ECOLOGY AND CONSERVATION OF KOKI (*Prosopeia tabuensis*) IN TONGA

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of the requirements for the degree of
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MINOR AMENDMENTS

Abstract: Para 2 line 3 should read: "Highest koki density estimate was about 0.19 per hectare, and the average about 0.15 per hectare, suggesting about 1 koki per 6.6 hectares in 'Eua Plantation Forest".

Page 4: Delete the final sentence.

Tables 2.2, 2.4, 2.8: Read all mean values to one decimal place.

Page 47 last para: Read all mean values to one decimal place.

Page 50 last sentence should read: "Thus disturbances by people may limit the detectability and distribution of koki,....Chapter 3".

Tables 3.24; 3.25: Add to the Captions: "Fruit bats included for completeness"

This thesis is dedicated to my loving parents,

Sione Kiteau and Meliame Saafi

Photograph by E.Minot

Pea folofola ‘a e ‘Otua .....ke puna ‘a e manupuna ‘i he funga fonua moe mata ‘o e langi. Pea na’e fakatupu ‘e he ‘Otua.....mo e manupuna ‘oku kapakau ‘o fakafa’ahinga, pea na’e ‘afio ki ai ‘a e ‘Otua kuo lelei. Pea na’e tapuaki’i kinautolu ‘e he ‘Otua ‘o pehe.....ke tokolahi ‘a e manupuna ‘i he fonua (Senesi 1: 20 – 21).

ABSTRACT

The population of Koki *Prosopeia tabuensis* on 'Eua, Tonga, was studied from August 1999 – November 2000. Line Transect and Point Count methods were used to estimate Koki density and abundance in 'Eua Plantation Forest and analyzed by distance sampling techniques. The density estimates derived by the two methods were compared.

Population estimates along six transect lines established in different forest types showed that the Point Count method tended to overestimate Koki density compared with the Line Transect method. Highest Koki density was 0.193 per hectare, and the average density was 0.153 per hectare, suggesting about 1 Koki per 6 hectares in 'Eua Plantation Forest.

The 'Eua Plantation forest was divided into four principal forest types and Koki density in each forest types was estimated using the Line Transect and the Point Count methods. Again, the Line Transect method better represented Koki density in these four forest types. Highest Koki density and abundance was associated with Native Forest, closely followed by *Pinus caribaea* Forest. It is estimated that there were approximately 620 Koki in the 'Eua Plantation Forest in 1999 - 2000.

Thirteen other birds were present at the 'Eua Plantation and they did not appear to compete with Koki for the same food sources.

Koki flying over the 'Eua National Park were calling when flying longer distances. The mean interval between calls for Koki calling while flying was 6.79 (95% C.I. = 5.78 – 7.99) seconds. The mean distance travelled by Koki flying and calling over the National Park was 134.50 (95% C.I. = 96.73 – 187.02) meters.

Koki fed on a variety of wild fruits and seeds including pinecones and pawpaw. Pinecones appeared to be a major food item in Koki diet at the 'Eua Plantation Forest. Eight Koki nests were found in the year 2000 breeding season. The eight nest trees suffered considerable damage by locals, removing the Koki chicks for sale. The implications of the research findings for future monitoring and conservation of Koki are discussed.

ACKNOWLEDGEMENTS

'Eiki lelei, teu kei fakafeta'ia mo fakamalo'ia aipe 'a e ngaahi tapuaki kuo ke faka'inasi'aki 'a 'eku nge'esi mo'ui ni. Sisu ke ke ma'u ma'au 'a 'eku ngaahi me'a kotoa, pea ke kei 'o 'ou 'a e kololia moe langilangi 'o lauikuonga.

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TABLE OF CONTENTS

Images heading chapter from: Forshaw, J.M.; Cooper, W.T. 1973. Parrots of the World. Lansdowne Press. Melbourne.

