

# Notes on breeding and conservation of birds on Niuafo'ou Island, Kingdom of Tonga

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Niuafo'ou lies very isolated in the Pacific, is well forested and not densely populated by humans. These facts as well as the lack of larger rat species make it a refuge for birds rare elsewhere in the region. This paper covers all 17 breeding species and gives breeding data for 14 of them, collected from October 1991 to December 1992. Ten species had a well-defined breeding season of 2–7 months somewhere between September and April, which often differed from other adjacent islands: Audubon's Shearwater *Puffinus lherminieri*, Pacific Black Duck *Anas superciliosa*, Banded Rail *Rallus philippensis*, Spotless Crake *Porzana tabuensis*, Purple Swampphen *Porphyrio porphyrio*, Barn Owl *Tyto alba*, Red-vented Bulbul *Pycnonotus cafer*, Polynesian Starling *Aplonis tabuensis nesiotes*, and Jungle Myna *Acridotheres fuscus*. The Blue-crowned Lorikeet *Vini australis* nested in October, November and July. It did not only breed in tree hollows, but also inside a rotten log on the ground. Other observations suggest that it visits ground holes as well, either for nesting or resting. A breeding colony of Audubon's Shearwater is the first one confirmed for Tonga. Four species nested in the wet and dry season: White-tailed Tropicbird *Phaethon lepturus*, Pacific Reef-heron *Egretta sacra*, Pacific Pigeon *Ducula pacifica* and Polynesian Megapode *Megapodius pritchardii*.

Since September to March is the main breeding season for birds on Niuafo'ou, it is proposed that hunting and egg collecting, both important parts of the local tradition, are restricted to the other months of the year. In case of the endangered Polynesian Megapode we suggest a restriction of egg collecting and propose a translocation programme to another island. Additionally, we suggest that the islets in the crater lake become protected as they are free of feral cats, and some birds occur in higher densities there. Niuafo'ou also deserves attention as resting place for six vagrant and migrant species; large numbers of Wedge-tailed Shearwaters *Puffinus pacificus* are hunted when they visit between October and June.

Key words: Niuafo'ou, Tonga, Birds, Breeding, Food, Conservation.

## INTRODUCTION

THE volcanic island Niuafo'ou lies in the northern Tongan Archipelago, about 400 km from Western Samoa, Vava'u in Tonga and Vanua Levu in Fiji (Fig. 1). Niuafo'ou is well forested and not densely populated by humans. These facts, as well as its isolation and the lack of Norway Rats and Black Rats *Rattus norvegicus* and *R. rattus*, have made Niuafo'ou a continuing refuge for birds. The island is home to the endemic Polynesian Megapode *Megapodius pritchardii* and an endemic subspecies of the Polynesian Starling *Aplonis tabuensis nesiotes*. It also contains some healthy populations of birds uncommon elsewhere in the region, including the Blue-crowned Lorikeet *Vini australis*. A breeding colony of Audubon's Shearwater *Puffinus lherminieri* is the first one confirmed for Tonga. The long-term survival of many bird species is threatened, mainly by hunting, egg-collecting, feral cats and plans to build a harbour, which would enable Norway and Black Rats to enter the island and damage the bird populations.

To develop protection measures for the birds on Niuafo'ou, it is necessary to know details about their autecology, especially their demands towards the environment. The first bird records on Niuafo'ou were collected by Finsch (1877), Kellers (1931) and the Whitney South Sea Expedition (for a summary see Rinke 1991). More species accounts were presented by Rinke

(1986, 1991), who surveyed the island for periods of up to two weeks. We visited Niuafo'ou for a period of 15 months when we studied the Polynesian Megapode and developed protection measures for this endangered bird (Göth 1995; Göth and Vogel 1995, 1997; Göth *et al.* 1999). Our results give much needed new information on the autecology of most bird species. "A deficiency in our knowledge of Tongan birds is the poor state of autecological information . . . Only through detailed nesting and feeding studies of individual species can we better understand their role in Tonga's terrestrial ecosystems" (Steadman 1998, P. 27).

In this paper, we concentrate on breeding birds. Visiting birds are mentioned briefly, with the exception of non-breeding sea-birds (excluding the Wedge-tailed Shearwater *Puffinus pacificus*) as their status in Tonga has been reviewed by Jenkins (1979, 1980, 1982). Based on our observations, we give recommendations for the protection of the bird fauna on Niuafo'ou.

## NIUAFO'OU — BIOPHYSICAL ASPECTS

Niuafo'ou (15°36'S, 175°38'W), one of the youngest islands in the Tongan Archipelago, is an active volcano with at least nine eruptions in the last 200 years (Richard 1962). It is almost circular and has an area of roughly 58 km<sup>2</sup>, with about 18 km<sup>2</sup> consisting of a central fresh water crater lake containing three small islets

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(Fig. 1). The crater rim rises to 300 m and divides the island into an inner crater wall with a dense, humid broad-leaved forest and an outer slope, which contains the villages, plantations and lava fields. Since many plantations, especially in the remoter parts of the island, are in a fairly neglected state, all stages of regeneration into secondary forest are present. Details on the plant composition are given in Yuncker (1959) and Uhe (1974). Long-term data of rainfall and temperatures are figured in Göth and Vogel (1997).

Niuafo'ou has approximately 760 inhabitants (Anonymous 1991). Following the last eruption of 1946, which destroyed the main village, people were evacuated and were not allowed to return until 1958. Prior to this evacuation around 1 300 people lived on Niuafo'ou (Rogers 1986).

### METHODS

A field survey on Niuafo'ou was carried out from October 1991 to January 1993, except for five periods of 2–3 weeks in March, June,

August, September and October 1992, when we left the island to prepare and carry out translocation activities for the Polynesian Megapode.

