

**Ecology, abundance and distribution assessment of the  
endemic Rarotonga Starling (*Aplonis cinerascens*)**

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## Abstract

*Aplonis cinerascens*, or I'oi, an endemic Starling found on the island of Rarotonga, Cook Islands, was studied through field observations, literature review, questionnaire surveys and communication with knowledgeable individuals and research institutions. The Rarotongan species represents the most southerly and easterly extent in the range of the extant *Aplonis* genus. Previous research on the species has been ad hoc in manner. This study is the first attempt in dedicating research on I'oi, and aims to consolidate all currently available information in to one report, together with results of an investigation of the distribution, abundance, and ecology of the bird.

Key words: I'oi, Starling, Distribution, Abundance, *Aplonis cinerascens*, Rarotonga, Cook Islands, Ecology

## 1 Introduction

The Cook Islands comprises 15 small islands scattered over 1.8 million square kilometres of the South Pacific Ocean. Located between latitudes 9 degrees and 22 degrees south and longitudes 157 degrees and 166 degrees West, the islands are flanked by Samoa and Tonga on the west, French Polynesia on the east, and Kiribati to the North.

With a total land area of only 240 sq. km, the islands are divided geographically, into the Northern and Southern groups. Six islands make up the Northern group - Suvarrow, Nassau, Pukapuka, Rakahanga, Manihiki and Penryhn while the Southern group comprises nine islands - Palmerston, Aitutaki, Manuae, Takutea, Atiu, Mitiaro, Mauke, Mangaia and Rarotonga.

Rarotonga is of volcanic origin, and is the commercial center of the Cook Islands. It has an area of 67 sq. km., with its highest point reaching 652m - making it the largest and highest of the 15 islands. The island comprises 28% of the country's land area (McCormack & Kunzle 1990).

### 1.1 Cook Island Birds

Despite the paucity of bird species, the Cook Islands has relatively high numbers of endemics. Over half of the Cook Islands resident land birds are endemic to the Cook Islands (McCormack 1997).

The low-lying islands of the northern Cook Islands support mainly seabirds. They have only one resident land bird - the Pacific pigeon (Holyoak 1974, McCormack 1997). In contrast, the higher islands of the Southern group support 11 indigenous land birds (Holyoak 1980, McCormack 1997). These include four single island endemics, two island endemics and five

multi-island non endemic (McCormack 1997). In addition to the native land birds, three introduced species have naturalized - the Jungle fowl (*Gallus gallus*), Blue Lorikeet (*Vini peruviana*) and the Myna (*Acridotheres tristis*). The sand cay island of Takutea supports nationally significant seabird colonies. A number of migratory seabirds frequent the Cook Islands including the Bristle-thighed Curlew (*Numenius tahitiensis*), which has a world conservation listing as Vulnerable.

In 2007, 27 Rimatara Lorikeets (*Vini kuhlii*) were reintroduced to Atiu, where they were once present, from Rimatara, French Polynesia. Various counts indicate that the 27 birds of 2007 have increased to around 80 birds today (CI News 2010). In 2001, ten Kakerori (*Pomarea dimidiata*) were translocated from Rarotonga and also released on ship rat free Atiu, 180 km north-east of Rarotonga. Another 10 birds consisting of mainly one to two-year-old birds were transferred in 2002, and a further 10 birds in 2003, making a total of 30 birds relocated to Atiu. Today they number around 100 on Atiu (pers. comm E Saul).

## 1.2 *Plants of Rarotonga*

In order to gain an understanding of the habitat available to Cook Islands birds, some information of vegetation is necessary. Rarotonga has distinct plant communities (McCormack & Kunzle 1990, 1995, Sykes in Merlin 1985) that can be broadly divided into coastal, lowland, sloped forest and cloud forest. The first two zones consist predominately of exotic species, while the upper regions are mainly dominated by native species. The native vegetation in the low land areas has been heavily modified through removal or introduction disturbances (Merlin 1985).