LIST OF FIGURES

CHAPTER THREE

CHAPTER FOUR

CHAPTER FIVE

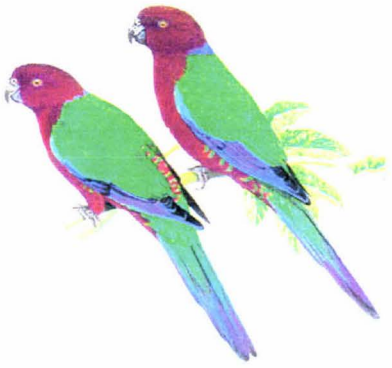
LIST OF TABLES

CHAPTER TWO

CHAPTER THREE

CHAPTER FOUR

CHAPTER FIVE



CHAPTER 1

GENERAL INTRODUCTION

1.1 KOKI

The Koki (Red Shining Parrot) (*Prosopeia tabuensis*) belongs to the family of parrots and lories known as Psittacidae. Within the Psittacidae there are four subfamilies. The Koki is a member of the subfamily Psittacinae (Forshaw and Cooper 1973). According to Forshaw and Cooper (1973), there are 271 species in 64 genera of Psittacidae and 261 species in 61 genera of Psittacinae. Different authors have used different forms of classifications of parrots within the Psittacidae. Higgins (1999) identified four subfamilies in the family Psittacidae but the subfamily Platycercinae is used in the place of Psittacinae. Close relatives of *Prosopeia tabuensis* include the Masked Shining parrot (*Prosopeia personata*) of Fiji, *the* Norfolk Island parakeet (*Cyanoramphus cookii*), the Antipodes parakeet (*Cyanoramphus unicolor)* of New Zealand and the endangered Orange-bellied parrot (*Neophema chrysogaster*) of Australia (Higgin 1999).

The Koki obtained its name from the local people of Tonga naming it according to the sounds it makes, which was *ko-ki-ko-ki* (Moala 1994). Rinke (1987) describes the voice of Koki as a dry rattle or variety of raucous squawks and screeches. However, Juniper and Parr (1998) characterizes the Koki voice as a harsh, loud *nea nea* and a grating *arrrrr* repeated in bursts and also a *ra-ra-ra-ra,* a dry bill rattle, various other hoots, squawks

and screeches and distinctive *tok* when it approaches the nest.

A large, long tailed parrot the Koki has a bright green back and rump. A broad blue collar extends down the lower neck to the primary feathers of the wings and the ends of the tail feathers. The head and underparts are red/maroon (Forshaw and Cooper 1973, Watling 1982, Juniper and Parr 1998). Forshaw and Cooper (1973), Watling (1982) and Juniper and Parr (1998) all give the length of Koki as 45cm. Wing, tail, bill and tarsus measurements can be found in Forshaw and Cooper (1973) and Juniper and Parr (1998). No information on Koki longevity is available but there are records of captive parrots living for between thirty and fifty year (Forshaw and Cooper 1973). In the wild a female Kaka (*Nestor meridionalis)* is known to have lived for at least 27 years on Kapiti Island in New Zealand (Moorhouse and Greene 1995).

Currently five subspecies of Prosopeia tabuensis are recognized: *P. t.atrogularis, P.t.koroensis, P.t.taviuensis, P.t.tabuensis* and *P.t.splendens* (Watling 1982). Of the five subspecies *P.t. tabuensis* is the only subspecies found on 'Eua, Tonga. The other subspecies are found only in Fiji (Forshaw and Cooper 1973,Watling 1982, Juniper and Parr 1998). Watling (1982) identified the subspecies found in Tonga, as a variate in adult colouring, which is intermediate between *P.t. atrogularis* and *P.t.koroensis*. The change of plumage colouring is believed to be a result of introducing two or more subspecies to Tonga (Forshaw and Cooper 1973).

The sexes are morphologically very similar, although females have narrower upper mandibles than males (Rinke 1987, Juniper and Parr 1998). This difference can be easily seen in Koki nestlings as early as three weeks old (Rinke 1995). At one nest in Rinke's 1987 study where a female and a male nestling were weighed, the male nestling weighed 260g and the female nestling weighed 205g (Rinke 1987). All incubation and feeding of the young while they are in the nest is carried out by the female (Rinke 1987). On one occasion, however, in Rinke's work both parents were seen feeding the fully-feathered nestling at the entrance of the nest cavity.