During the first months, we made daily excursions from the village of Esia to all parts of the island. From January 1992 onwards, the investigations on the megapode took place on the densely wooded islet of Motu Molemole (MMM, area 12 ha) in the crater lake, where we camped during the week. Daily patrols of at least two hours were undertaken, thus monitoring all parts of MMM. We also had seven other study areas where we censused megapodes, and we visited all parts of the island regularly to evaluate the total area where megapodes occur. Altogether we totalled about 1 300 hours of field work during 232 days. Along with our studies of megapodes we made opportunistic notes on the other birds, including relative abundance, behaviour, habitat preferences, location, time of day and weather. Plant identifications were determined using Yuncker (1959).

Many of the observations were made on mainland Niuafo'ou. If made on one of the islets in the crater lake (MMM, Motu Lahi and Motu Si'i), this is mentioned separately. Because there are no feral cats on the islets, densities of birds are often higher and some behaviour, like breeding on the ground, might only occur there.

### SPECIES ACCOUNTS — BREEDING BIRDS

Here we give observations for each species, followed by a discussion that compares our results with those published for other Tongan islands (mainly Tongatapu and 'Eua) as well as adjacent Pacific islands. The Tongan bird names used on Niuafo'ou are given where known; they were collected during talks with different residents. Our terminology for status is imprecise because we did not count numbers of any species except the megapode. "Common" is used if a species was so numerous and conspicuous that it would be hard for an observer to miss. Birds that are described as "moderately common" are present in lower numbers and seen regularly, but may be difficult to find on a given day. "Uncommon" species we only observed a few times during our stay, "rare" birds have low populations and require special effort to see them.

It is worth noting that a Pacific-wide El Niño event occurred during our stay, leading to a period of unusual dry weather, especially in January 1992. This phenomenon corresponded to a period of reduced egg laying in the Polynesian Megapode (see below) and might also have influenced the breeding activities of other birds.

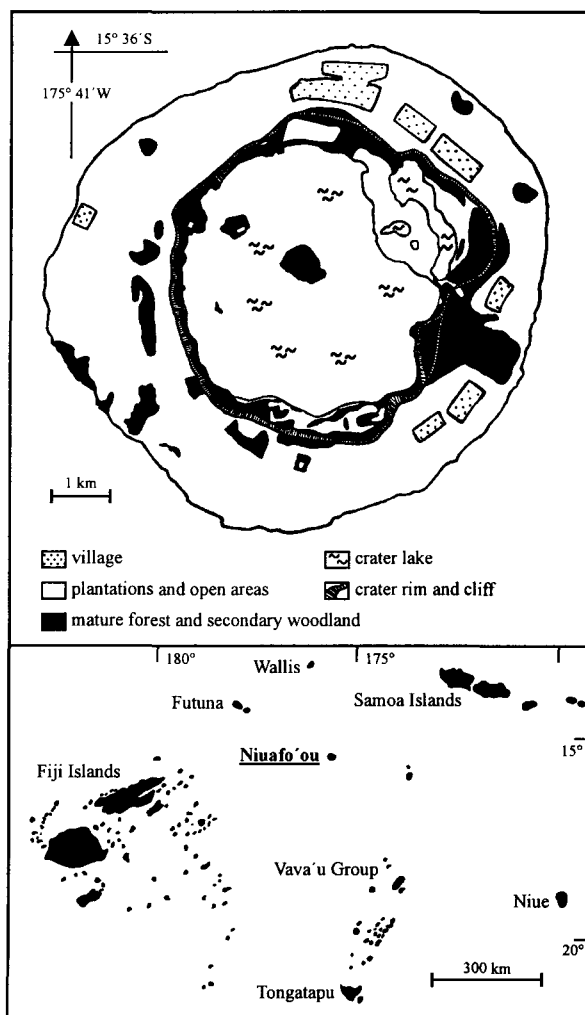


Fig. 1. Map of Niuafo'ou and its position.

### Audubon's Shearwater *Puffinus lherminieri*

*Distribution and status:* Large numbers visit Niuafo'ou for breeding between November and April.

*Breeding:* First observed between November 1991 and April 1992, when up to 100 flew over the lake at dawn and after dusk each evening, uttering calls. On 2 April 1992, we discovered breeding burrows on the islet Motu Si'i in the lake; about ten dead shearwaters were found in front of these. We saw no signs of live birds during the day. After some months, they were seen again every evening in December 1992 and January 1993, always up to 200, mostly in groups of 2–6 birds, circling over Motu Si'i at dusk and later on, uttering calls. They landed on the islet by crashing into a tree on the beach and falling down clumsily. They then crawled into burrows and uttered soft calls from inside that sounded like repeated, snoring, inhaling and exhaling.

In Vanuatu, this shearwater breeds between September and April (Bregulla 1992). Watling (1982) concluded that it had an extended breeding season in Fiji. World-wide, its season and length of cycle varies with locality (del Hoyo *et al.* 1992).

The breeding colony on the islet Motu Si'i was mentioned last century by Hübner (in Finsch 1877, P. 787): "The Teiko [local name for Audubon's Shearwater on other Pacific islands] lives on a small island [in the crater lake] in holes in the rocks. I obtained my specimens by rowing just before daybreak in a canoe round the island. We watched when the birds left their holes and, becoming confused by the glare of a torch, allowed us to catch them by hand". Nowadays, the colony on Motu Si'i is not known to the residents, because the islet is not visited after dark, the time when the shearwaters arrive. This is the first breeding record for Tonga, although it has been reported that they might nest on islands in the Ha'apai Group and on 'Ata (Jenkins 1980).

### White-tailed Tropicbird *Phaethon lepturus*, Tavake

*Distribution and status:* Moderately common; flying birds along the steep cliffs of the inner crater wall throughout the year.