In a woody vegetation survey of the upland forest of Rarotonga conducted by Merlin (1985), it was found that 92% of woody plants were either indigenous or endemic to the island. The cloud forest, which occurs above 400m, has the most species unique to Rarotonga with nine flowering plants restricted to this area, four of which are endemic (Merlin 1985).

The elevated inland area (30 metres above sea level) of Rarotonga contains approximately 105 native and over 230 introduced flowering plants. Of the native flowering plants, 10 are restricted to Polynesia and 15 are Rarotongan endemics. There are 88 species of fern of which one is a Cook Island endemic and 4 are unique to Rarotonga (McCormack & Kunzle, 1990).

## **2 Rationale for studying I'oi**

There is very little documented information on the inconspicuous I'oi, apart from brief descriptions in several publications. Although there is no substantial individual document on I'oi, there have been short condensed awareness articles published for general local audience (McCormack 1993, Tiraa 2002, 2003). The articles feature aspects of the bird's description, calls, diet, distribution and breeding, and were written in an attempt to increase awareness of I'oi for locals.

The IUCN classification listing of I'oi is Vulnerable, qualifying for this classification because it is assumed to have a small population confined to just one small island (Stattersfield et al. 1998). Although the population is assumed to be stable, there are currently few data on numbers and distribution to either support or dispute this assumption, and thus numbers could be declining undetected.

In 1999, a workshop to assess priority avifauna conservation projects for Polynesian countries was held in Rarotonga. At this workshop, one of the projects identified by the Cook Islands participants was to conduct a survey of I'oi to establish their numbers (Sherley 2001).

This recognition of the paucity of recorded information on I'oi was a major factor in the decision to undertake field research on the I'oi over a 3-month period in 2002 and 2003. With this in mind, the main objective of this paper is to provide information on the abundance, distribution, and other aspects of the biology and ecology on the bird.

## **3 Aims**

The main aims of this study are:

1. To estimate the abundance and distribution of the I'oi based on information collected.
2. To review new and existing information, including observations on aspects of the ecology of I'oi, through published and unpublished sources and update this information into a single document
3. To ascertain local people's knowledge on I'oi.

## 4 Methodology

Information gained for this study was obtained through fieldwork surveys, observation of I'oi, questionnaires, an in-depth desktop review, and contacting institutions and experts with relevant information for this study. A list of those contacted is attached as Appendix 2. This paper is an analysis report on data collected on I'oi mainly during 2001 and 2002, though some more recent information has also been included.

### 4.1 *Fieldwork surveys*

Visits were made to Rarotonga's inland valleys and ridges, and major peaks on the island to record and map I'oi that were seen and heard. An absolute count covering 100% of the island was not feasible with the limited time and human resources available. A more detailed survey of one location recorded I'oi heard and seen in the Takitumu Conservation Area of 155 hectares, on the southeast side of the island. This allowed an estimate of I'oi population by extrapolating counts according to total suitable areas. Recordings were digitized onto MapInfo computer software programme.

A monitoring survey of I'oi that involved recording the number heard and seen within two separate one hour periods, one at sunrise and another just before sunset, was conducted in Turoa (part of the Takitumu Conservation Area<sup>1</sup>) and Matavera valleys on successive days. These surveys were carried out once a month from January to November 2002, with a total of seven surveys undertaken. Timed stationary counts were also conducted on one day. A total of 25 five minutes counts recorded I'oi and other birds seen and heard. This was done once each hour from 6am to 7pm.

### 4.2 *Questionnaire*

A standard questionnaire to ascertain the level of knowledge on I'oi by local people was undertaken. Interviewees were categorised into four different age groups and between 20 and 40 individuals people from each age category were interviewed (120 people total). The questionnaire was used to determine the extent of local knowledge on I'oi. Interviewees consisted of senior college students at Titikaveka and Tereora colleges (15-19 years olds), and others from the general public in 20-40, 40-60 and 60+ years age groups. The questions

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<sup>1</sup> In 1996 the three main landowning tribes established the Takitumu Conservation Area (TCA). The 155 hectares TCA is the core breeding area of the Kakerori (*Pomarea dimidiata*)

included age, the island the respondent was from and if they have heard of or seen I'oi. To assist this exercise, a photograph of the bird was shown and the bird's call was imitated.