Watling (1982) and Rinke (1987) found that in Tonga the Koki breeds during the cool and dry season, which lasts from May to October. Rinke (1987) recorded Koki nests in tree cavities where they lay two to three eggs at intervals of two days. The incubation period is 24 days and the young Koki stays in the nest for seven weeks before fledging (Rinke 1987).

Koki build nests in cavities of trees that grow in the remaining native forests on 'Eua, and occasionally in trees growing in plantations (Rinke 1987). Rinke (1987) found that the birds use a number of tree species including tavahi *(Rhus taitensis),* ngatata *(Elattostachys falcata)* and salato *(Laportea harveyi).*

The parrots feed on a variety of fruits and seeds (Watling 1982), including mango *Mangifera indica,* pawpaw *Carica papaya,* guava *Psidium guajava,* bananas *Musa spp* and kotone *Myristica hypargyraea* (Juniper and Parr 1998). Rinke (1995) shows Koki feeding on the cones of *Pinus caribaea.*

1.2 THE STATUS OF KOKI IN TONGA

The loss of birdlife in the tropical Pacific is accelerating and represents a 20 percent worldwide reduction in the number of species of birds. This accelerating reduction is mainly due to human impacts in recent centuries (Steadman 1995). The colonization of numerous islands by Polynesian settlers caused the first wave of impact on Pacific Island birdlife, and a second wave was initiated by the arrival of Western people (especially Europeans) in the Pacific (Rinke 1987).

Most Pacific islands, particularly large ones like Hawaii and New Zealand, supported rich avifaunas until the arrival of humans (Steadman 1995). On 'Eua, Tonga where the current research took place, bone deposits pre-date human arrival by tens of thousand of years (Watling 1982, Low 1994). At least 27 species of land birds lived on 'Eua in pre-human times, but only six of these have survived the past two centuries (Steadman 1995). Steadman (1995) also states that the toothbilled pigeon *(Didunculus*), regarded as

endemic to Samoa, once lived on 'Eua, as did the megapode *Megapodius pritchardii*, believed to be endemic to Niuafo'ou.

The Koki occurs naturally on the islands of Fiji and was first introduced to Tonga in the eighteenth century through trading activities between Tonga and the Fiji (Watling 1982, Low 1994). It was once widespread throughout the main islands of Tongatapu and 'Eua but, due to human collection, habitat loss from clearance of forests for agricultural purposes, and predation by species such as rats *(Rattus exulans)* and owls *(Tyto alba)*, the Koki is now found naturally only on 'Eua in Tonga (Rinke 1987).

The Koki population on 'Eua was estimated in 1988 to be between 700 and 1000 birds (Juniper and Parr 1998) – a much smaller population than previously. The main cause of the marked decline of the Koki is local people hunting the bird for food, pets, and the much prized maroon/red feathers to decorate fine mats and handicrafts (Watling 1982, Low 1994). The second major cause of the decline of Koki population is loss of habitat resulting from clearance of native forest for agricultural purposes (Watling 1982, Juniper and Parr 1998). Native forest provides habitat and nesting sites for Koki which nest in cavities in mature trees (Rinke 1987). Rinke (1987) also found that the entrance to such cavities is usually from a branch that has broken off, leaving a nest cavity with an inner diameter of at least 15cm, and a depth varying from less than 0.5m to more than 5m. The existence of old, established native forest is, therefore, a significant resource for breeding Koki seeking nest sites.

A small part of the decline of the Koki population is due to predation by the Polynesian rat *(Rattus exulans)* and barn owls *(Tyto alba)* feeding on the eggs (Rinke 1987). Overall, the sharp decline of the Koki now classes it as an endangered bird in Tonga (Rinke, 1995). It is illegal to hunt and trade the Koki in Tonga but unfortunately such activities still exist (unpublished observations). The Koki population on 'Eua was estimated in 1988 to be between 700 and 1000 birds (Juniper and Parr 1998).