*Breeding:* From November to May, with one young seen in July. Four nests were found: one in a tree-hole at a height of 2 m; young called from inside (29 July 1992). One with incubating parent on a plateau in a cliff (27 November 1992), one in a ground hole on a slope, young called from inside (18 December 1992). In December 1991, one nest with one egg on the open forest floor on MMM, the adult incubated

for four weeks then deserted. The nest was placed on a plateau above a cliff, in which other tropicbirds nested in crevices or between roots. Fledglings were seen four times, flying with adults (26 March 1992), sitting on the ground on Motu Si'i while adults flew into crevices of a small cliff above (2 April 1992), sitting at the lake shore (16 May 1992) and swimming on the lake (10 January 1993). Rinke (1991) found two chicks in January. On 'Eua, breeding was observed in February, May, July and August (Rinke 1987). On other Pacific islands, the tropicbird lays eggs whenever local conditions are suitable (Prys-Jones and Peet 1980); it can be seasonal in some localities, but breeds more or less continuously elsewhere (del Hoyo *et al.* 1992).

### Pacific Reef-Heron *Egretta sacra*, Motuku

*Distribution and status:* Common around the lake within the crater; occasionally at the seashore. Three colour morphs occurred, with mottled grey-white birds being rare. Grey and white herons were about equally distributed, which agrees with Rinkes (1986) observations on Niuafo'ou.

*Breeding:* April and July. Two breeding records; a nest with one young in a coconut palm *Cocos nucifera* (2 April 1992) and a nest with three incubated eggs among the roots of a collapsed tree on MMM (23 July 1992). No communal nest sites, as previously reported for this species (Watling 1982). On Tinian, nests were found in April (Marshall 1949), in Vanuatu from February to July (Bregulla 1992), however, Bregulla also states that "the breeding time can vary depending on local conditions" (P. 113). In Fiji, this species is not seasonal (Clunie 1984). For the Pacific region in general, a breeding season between May and July as well as in September is given (del Hoyo *et al.* 1992).

*Food:* Fish caught along the outer coast, but mainly cichlid fish *Oreochromis mosambiquus* from the lake. Usually prey were either caught by moving along the lake shore in the low or upright stalk posture or by assuming an alert or crouched position after a short flight, as described by Recher and Recher (1972). The motionless "stand and wait" posture was only observed rarely. A further hunting strategy was to fly close to the water surface into the wind, with a very slow, flapping flight while picking fish out of the lake. Both white and grey herons used the same hunting methods, as was also observed in Reef Herons on the Great Barrier Reef (Recher 1972).

### Pacific Black Duck *Anas superciliosa*, Toloa

*Distribution and status:* Uncommon; mostly in small flocks in bays along the south shore of the lake.

**Breeding:** From January to April. One duckling (16 April 1992) or three ducklings (27 January, 3 and 18 February 1992) swimming with one parent. One incubated nest with eight eggs among buttresses of a *Casuarina* tree, 10 m from the lake (6 March 1992). In Fiji, this duck breeds from October to April (Clunie 1984), in Vanuatu from July to January (Bregulla 1992).

**Polynesian Megapode *Megapodius pritchardii*, Malau**

**Distribution and status:** Rare; restricted to Niuafo'ou, but before human arrival it occurred on many other Tongan islands as well (Steadman 1993, 1999). With only 188 to 235 reproductive pairs left (Göth and Vogel 1995) it is endangered.

**Breeding** (summarized from Göth and Vogel 1995, 1997): Buries its eggs at volcanically heated nesting sites (geothermal heat) in egg burrows filled with loose soil. The burrows are opened by a hen each time an egg is laid and refilled afterwards; often they are used by more than one female and over many years. Females produced an average of 11.6 to 16.4 eggs per year. Intervals of 14 to 16 days between successive eggs were observed for marked birds. Eggs were laid year-round with a period of reduced egg laying from January to August 1992. During this time we had unusually dry weather, caused by an El Niño event. This indicates a possible relationship between egg production and rainfall patterns. The incubation temperatures in most egg burrows were between 32°C and 33°C. On the islet MMM, three relatively cold egg burrows with 29.0, 30.8 and 30.9°C, were used much less often than one burrow with higher temperatures. Possibly the use of these cooler burrows resulted from competition between females for access to the warmer burrow. Eggs weighed around 24% of the body weight of the female. They were incubated most often for periods of 50 to 80 days.

**Banded Rail *Rallus philippensis*, Veka**

**Distribution and status:** Common; often seen on roads, at the lake shore, in clearings and in secondary bush-vegetation; seldom in primary forest. Not often caught for food, in contrast to the situation on other Tongan islands.

**Breeding:** From November to February. Once, two young observed with one adult (30 December 1991), thrice two young with two adults (13, 15 and 18 January 1993), once three young with one adult (3 February 1992), and one young was caught in a trap (8 November 1992). An extended breeding season, as assumed for Vanuatu (Bregulla 1992) and Fiji (Clunie 1984), does not seem to exist. On other islands,

observations indicate a marked variation in breeding season: In the Tongan Archipelago, observations are from February and August on 'Eua (Rinke 1987), July on Lifuka (Steadman 1998) and October on Foloa (Curio and Onnebrink 1991). In Samoa, they are from November to April as well as June and July (Dhondt 1976a) and May (Green 1965). August is given as breeding season on Niue (Wodzicki 1971) and September to November on Palau and surrounding islands (Marshall 1949).

**Spotless Crake *Porzana tabuensis*, Mohe**

**Distribution and status:** Rare; only observed on the islets in the lake. Although this was partly caused by our frequent residence there, we conclude that feral cats have possibly reduced numbers on the main island. Wodzicki (1971) mentions that "this rail is very rare on Niue Island and might only occur in the remote interior. It might be susceptible to predation by cats".