## 5 Overview of genus *Aplonis*

The *Aplonis* genus belongs to the Sturnidae Family, commonly recognized as Starlings and Mynas. They form part of the group of birds known as passerines. The genus comprises 21 extant species whereas previously, there were 24 known species (Feare & Craig 1998). Unfortunately, within the last two centuries three have become extinct, including another Cook Islands' endemic from Mauke, the **Kioki** (*Aplonis maukeavornata*). The Kioki was darker and smaller than its Rarotongan relative (Olson 1985). The other two extinct species were also island endemics from Kosrae and Lord Howe and Norfolk Islands (Feare & Craig 1998, Hume 2002). *Aplonis* starlings range from east India to the Pacific region (ibid). The Rarotonga species has the furthest south and east range of the extant *Aplonis*.

The majority of *Aplonis* are island species (Craig & Fearce 1998), only establishing continental locations on the Malay Peninsula, Southern Vietnam and Northeast Queensland. Most *Aplonis* are native to the tropical Pacific. The greatest diversity of species is concentrated on the general New Guinea area (ibid).

The genus has five single island endemics all of which are found in the Pacific region, representing all 3 sub-regions (Micronesia, Polynesia and Melanesia). The following tables are modified from Feare and Craig 1998, Dutson unpub manuscript, and BirdLife Species Web Fact Sheets. The distribution and conservation status of the birds are given.

Table 1. *Aplonis* Single Island Endemics

<i>Aplonis</i>	Island, Country	Habitat	IUCN Red List Status
<i>A. pelzelni</i>	Pohnpei, Federated States of Micronesia	Mountain Forest	CE
<i>A. dichroa</i>	Makira, Solomon Islands	Forest Edge and Secondary forest	LC
<i>A. santovestris</i>	Santo, Vanuatu	High altitude Forest	V
<i>A. cinerascens</i>	Rarotonga, Cook Islands	Forest	V
<i>A. insularis</i>	Rennell, Solomon Islands	Forest	LC

The above table shows that the Solomon Islands contain two single island endemics

Table 2. *Aplonis* Country Endemic

<i>Aplonis</i>	Islands, Country	Status
<i>A. crassa</i>	Indonesia, Tanimbar islands, (Lesser Sundas)	NT
<i>A. magna</i>	Biak and Numfor Islands (off Irian Jaya) Indonesia	LC
<i>A. striata</i>	Loyalty Islands, New Caledonia.	LC
<i>A. mysolensis</i>	Islands of Indonesia	LC

Table 3. *Aplonis* genus present in more than one country

<i>Aplonis</i>	Countries	Status
<i>A. mystacea</i>	Papua, Indonesia and Papua New Guinea	NT
<i>A. brunneicapillus</i>	Bougainville, PNG to Guadalcanal, Solomon Islands	EN
<i>A. grandis</i>	All islands of the Solomons except Makira, Papua New Guinea	LC
<i>A. zelandica</i>	Vanuatu (Banks and Santa Cruz islands) and Solomon Islands	NT
<i>A. atrifusca</i>	American Samoa and Samoa.	LC
<i>A. opaca</i>	Micronesian Islands of Palau, FSM and Marianas.	LC
<i>A. minor</i>	Philippines and Indonesia	LC
<i>A. panayensis</i>	Indochina and eastern India	LC
<i>A. tabuensis</i>	Samoa, American Samoa, Fiji, Tonga and Niue	LC
<i>A. cantoroides</i>	Small offshore Indonesian islands off Irian Jaya, New Guinea, Solomon Islands and Australia. Not present on all the islands of these groups.	LC
<i>A. metallica</i>	Small offshore Indonesian islands, New Guinea, Solomon Islands and Australia.	LC
<i>A. feadensis</i>	Bismarcks (PNG) and and Solomon Islands	NT

Critically Endangered (CE), Endangered (EN), Vulnerable (VU), Near Threatened (NT), Least Concern (LC).