1.3 'EUA

The Kingdom of Tonga consists of more than 150 islands. 'Eua island is the third largest island of the Tongan archipelago, lying within tropical latitudes (21°17'–21°27', S 174°55'W) in the southwest Pacific Ocean (Rinke 1987). 'Eua lies 20km south west of the main island Tongatapu, (Figure 1.1) (Bellingham and Fitzgerald 1997). The nearest land to the Tongan archipelago is Viti Levu, Fiji, 800km to the northwest, and Savaii Samoa 800km north. 'Eua also lies about 3300km east of Queensland, Australia and 1800km north northeast of Auckland New Zealand (Rinke 1987), and stands on the western edge, of the Tongan Trench.

'Eua is a high island approximately 81km² (Hoffmeister 1932), however recent studies estimated 'Eua to be 88km² (Bellingham and Fitzgerald 1997). Wilde and Hewitt (1983) estimated the island to be 19km long and up to 7km wide occupying 8100ha. A census by Bellingham and Fitzgerald (1998) showed that 'Eua has a population of 5000 in about 800 households. In all there are 15 villages on 'Eua, situated along the western side of the island. The main village on 'Eua is 'Ohonua, where the commercial center and Nafanua wharf is located (the only dock for all sea transport) (Figure 1.2). The most northern village is Houma and the most southern village is Ha'atu'a. The main form of transport from 'Eua to the main island Tongatapu is by ferry a 1 to 1½ hour journey. Plane flights from Kaufana Airport in the village Fata'ulua to Tongatapu takes 7 minutes.

'Eua rises from west to east along a series of raised terraces to high cliffs above its eastern coast (Bellingham and Fitzgerald 1997). The high eastern ridge reaches a maximum elevation of 312 m a.s.l. (Hoffmeister 1932, Drake 1996). Hoffmeister (1932) mapped five physiographic provinces on 'Eua. Figure 1.3 shows the five physiographic provinces described by Hoffmeister: 1) the eastern terraces and coastal regions, 2) the eastern ridge, 3) western slope of the eastern ridge, 4) the western ridge and central valley and 5) the western slope terraces and coastal region.