**Breeding:** From September to November; two observations of one chick, about 4 cm long, with one adult (4 September and 4 November 1992); once a chick, same size, was found by itself (14 November 1992). Another time, an adult behaved as if its nest was close by; it approached the observer, ran around him at a distance of only 5 m, its tail pointing upwards. It uttered many "pit"-calls and stretched one wing and leg on the same side, as if they were broken (30 October 1992).

Very few reports from the Pacific area of distribution are known, since this bird is elusive and shy and more likely to be heard than seen (Bregulla 1992). Bregulla also states that in Vanuatu the breeding season is apparently from September to February.

**Food:** In contrast to Pratt *et al.* (1987), who concluded that this rail is active at dawn and dusk, we found it active throughout the day. On MMM, it was mostly seen foraging alone on the shore of the lake — its main food is small aquatic animals (Watling 1982). One bird was observed picking up leaves from the litter on the forest floor, throwing them aside and searching for food beneath them.

**Measurements:** One adult caught in a trap in December 1992: tarsus 28.3 mm, middle toe with claw 32.0 mm, bill 7.8 mm, wing 78.0 mm.

**Purple Swamphen *Porphyrio porphyrio*, Kalae**

**Distribution and status:** Moderately common; throughout the island in forests. Considered a pest to crops by the residents and killed whenever possible.

**Breeding:** Young observed between September and March. Two black chicks were by themselves

in the forest (6 September 1992), one waded in the water at the edge of the lake (18 November 1992) and one swam on the lake by itself and escaped by diving (4 March 1992). Once, five adults and at least five chicks foraged together in a mud area (13 February 1992). On Tongatapu, breeding occurs in August and September (Gräffe 1870), on Palau and in the Eastern Solomons in September (Marshall 1949; Cain and Galbraith 1956). In Vanuatu, the breeding season is from August to January, but eggs may be laid as late as March or as early as July, when conditions are favourable (Bregulla 1992).

**Food:** Thrice, we saw single adults flying up from a plantation. Single adults also foraged in the leaf litter on MMM, pushing leaves aside with their bill and pecking at food items (two observations). On three occasions, single birds pecked at fish and small invertebrates at the lake shore. One carried away a seed of a *Pandanus* *Pandanus tectorius* on MMM, coming back twice to get a new one. We do not know whether it was able to crack and eat the big, hard seeds.

#### **White Tern *Gygis alba*, Tala**

**Distribution and status:** Moderately common; reported throughout the year above the forests or the lake, often fishing for cichlid fish.

**Breeding:** Only one young bird, not capable of flight, on the forest floor, at the end of October 1992. On 'Eue'iki, in southern Tonga, an incubated egg was found in November (Rinke *et al.* 1992).

#### **Purple-capped Fruit-Dove *Ptilinopus porphyraceus*, Kulukulu**

**Distribution and status:** Moderately common; heard in all primary forests throughout the island, but also in smaller patches of secondary forest between the lava fields.

**Breeding:** Due to its secretive behaviour high up in the canopy, no data could be gained. On Tongatapu, it breeds in December and January (Gräffe 1870), in Fiji between July and January (Clunie 1984).

#### **Pacific Pigeon *Ducula pacifica*, Lupe**

**Distribution and status:** Moderately common; the conspicuous call is heard regularly in all primary forests. We did, though, have the impression that more occurred on the two larger islets in the crater lake. They are hunted by residents, but not often, because they lack cartridges for their shotguns.

**Breeding:** Obviously a prolonged breeding period, as nests or young birds were found in January, July and November. Two young observed, one in a tree (5 November 1992), another one on the ground, with broken upper

beak and two missing claws (15 January 1992). One nest, at a height of 10 m in a *Syzygium* tree, built of coarse twigs, round and about 30 cm in diameter (17 July 1992). One observation of an adult breaking off dry twigs from a tree (25 July 1992). A display flight was observed in December, which also hints at the mating season: The bird first uttered a high-pitched "huhu"-call from a tree, flew then upwards with noisy wing beats and glided down slowly again. On 'Eua, breeding occurred in January and February (Rinke 1987), on Tongatapu in August and September (Gräffe 1870), in Fiji from May to January (Clunie 1984) and on Tutuila from January to September, with most records from May to August (del Hoyo *et al.* 1998).

#### **Blue-crowned Lorikeet *Vini australis*, Henga**

**Distribution and status:** Common; found throughout the island, its high pitched calls are frequently heard.

**Breeding:** Blue-crowned Lorikeets breed in holes or cracks in trees (Mayr 1945; Clunie 1984; Rinke 1985), which is supported by our observations at sites A-C on MMM:

**Site A:** 1 August 1992: Nest in a hole in the stem of *Syzygium clusiaefolium* at a height of 5 m. One adult flew in and out, begging calls inside. 1 September 1992: Still begging calls. 7 September 1992: Two young sat close to the hole entrance, almost fully feathered. We could not determine when they left the nest. **Site B:** 2 November 1992: One flew out from a hole in the stem of a *Syzygium* tree at a height of 2 m, the hole was too deep for inspection. **Site C:** 5 January 1993: A pair landed in a *Casuarina* tree. One flew to the entrance of a hole in this tree, 10 m from the ground, looked into it and flew back to the other bird.

Additionally (*site D*), we found one nest close to the ground in a large rotten log, 10 m away from *Site A*, and followed the development of the chicks:

22 July 1992: Nest discovered. The log had a hollow (diameter 15 cm) in the middle, where the wood had fallen apart. Its upper layer could be lifted. A large fungus had grown in the hollow and the lorikeet nest was placed under it. The bird reached the hole by crawling through a small fissure, about 3 cm wide, at the side of the log. The nest was circular, about 15 cm in diameter and covered with 30 small lorikeet feathers and small leaves that had been torn apart. It contained two eggs, 20.7 × 17.8 mm and 21.8 × 17.9 mm. 8 August 1992: Two young lorikeets had hatched during the last three days, an adult was with them, their eyes were closed and they uttered soft calls. Weights: 12 and 14 g. 27 August 1992: Eyes open, first feather

sheaths on back and head. 1 September 1992: First coloured feathers on head and back, the primaries were still ensheathed, the secondaries and tail feathers had lost the sheaths. Weights: 65 and 66 g. 6 September 1992: Still in the nest, almost fully feathered, weights: 69 and 70.5 g, wing length of one bird: 5.9 cm. It is known that the young have less colour on the undersides than adults (del Hoyo *et al.* 1998). We also noted that the beak was black instead of orange, the blue midcrown was smaller and they had no red on the breast (only the red throat was fully developed). Unfortunately, we could not record when they left the nest.

