration must have had a major impact, a series of other factors has probably contributed to the demise of an already stressed population. At present, a conspicuous problem is the lack of tree hollows.

Habitat change: The owl appears to prefer a plantation of exotic trees to the surrounding native forest. The plantation is relatively clear beneath the canopy, with only occasional low shrubs and ground cover. By contrast the forest in most other places has a relatively dense understory. Opinions differ as to the state of the original forest. Turner *et al.* (1975) thought it likely that the "original plant cover (undisturbed by man until 1788) was a dense and largely impenetrable jungle ...". However, Wales and Forster, who arrived with Cook about 1774, each reported that "a little way inland the woods were perfectly clear and easy to walk in" (p.45, A.N.P.W.S. 1984). The owl would almost certainly be able to hunt more effectively within an uncluttered forest.

Rats and Cats: The Polynesian Rat is thought to have been introduced to the island by visiting Polynesians over 700 years ago (Schodde *et al.* 1983). It was once considered to be rare, possibly extinct, due to displacement by the Black Rat *Rattus rattus* (Hermes 1986), which arrived on ships during the time of the first or second penal settlement (1788-1814 or 1825-1856; Anon. 1984). The Polynesian Rat is now known to be common and widespread on the island, and during a recent survey was trapped in greater numbers than the Black Rat (Gorta 1986).

Our activities caused rats to flush both by day and night, and we saw rat droppings high in trees, on branches and in hollows, in many parts of the island. The nests of two passerines were found with eggs freshly smashed and contents eaten, evidently by rats.

In view of the length of time that the Polynesian Rat has been present on the island, it is unlikely to have played a major part in the decline of the Boobook population; Gorta (1986) concurs with this. Similarly, a reasonable population of owls remained well (at least 60 years) after the Black Rat was introduced.

The possibility exists that more recent changes on the island have resulted in a great increase in the rat population which in turn has placed greater pressure on the island's bird life through the rat's depredations and competition for tree hollows. However, there is no evidence of such a change. Further, the Boobook would be a formidable opponent for even the largest rat, and smaller rats are probably a valuable food source.

Cats *Felis catus*, both domestic and feral, have been on the island since the second penal settlement (1825-56, Best 1838). While cats could destroy owlets and trap incubating adults in hollows, their coexistence with the owl for at least 130 years makes them an unlikely major contributor to its decline.

Pesticides: A variety of pesticides has been and is being used on the island. Of particular concern at present is the organochlorine dieldrin, which was seen on the shelves of shops selling agricultural/horticultural chemicals. Dieldrin is now banned or severely restricted in many developed countries (Newton 1979), including Australia. Also of concern is the free distribution of 'Bro-water' rat poison by the Forestry Section (Plant 1986) for rat control.

Collecting: In 1912 and 1913, Roy Bell took about 30 owls for an Australian collector, A. F. Bassett-Hull, despite having a permit to remove only six (Bell 1912, 1913). An additional seven specimens were taken during the Whitney South Sea Expedition in 1926. The removal of a relatively large proportion of the population would have reduced genetic variability in what must already have been a genetic bottleneck.

Competitors: The self-introduced Australian Kestrel *Falco cenchroides* was first recorded on the island in 1969 (Smithers & Disney 1969); it can nest in tree hollows and has a similar diet to the owl. During the 1970s it was considered a rare non-breeding visitor (Schodde *et al.* 1983), but there is now a small breeding population established. Unlike the owl, the Kestrel is found in open

areas cleared of most trees. Further, the owl was considered very rare before their arrival, so that it is doubtful that Kestrels have contributed significantly to its decline.

The Crimson Rosella *Platycercus elegans*, an early introduction, and Common Starling *Sturnus vulgaris*, first recorded in 1913 (Schodde *et al.* 1983), are both aggressive species that nest in tree hollows. Boobooks on the Australian mainland have been known to usurp the hollow of a nesting Galah *Cacatua roseicapilla* (Schodde & Mason 1980), so it is quite possible that the Norfolk Island Boobook would not be deterred from nesting by either species. While both would compete to some extent with the owl, the latter most likely prefers larger hollows than either exotic species.

RECOMMENDATIONS

A report discussing possible courses of action and recommending that a re-establishment programme be immediately instigated was submitted to ANPWS. Briefly, the first stage of the programme is concerned with maximising the chances of survival and successful breeding of the Norfolk Island female. It involves the release of male New Zealand Boobooks, fitted with transmitters, into the female's territory on Norfolk Island. Several artificial nestboxes would be erected. By back-crossing the female with any offspring and selection of phenotypes most resembling that of the Norfolk Island Boobook, a population of owls could be rebuilt. Captive breeding may be used later in the re-establishment programme in combination with breeding in the wild.