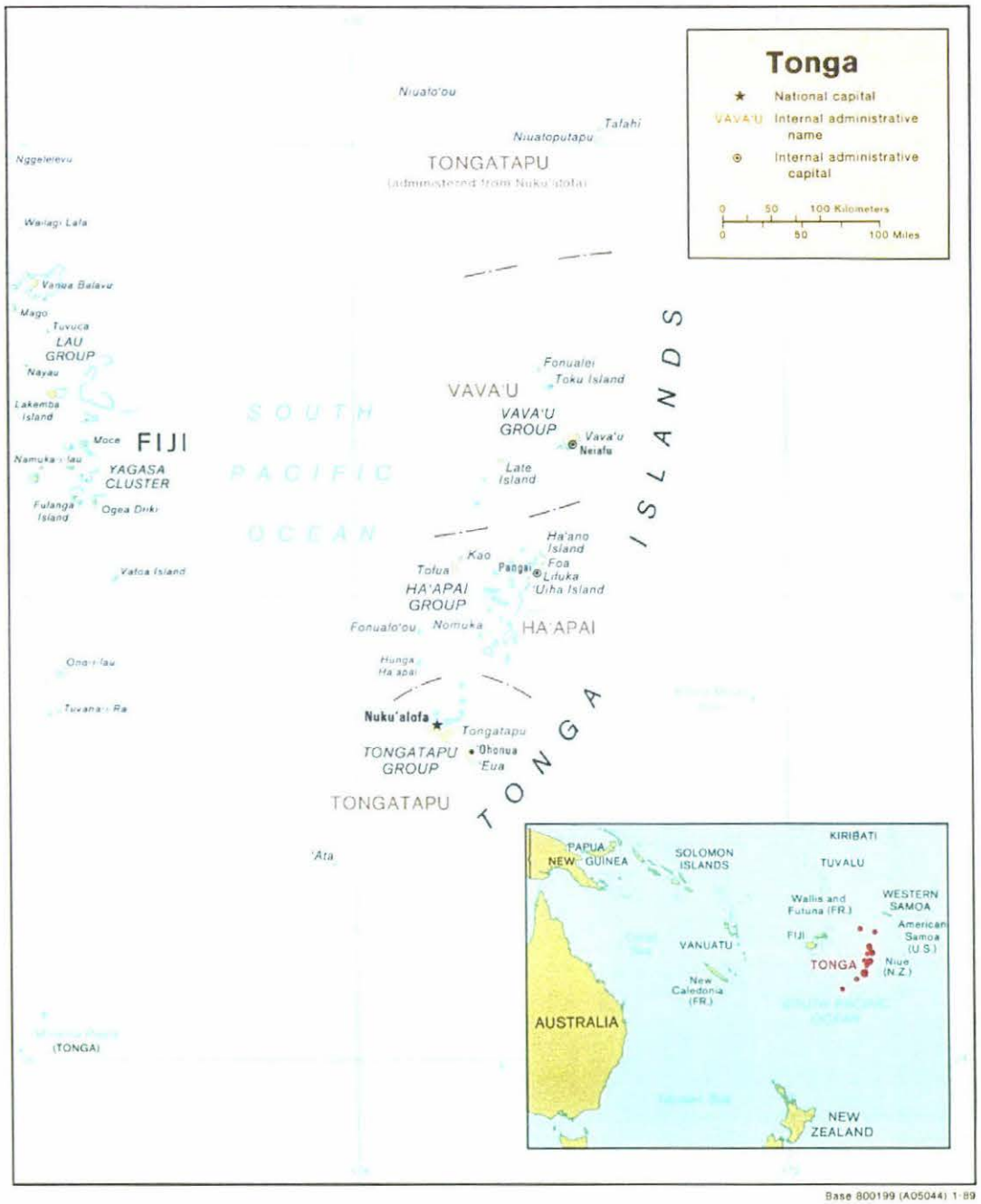


Figure 1.1 Map of the Tongan group of islands. From 'The Perry-Castañeda Library Map Collection, (http://pidp.eastwestcenter.org/pibn/countries/tonga.htm).