There is no previous information on the nestling period (Rinke 1985). Our findings of at least 38 days (nest site A) and at least 29 days (nest site D) are the first in the wild.

In addition, we saw birds flying with or fed by adults in July, October and November, in the top of coconut trees (9 July 1992, 4 and 5 November 1992), on a flower of the African Tulip tree *Spathodea campanulata* (15 July 1992), on flowers of *Syzygium* trees (30 October 1992, 10 and 14 November 1992) and in the top of a *Casuarina* tree (30 November 1992).

Thus, breeding occurs between July and November. Gräffe (1870) gives January to March as the breeding season on Tongatapu. On Tofua (Tonga), we observed many fledglings from 21 to 28 June 1992, being fed in coconut palms. The distinct breeding season on Niuafo'ou also differs from statements of del Hoyo *et al.* (1998), who conclude that breeding activities occur throughout the year, as this bird was found to breed in March, June, August and December on different islands in the Pacific.

*Ground holes — nesting or resting sites?*: We frequently observed lorikeets entering and leaving holes in the ground on the islets in the crater lake: 31 December 1991, 7.30 pm, MMM: One flew out from a hole in the ground (diameter 5 cm), below a tree root. The end of the deep and curved hole could not be reached by hand, one lorikeet feather was lying at its entrance. 2 April 1992, 4.30 pm, Motu Si'i: Two flew out from a small hole in the ground, below a large flat stone. They sat in a tree nearby and watched us. Again, we could not reach the end of the hole. 4 April 1992, 4 pm, Motu Si'i: Similar observation of one escaping straight into the air from an area with many small holes. 14 May 1992, 2.30 pm, MMM: One escaped by flying up from a small hole in the ground. After a few minutes, it came back into a tree and looked at the hole. 6 September 1992, 6.35 pm, MMM: Two landed in a big *Casuarina* tree, one flew into one of several holes in the root region of the tree. 22 December

1992, 10.30 am, MMM: One flew out of a hole in the ground, below a big root, at the sandy beach of the lake.

The reason for this behaviour remains a mystery, since we were not able to inspect the holes for nests and do not know whether they were nesting or resting sites. The fact that the lorikeets visited them during different times of the day could hint at a use as nesting burrows. On the other hand, some of these observations were made outside the breeding season mentioned above, which would appear to indicate that the holes are used as resting sites during the day. Watling (1982) also indicates that Blue-crowned Lorikeets have been recorded as digging burrows in earth banks.

*Food*: Berries taken from a fig tree *Ficus* spp. (2 March 1992); nectar or pollen from the African Tulip Tree (22 July 1992), as well as from *Morinda citrifolia* (24 October 1991), *Syzygium clusiaefolium* (15 April; 13 July; 22 July and 30 October 1992) and *Fagraea berteriana* (3 December 1992). All these shrubs or trees are in addition to those mentioned by Rinke (1985, 1986). Between November and January, lorikeets are often seen feeding on Ironwood trees *Casuarina equisetifolia*, a behaviour only known from Niuafo'ou (del Hoyo *et al.* 1998). Since we only observed them feeding on the male flower panicles of this tree, they might eat the pollen. The tongue of lorikeets is well adapted for collecting pollen, which might even be the primary food source for most Loriinae (Schuchmann 1984).

### **Barn Owl *Tyto alba*, Lulu**

*Distribution and status*: Presumably common; leads a secretive life during most months and is then hard to detect; easier to observe in the breeding season when more calls are heard.

*Breeding*: Young heard in November and December. Three times, begging calls from a group of 3–4 owls (20 December 1991, 20 and 27 November 1992), once this was close to a crevice in a rock wall which was covered with faeces. Breeding very likely also in September and January, as owls called more often and almost all our observations are from this time (see below). On 'Eua, eggs were found in May (Rinke 1987), in Vanuatu, from April to October, and on New Caledonia from May to August (Bregulla 1992). In Fiji, this bird appears to be not seasonal (Clunie 1984).

*Activity*: Often seen during dawn or in the dark but also active during the day. Field notes during darkness (about 6 pm to 5 am) are, in 1991, from 13 November and 20 December, in 1992 from 6 September, 20 and 26 November and 7 January. Field notes during the day are from 28 October 1991, 31 August 1992,

6 September 1992, 26 November 1992 and 3 December 1992. This shift of activity patterns is also known from Samoa (Dhondt 1976a), whereas in Fiji the Barn Owl remains silently perched in a tree or cave during the day (Watling 1982). This difference might have resulted from a lack of competition from other raptors on Niuafo'ou and Samoa.

**White-rumped Swiftlet *Collocalia spodiopygius*, Peke Peke**

*Distribution and status:* Moderately common; mainly seen along the inner crater wall but absent around the outer lava fields.

*Breeding:* Only one cave, in which they build their nests, was known to us. Residents have known this site ("Akofa") for at least one generation. There might be others along the steep cliffs of the inner crater wall. The nests contained eggs and young from October to December 1991, but we did not visit them again later. In Samoa, these birds breed in late June (Dhondt 1976a) as well as in February, April, June and November (Ashmole 1963), in Fiji between September and March (Clunie 1984). In Vanuatu, they have an irregular or extended breeding season (Bregulla 1992).