The report recommended that the plantation used by the owl be preserved because it appeared to be suitable hunting habitat and was approaching an age when hollows for nesting would begin to form. Although revegetation and weeding of the National Park has commenced, it will be several decades before the forest is re-established and trees begin to form hollows. The plantation could act as a 'bandaid' in the meantime. The report also endorsed the recommendation of Gorta (1986) that the use of the rat baits bromadiolone and brodifacoum should be restricted to "areas where the owl is not likely to feed on dead", dying or sick rats.

To take the female into captivity, although providing better control than breeding in the wild, was considered less acceptable on the grounds that it would be more stressful to the owl. It was more costly and there was no evidence that an attempt to breed from her was likely to be more successful in captivity than in the wild. Nevertheless, if a re-establishment programme does not go ahead on the island, it has been recommended that the owl be sent to New Zealand and an attempt made to breed from her in captivity there.

No action would result in certain extinction of a second unique Australian owl in historical times. The Lord Howe Island Boobook *N. n. albaria* was driven to extinction by about 1950.

Taxonomic, Biological and Genetic Considerations

So that an informed decision can be made on the most suitable subspecies for a reintroduction programme, the taxonomic relationships amongst the various Boobook owls must be reviewed. Originally, all the Boobooks were considered subspecies of *Ninox novaeseelandiae* (Latham 1801). Later they were separated into two species, one based on the New Zealand Boobook (*novaeseelandiae*) and the other Australian (*boobook*). At the specific level, Mathews (1912) placed the Norfolk Island with *boobook* but Bassett-Hull (1910) remarked that it would more likely prove to be *novaeseelandiae*. Later Mees (1964) reverted to Latham's use of *novaeseelandiae*. Others treated the Norfolk Island owl as a full species (Schodde *et al.* 1983; Hermes 1985). To-day, as predicted by Bassett-Hull, it is considered a subspecies of *novaeseelandiae* (Schodde, pers. comm.).

Although a very distinctive subspecies confined to Norfolk Island, various characteristics clearly place the Norfolk Island Boobook with the New Zealand Boobooks and distinguish it from Boobooks in the rest of Australia. Its feet and cere are yellow or yellowish while those of Australian Boobooks are grey. Its wing formula is like that of the New Zealand species. The outermost primary (first) is shorter than the eighth primary, the second shorter than the sixth and the third shorter than the fifth; these are all longer in *boobook*. Its tail is relatively long at about 65% of wing-length, as in *novaeseelandiae*, and differs from that of *boobook* at about 58%. It lacks the more or less distinct pale outline to the facial mask found in *boobook*. Also its upper mandible has a pale grey midline while that of the Australian species is more uniformly dark grey. In addition, like

New Zealand Boobooks, it is small, dark-plumaged and relatively uniformly coloured when compared with Australian Boobooks.

Nevertheless, the Norfolk Island Boobook differs from the New Zealand Boobook in features of its plumage and its larger size. It is slightly red-brown rather than the grey-brown of New Zealand Boobooks and its underparts are more finely spotted, and never streaked as in some New Zealand individuals.

Although little is known of the habits of the Norfolk Island Boobook, it appears to be very similar ecologically to the New Zealand Boobook. Both appear to prefer extensive areas of forest and have a similar range of prey.

Breeding on Norfolk Island is said to be from September to November (Ovington 1978). However, no nest has been found. Bell (1912-13) describes behaviour seen on December 23rd that was probably related to the exchange of food between an adult pair or an adult and its offspring. Moulting present on museum skins indicates that the owl finishes its moult by April. This is consistent with an approximate time of egg laying around October. New Zealand Boobooks lay from early October with a peak in November (Imboden 1985). Clutch size of the Norfolk Island Boobook is given as "usually three" (Ovington 1978), but is more likely to be usually two as in the New Zealand owl.

The proposed scheme involves the building of a population from extremely limited genetic stock, and inbreeding. While it is often considered desirable to avoid inbreeding, hence so-called inbreeding depression, and to retain a reasonable amount of genetic diversity (Soule & Wilcox 1980; Frankel & Soule 1981), few field studies have been conducted. In fact, Noordwijk & Soule (1981) found increased survival in inbred clutches of Great Tit compared with those that were not inbred. It is also likely that a small, isolated population such as that of the Norfolk Island Boobook had little genetic diversity anyway. Lovejoy (1978) speculated that populations that have passed through previous genetic bottlenecks may be better able to survive because deleterious alleles have been eliminated during the passage. Species colonising remote oceanic islands would almost certainly have passed through such a bottleneck in the course of their evolution (Temple 1986). Populations of other bird species have built up from very low numbers. The Mauritius Kestrel *Falco punctatus* reached a low of two pairs and apparently recovered because of a change in nesting habits in only one of the pairs (Temple 1986). Introducing New Zealand Boobooks to Norfolk Island may increase the gene pool considerably and thus may present fewer of the potential problems associated with inbreeding and lack of genetic diversity.

Postscript: In July-August 1987, a follow-up survey was undertaken; only the female was found. In September 1987 two male New Zealand Boobooks were released on Norfolk Island.

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