‘Eua Island

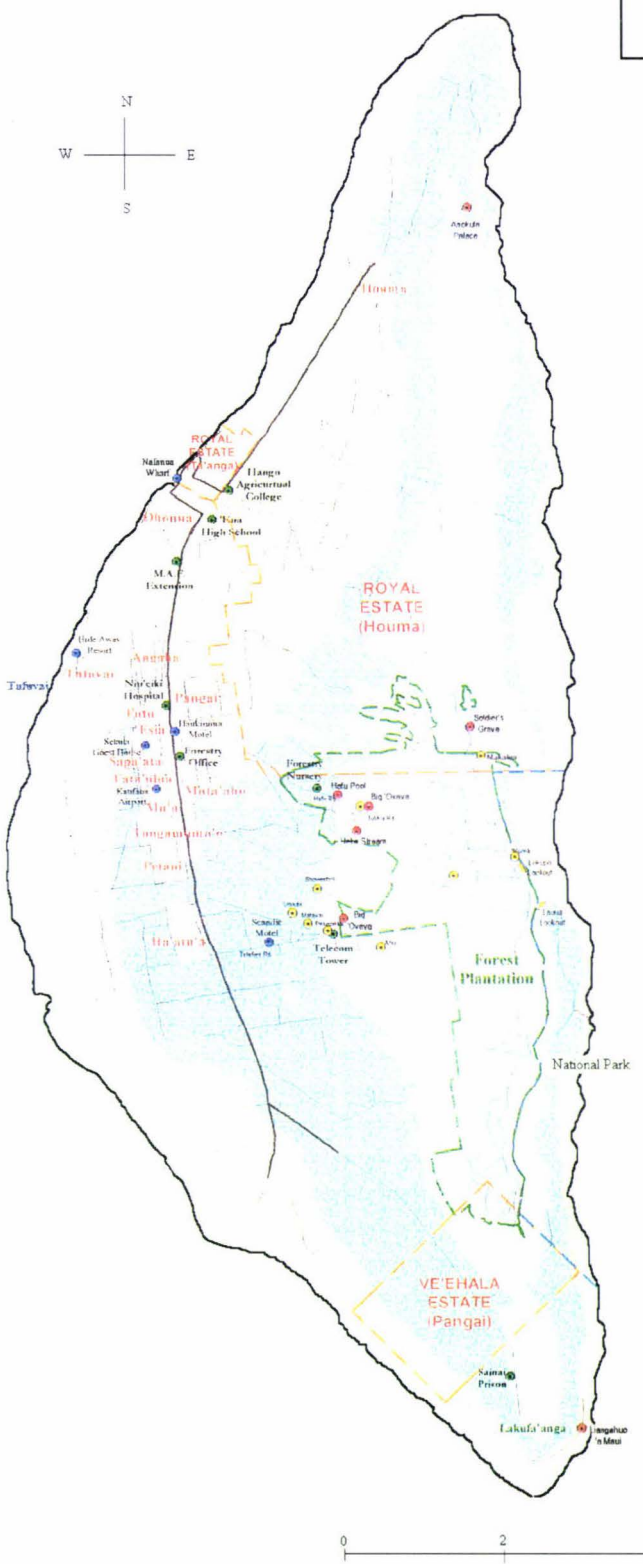


Figure 1.2 Map of ‘Eua Island.

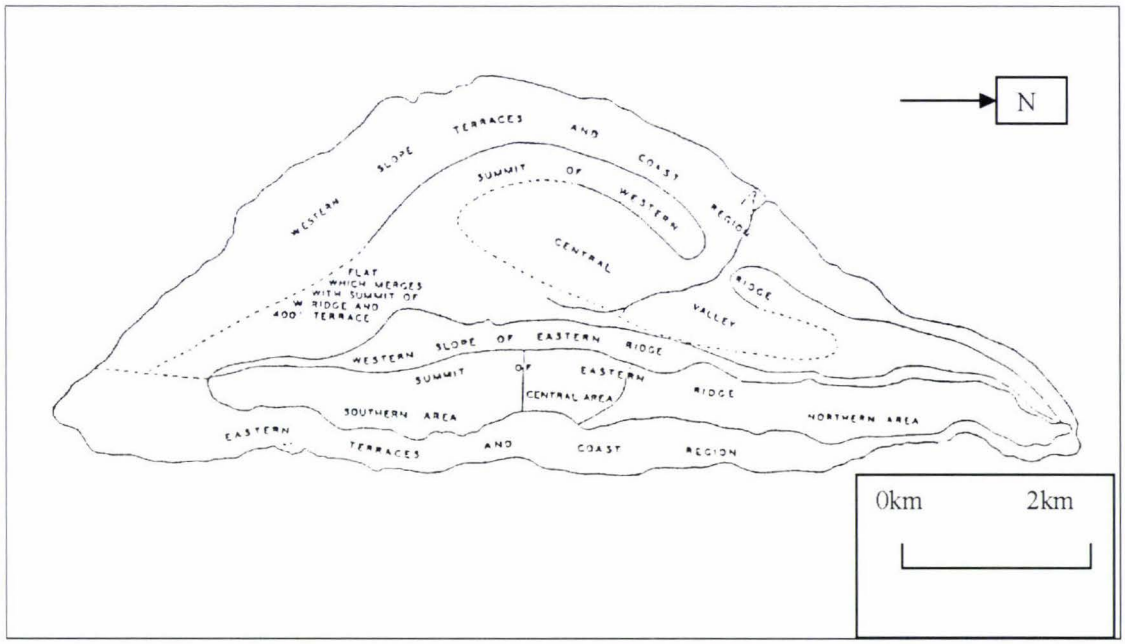


Figure 1.3 Map of the five physiographic provinces of 'Eua. From Wilde and Hewitt.

The 'Eua land surface is covered by limestone with a core of volcanic rocks (Drake 1996). The eastern side of the island is mostly steep cliffs, in some places falling 120m directly to the sea and in other places dropping 30-60m to the sea (Hoffmeister 1932). On the western side of the island, however, the cliffs are lower (6-10m high) falling to broader and more numerous beaches (Hoffmeister 1932).