**Polynesian Starling *Aplonis tabuensis nesiotus*, Misi**

*Distribution and status:* Common; found in most habitats including the villages, mostly in pairs, sometimes in small flocks. This is an endemic subspecies which has a yellow iris instead of a brown one. The iris of all young birds we observed being fed by their parents was brown.

*Breeding:* Between October and January, with one young bird seen in May. Always one or two young with one or both parents, twice in 1991 (24 and 28 October) and five times in 1992 (13 January, 21 May, 29 and 30 October, 5 and 14 November). Three nests with young, two in a crevice in a hollow trunk (2 and 17 December 1991) and one in a *Syzygium* tree (3 October 1992). One fledling was observed eating spider-webs (21 May 1992). Rinke (1991) found one young in January. On 'Eua, juveniles were seen from September to February (Rinke 1987), on Tongatapu from November to January (Gräffe 1870), in Fiji, from June to January (Clunie 1984), and in Samoa, one brood was found in August (Child 1979).

*Food:* Fruits (papaya and *Syzygium* fruits), nectar of *Syzygium* trees, cicadas or small food items collected from leaves.

*Behaviour:* Two birds observed sitting in front of each other imitating the alarm calls of the Polynesian Megapode and the Wandering Tattler *Heteroscelus incanus* (July 1992) — a mimicry not recorded for this species.

**Jungle Myna *Acridotheres fuscus*, Ngutu'enga**

*Distribution and status:* Introduced on many Pacific islands, first reported in Samoa in 1965 (for summary see Gill *et al.* 1993). Common all over Niuafo'ou; mainly in villages, but also in the forests of the inner crater wall, and on the islands in the lake. Mostly in flocks of 2–8 birds. According to residents, the Myna appeared on Niuafo'ou after scientists from the Russian Expedition Ship "Kalisto" had visited the island from 28 January to 1 February 1977. It is not mentioned in the scientists' bird-report (Stepanjan, L. S., "Ptizi Jugo-Sapadnoi Okeanii" = "The birds of the South Pacific Ocean"; in Russian, source unknown). David Todd, who stayed on Niuafo'ou in 1976, did not record this species (pers. comm.) and also Pernetta and Watling (1978) did not know about its presence on Niuafo'ou.

*Breeding:* Between December and January. Twice, we observed two fledlings with one adult (17 and 18 January 1993). In the village Esia, one nest was in a crevice in an old tree at 2 m height (1 December 1992). It contained one egg and two freshly hatched young. On 18 December, the young still called from inside. Another nest was presumably in a hole in a dead branch, as one adult flew in and out (31 December 1992). In Fiji, the myna usually has two broods, between September and March (Clunie 1984).

**Red-vented Bulbul *Pycnonotus cafer*, Manufo'ou**

*Distribution and status:* Introduced, not known when. Residents claim that it was there before the Jungle Myna. In Fiji, it appeared in about 1903 (Watling 1978), and since then it has established itself on many Pacific islands (Gill *et al.* 1995). On Tongatapu, it was first recorded in 1976 (Dhondt 1976b). Today, it is one of the most common birds on Niuafo'ou, found in all habitats, often in the villages, but also in the broad-leaved forests of the inner crater wall and on the islets, mostly in flocks of 4–6 birds.

*Breeding:* Young birds seen from October to January, either one with two adults (19 October 1991), one with one adult (6 and 11 January 1993), two with two parents (23 October 1991), two with one adult (24 October 1991) or one by itself on the ground (17 December 1991 and 18 January 1992). Twice, a male was observed being engaged in courtship display (11 May and 5 October 1992). In Fiji, bulbuls breed from October to February or March (Watling 1982); in Samoa, records are from November and January (Goodman 1969; Dhondt 1977). In its original range (India, Pakistan, Burma and Sri Lanka), it has an extended breeding season, depending on the monsoon.

*Food:* Mango, Soursop fruits (*Annona* spp.), *Syzygium* fruits, insects caught in flight and cicadas collected from leaves.

#### SPECIES ACCOUNTS — MIGRANTS AND VAGRANTS

##### **Wedge-tailed Shearwater *Puffinus pacificus*, Manu'uli**

Residents caught these birds for food at dusk and at night, between October and May or June. They attracted them by uttering whining calls from a rock at the coast. The shearwaters circled above them silently, were hit with long, thin sticks and, once on the ground, caught by dogs. One man could often catch up to 70 shearwaters a night, and we estimated the number caught by all men in one season to be more than 1 000. Dissections showed that both sexes were represented and that they had limestone pebbles (3–8 mm) in their stomachs. Since these are usually picked up as nestlings in the burrows (Johnstone, pers. comm.), the shearwaters must have hatched on a limestone island. We could not find any nest burrows of these birds along the inner crater wall or on the islets in the lake. The birds were also never heard calling after dusk; at their breeding grounds, they are recorded as being very vocal at night (Watling 1982). The residents did not know anything about colonies on the outer crater rim or about calling shearwaters at night — those caught were approaching silently. It is therefore unlikely that any colonies exist on Niuafu'ou. The region of origin for the large number of Wedge-tailed Shearwaters appearing between October and June is unknown.

The absence of this shearwater between July and September agrees with the findings of Jenkin's (1979, 1980) for other Tongan islands with details of a breeding colony on Fonualei in Tonga, based on descriptions given by Davidson (1932).

##### **Swamp Harrier *Circus approximans***

Rare visitor to Niuafu'ou. One in February 1992, flying over the lake, possibly from Fiji, where Swamp Harriers are common (Holyoak 1977; Watling 1982) or from Tofua in Tonga, where we observed individuals thrice in 1992. Steadman (1998) also reported them from Tofua.

##### **Long-tailed Cuckoo *Eudynamis taitensis***

Breeding in New Zealand and migrating to many Polynesian islands. Observed thrice, in April, May and October 1992. In Vanuatu, this cuckoo arrives in about April and departs in September, though some individuals remain

longer (Bregulla 1992). In the Cook Islands, it is commonest from March to August (Gill 1996). In July, Steadman (1998) recorded it on 3 of 13 islands in the Ha'apai Group (Tonga).

##### **Pacific Golden Plover *Pluvialis [dominica] fulva*, Kiu**

Common during the summer, on all open areas of the island. Observed regularly from November 1991 to April 1992, mainly single birds which foraged on the lake shore, on roads or other open ground. Then seen less frequently until August 1992, mainly as single birds in the villages. Common again from September 1992 on. On 'Eua, Rinke (1987) reported plovers during all months, but most often between September and February. In Fiji, most birds arrive in September and leave in April (Watling 1982).

##### **Wandering Tattler *Heteroscelus incanus*, Koko**

Moderately common, only observed at the lake shore, solitary or in flocks of up to four birds. Mainly observed in July and August 1992, two records in October and November 1992, one of them of one bird moulting its tail feathers. In Fiji, Wandering Tattlers are much more common and occur throughout the year (Watling 1982).

##### **Ruddy Turnstone *Arenaria interpres***

One record; two adults flying along the lake shore on 27 August 1992. In Fiji, this bird is a common migrant and found throughout the region (Watling 1982).

#### CONSERVATION

Based on our observations, we give the following recommendations for the protection of the bird fauna on Niuafu'ou:

##### **Protection of the islets**

On the islets in the crater lake, not inhabited by feral cats, some species (e.g., Polynesian Megapode, Spotless Crake) occur at higher densities than on mainland Niuafu'ou. The islets are important breeding areas for the Blue-crowned Lorikeet, which even utilizes ground holes there, and of Audubon's Shearwater. Breeding colonies of a few hundred fruit-bats *Pteropus tonganus*, which have become rare on most other Tongan islands, are found on all three islets. It is now known that flying foxes are important pollinators for rainforest trees; many tree species would not be able to reproduce without them. Additionally, we found that the rare Black Skink *Emoia nigra* occurred at much higher densities on the islets. It would be ideal if the people of Niuafu'ou would



protect the islets as Nature Reserves and limit their intrusions, possibly with financial help from international conservation organizations. It is important to remove pigs and goats from the two larger islets, Motu Molemole and Motu Lahi, which were introduced within the last five years and have damaged the natural vegetation (Fonua 1997a; Pe'ei, pers. comm.).

#### Feral cats

The higher population density of megapodes and Spotless Crakes on the islets is probably a result of the lack of cats, which are abundant elsewhere on Niuafo'ou. There, they are known to catch the female megapodes while they bury their egg in a deep hole in the ground (Todd 1983). Approximately 15 times, we saw cats along the lake shore, far away from the villages. We never encountered them on the islets, but it might simply be a matter of time before they reach them as well. A cat eradication programme, probably following methods described by Veitch (1985), is desirable but hard to carry out, as some parts of the island are steep and difficult to reach. A monitoring programme should ensure that cats have not established themselves on the islets.

#### Hunting

Ten of the 14 species for which we observed breeding had their main breeding season between September and April (see Appendix for summary). Hunting birds and collection of eggs is part of the local tradition (see below) and cannot be easily prohibited. Nevertheless, it would benefit wildlife if hunting and collection were restricted to the non-breeding season between May and August. The practice of eating bulbuls or mynas could remain as they are introduced birds. Because Wedge-tailed Shearwaters form such an important part of the diet, some sort of quota system might be applied rather than a complete ban.

#### Introduction of rats and snakes

Up to now, only the Polynesian Rat *Rattus exulans* occurs on Niuafo'ou. Norway Rats and especially Black Rats have done considerable damage to bird populations on other Polynesian islands (Atkinson 1985; Seitre and Seitre 1992). If they reached Niuafo'ou as well, they would considerably damage the healthy populations of many birds, especially the lorikeets and starlings. As large ships cannot land on the island, the introduction of rats is unlikely. However, the Tongan Government presently plans to build a harbour on Niuafo'ou (Fonua 1997b). This would greatly increase the risk of introducing Norway Rats and Black Rats. Procedures for quarantine regulations to prevent

their introduction should be adopted before the harbour is built. This would also help to ensure that other bird predators, like the Brown Tree Snake *Boiga irregularis*, do not reach the island.

#### Species which deserve special attention

*The Polynesian Megapode (Malau)*: Our census yielded a population number of between 188 and 235 reproductive pairs (Göth and Vogel 1995) and showed that the bird has retreated from habitat still inhabited during the last census in 1979, which yielded 800 pairs (Todd 1983). The species is assigned to the Mace-Lande threat category "endangered" (Dekker and McGowan 1995). The ICBP (1992) lists it as a Restricted Range Species, occurring in Endemic Bird Area f16 which is not a highlighted Endemic Bird Area. Its conservation status, according to the 1994 IUCN threat categories, has been listed as endangered/B1+2e, C2a (Dekker 1999).

The long-term viability of the Malau is threatened. Egg-collecting is the main reason for the decline (Göth and Vogel 1995), although it is currently forbidden by Tongan law. This law could be better enforced by a resident endowed with the necessary executive power; the main island of Tongatapu with the central government is too far away. A restriction on egg-collecting to certain seasons and certain nesting grounds, as it has existed in former times when local chiefs controlled the harvest (Gray 1864; Friedländer 1899), should be a goal, if no strict regulations are possible. A community awareness programme would be desirable, taking into account the cultural role of the Malau for the Tongan people; the bird and its nourishing eggs appear in many stories and songs. One such step was undertaken with the distribution of a bi-lingual booklet (Tongan-English) on the Malau among the people of the island (Rinke 1995).