'Eua lies in the south-east tradewind zone (Drake 1996), where the wind blows from the east to south-east from April to November i.e. three quarters of the year. (Bellingham and Fitzgerald 1997). The dry season runs from May to October and the wet season from November till April. The average annual rainfall is 2,700mm and 66% (c 178mm) falls during the wet season (Thompson (1986) cited in Drake (1996). During heavy rainfall periods some forest tracks are impassable with vehicles.

'Eua supports the most unique forest in the Tongan group (Drake 1996), comprising predominantly tropical and subtropical species (Wilde and Hewitt 1983). Many factors contribute to the uniqueness of the 'Eua forest. Plant taxa in the Pacific region decrease with increasing distance from the Malesian source area as quoted in Stoddart 1992

(Drake 1996). The combination of limestone substrate, and elevation leads raised islands such as 'Eua to have distinctive floras (Stoddart 1992). Wilde and Hewitt (1983) found that the presence of limestone is reflected by the vegetation, which is also influenced by the southeast trade winds atlitude and angle of the slopes (Wilde and Hewitt 1983). Plant composition on 'Eua is differs from that found in the more northern Vava'u island group, where the plant species composition did vary greatly with elevation (Drake 1996).

As agricultural practices developed the of 'Eua has gradually changed, for instance areas of forest have been cleared to plant crops. The remaining forests are now found on the steep slopes of the eastern coast (Bellingham and Fitzgerald 1997) and are protected as the 'Eua National Park (refer to Figure 1.2). There are other types of sparse forest on the coastal area of the island, which are either not, or scarcely, found in the National Park. For example on the highest point of the island, feto'omaka *Garcinia myrtifolia*, is the common plant and on other coastal forest, pekepeka *Maniltoa grandiflora*, is the common species (Bellingham and Fitzgerald 1997). Eight threatened flowering plants occur on 'Eua and 16 other threatened plants found in other parts of the Pacific are also found in 'Eua (Bellingham and Fitzgerald 1997).

'Eua supports 13 land bird species of which none is unique to Tonga (Bellingham and Fitzgerald 1997). Bellingham and Fitzgerald (1997) also recorded nine species of lizards 'Eua and two species of bats, peka (*Pteropus tonganus*) and pekepeka (*Emballonura semicaudata).*

Because 'Eua supports a rich and unique forest, in the 1960's, the first recommendation by to preserve an area of rainforest as a National Park. A similar recommendation was made by the East-West center of Hawaii in 1989 and other agencies in New Zealand and again in 1996 by Bellingham and Fitzgerald. Bellingham and Fitzgerald (1997) noted that 'Eua contains some of the last substantial areas of rain forest to be found in Tonga. 'Eua National Park now constitutes an area of 449.4 ha of tropical rainforest occupying most of the coastal south-eastern part of the island (Bellingham and Fitzgerald 1997), preserves and conserves the remaining biotically significant forest of 'Eua.

1.4 THESIS ORGANISATION

In order to recommend ways of monitoring and conserving a declining population, it is vital to know the size and density of the population, and how other areas of the species' ecology influence population size. This thesis comprises four data chapters and a concluding synthesis chapter where the overall findings are drawn together.

Chapter Two presents estimates of Koki density by Line Transect and Point Count methods for six transect lines in the 'Eua Plantation Forest. Koki flights and calling above the National Park, as observed from two lookouts, are also presented.

Chapter Three discusses the forest on 'Eua and its division into four forest types. Existing detailed maps and the Line Transect and Point Count data collected on the six transect lines were used to determine in which forest type each Koki was detected. Koki density was estimated for the four forest types, and Koki abundance was calculated, based on the density estimates. Other bird species present in the 'Eua Plantation Forest, and the tree species used by Koki are also presented in Chapter Three.

Chapter Four presents information on how Koki feed on pawpaw and other wild fruits, an assessment of the utilization of pinecones by Koki, and observations on the feeding behaviour of two captive parrots kept separately by locals as pets.

Chapter Five describes the locations of Koki nests found during the period June to October 2000. The activity of breeding Koki at these nests, and their outcomes, and the description of each nest site is also presented.

Chapter Six, summarizes the results from the previous chapters. Recommendations for future Koki management and monitoring are presented.