Beside all efforts to restore the only existing population on Niuafo'ou, there is always the danger that a new volcanic eruption could wipe out the remaining population. The island has a regular volcanic history (Richard 1962). A continuation of the translocation programme started by us and by D. Rinke is therefore highly recommended. The translocation is proposed on the basis of the more extended range of the megapode in former, pre-human times (Steadman 1993, 1998). In 1992, we surveyed three other volcanic islands in the Tongan Archipelago, Fonualei, Tofua and Late (Vava'u and Ha'apai Group). We found Late, a semi-dormant volcano peak of 19 km<sup>2</sup>, most suitable as a reserve for the megapode. It is uninhabited, has large forests and obviously no feral mammals other than the Polynesian rat. Also, important

for the Malau, geothermally heated sites occur as nesting sites at the lake shore, and the ground vegetation cover as well as the food availability are similar to the situation on Niuafo'ou (unpubl. result). Following this feasibility study, we first transferred 31, and one month later 32 eggs to Late via plane and fishing boat. The success could not be controlled, except that when we transferred the second clutch, six eggs were added, the others were still intact (10) or had hatched. Before new translocations take place, the ground temperature at the lake shore has to be measured to ensure that it still provides sufficient heat for incubating the eggs. Because of the small population on Niuafo'ou, clutches of no more than 30 eggs should be transferred, three or four times a year. Adults should not be removed from the population. Only old eggs, less susceptible to temperature changes, should be taken from the nesting grounds, and the additional harvest of eggs by the locals during the transfer has to be minimized to prevent a possible fatal decline in reproduction. The translocation programme has to last at least two years, and monitoring the new population should take even longer. The transport by boat to Late takes too long, and landing in the swell of the unshielded island is too unpredictable. It should be carried out by helicopter. Landing is easier on the volcanic island Fonualei, where D. Rinke (1995) transferred eggs to. We regarded it as not suitable for the Malau, as large parts are barren and only little mature forest, the natural habitat of the bird, exists. Rinke (1995) claimed to have seen an adult Malau on the island during a control visit in 1994.

*The Polynesian Starling:* The sub-species *Aplonis tabuensis nesiotes* is endemic to Niuafo'ou. Currently, it is common and needs no special conservation measures to ensure its long-term survival. There are fears that this species, as well as the Purple-capped Fruit-Dove, suffer considerably from competition with mynahs and bulbuls (Rinke 1986). Although this might be the case around the villages, we did not have the impression that the starlings or fruit doves were driven back by the introduced species in the forests. Such changes in species composition can, of course, happen very slowly and are hard to notice, but we think that the most important measures to ensure the long-term survival of these species is to protect the wooded areas where they live and to prevent the introduction of Norway and Black Rats.

### Culture and conservation

Many social customs on Niuafo'ou are interwoven with the natural environment. Hunting birds is not only important for providing food, it is also recreational and proof of masculinity,

especially for young men. On an island so far removed from larger societies and with few jobs available, hunting birds or finding their eggs is a welcome pastime. Some bird species are of special importance for the local customs: The long tail feathers of the tropicbird are used as decoration in traditional costumes, the eggs of the megapode are not only nourishing, but also traditional presents for relatives on other islands. Being able to dig them out of the geothermally heated burrows — often quite an arduous and dangerous task — is said to prove strength. Ducklings of the Pacific Black Duck are caught on the lake shore and kept as pets before being eaten. The start of the Wedge-tailed Shearwater hunting season in October is an important social event.

Young people spend a lot of time in the bush, and the traditional knowledge of animals and plants is passed on to them. Most people know all birds and even the littlest plants by their Tongan name, a capability not common amongst the "Palangis" from the Western World. We as Westerners do not want or expect to dictate to the Tongan people how to use their natural resources. We can only hint on the threats that some species face and give whatever information is needed for facing these threats. We can also not neglect the growing economic pressure that exists on Tongan islands like Niuafo'ou. The birth rate is high, and the population increases rapidly. A few years ago, this increase was balanced by emigration, mainly to Australia, the U.S. and New Zealand. Nowadays, most young people cannot obtain a visa for these countries and have to stay on their home island, increasing the pressure on the natural resources.

We can thus only hope that the Tongan Government finds solutions for a sustainable protection of the forests and its inhabitants on islands like Niuafo'ou. With more and more rainforests vanishing world-wide, those left on the Tongan islands are very valuable, especially on remote volcanic islands like Niuafo'ou, Late and Tofua, where only little logging took place. Not only do they all contain a special composition of birds, many of them rare elsewhere, or even endemic, their forests are also an important part of the Tongan culture and a source of sustainable resources. All management plans considered should involve the local people with their deep traditional knowledge concerning the local fauna and flora. Conservation efforts that only try to impose Western conservation concepts on the indigenous people without considering their point of view are doomed to fail, as it happened recently in Samoa (Cox and Elmquist 1993). On Niuafo'ou, local chiefs controlled the hunting, collecting, logging and other use of natural resources during the last century. Nowadays, most decisions

are made by the government or nobles living on the main island Tongatapu, 800 km away. We suggest that these people involve a council of local people on Niuafu'ou, endowed with the necessary executive power to discuss and develop protection measures for the plants and animals with the people of the island and to enforce them later on.

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### APPENDIX

Summary of observed breeding times of birds on Niuafu'ou.

Species	Breeding observed
Audubon's Shearwater	November to April
White-tailed Tropicbird	November to May; July
Reef Heron	April, July
Pacific Black Duck	January to April
Polynesian Megapode	Throughout the year
Banded Rail	November to February
Spotless Crake	September to November
Purple Swampphen	September to March
Pacific Pigeon	Probably throughout the year (January, July, November)
Blue-crowned Lorikeet	July, October and especially November
Barn Owl	November and December
Red-vented Bulbul	October to January
Polynesian Starling	October to January, May
Jungle Myna	December and January

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