## 6 *Aplonis cinerascens* (I'oi)

The endemic *Aplonis cinerascens* or Rarotongan Starling is one of only four native land birds found on Rarotonga (Plate 1). Its local name I'oi was coined from its melodious *ii-oi, ii-oi* whistle (McCormack 1993). Most literature cites I'oi inhabiting areas from 150m to about 600m above sea level.

To date, there have been no formal surveys to determine the population size, though there have been three population estimates, one of approximately 500 (McCormack 1998), another of about 3000 (Holyoak 1980, Holyoak & Thibbault 1984), and a pessimistic 100 (Hay 1985).

Records on the habits, ecology and other specific information on I’oi have not advanced a great deal since Holyoak’s pioneer study in 1973 that resulted in the 1980 publication of the booklet - “Birds of the Cook Islands”.



Plate 1. An adult I’oi perching on a branch Photograph curtsy of Gerald McCormack

### 6.1 *Historical information on I’oi*

One of the earlier historical reports of I’oi comes from missionary William Wyatt-Gill, who wrote about many aspects of Cook Islands life. Gill recorded this piece of information while it was being related by a high-ranking local elder by the name of Vakatini at a public gathering. Vakatini informed a public meeting of a method to capture I’oi when flocks visited the coastal Ngatae tree (Indian coral tree, *Erythrina variegata*) to consume nectar produced by the bright red flowers.

*“He (Wyatt-Gill citing Vakatini) outlined a hunting method to catch flocks of I’oi that were feeding on the coral tree (Ngatae) when it was in bloom. Apparently, the nectar of the bright red flower was a favorite drink for the bird. They were captured either in the early morning or towards the evening, by using a coconut fibre noose placed near the flowers. This was when they flew from the inland to the coastal tree. As the bird stepped into the noose, the noose was pulled to trap the unlucky captive”.* (Wyatt-Gill 1885)



Wyatt-Gill's account gives the impression that I'oi was once abundant on the coastal areas and reveals a little information on their diet and distribution. Based on Wyatt-Gill's estimation of Vakatini's age when he related the story from his youth, the time period referred could be early 1800s. The Ngatae tree was once common on the lowlands, but today their numbers have diminished. The inference of flocks frequenting the coastal strip where the tree grows suggests that the bird was abundant in the early 1800s. The hunting reference implies that I'oi might have been a food source in the past.

I'oi was first officially described by Hartlaub and Finsch (1871) from specimens collected by American naturalist, Andrew Garrett (Hartlaub & Finsch 1871). Garrett specialized in malacology and ichthyology and at one stage was a collector for the Museum Godeffroy in Hamburg Germany (Thomas 1979) where the I'oi specimens are preserved. Five specimens were measured in Hartlaub & Finsch's paper (1871). However, the publication is vague on how many specimens they actually had in their possession as they affirm four specimens concur with their descriptive assessment while some (not one) were different in coloration. In Hartlaub and Finsch's 1871 paper, Garrett is quoted as providing the following description of the I'oi: "*Irides as dark slate; bill, legs and feet light bluish slate.* Apart from this note no other information on the habits, breeding and other aspects of I'oi was provided by Garrett (Hartlaub & Finsch 1871).

In 1895, Sigvard Jacob Dannefaerd, an Auckland based Danish trader who amongst other things dealt in skins and skeletons of rare birds and shells from all parts of the Pacific (pers.comm J. Cooper), dispatched two workers to Rarotonga to collect birds. In two unpublished letters both dated 25 October 1895 written by the trader to Hon. Walter Rothschild and Ernst Hartert, Rothschild's curator of birds (pers. comm J. Cooper), a description of an island containing very few birds is conjured. Dannefaerd had planned to join his men later, but received word that "you could travel for weeks and not see a solitary Bird" (letter to Rothschild: Oct 1895). Based on this message he did not go. Furthermore, in his letter to Hartert, Dannefaerd is clearly disappointed with the small number of birds collected on Rarotonga over a five-month period. The following marks his frustration.

*"I run short of Cash and had to sell a small but good Mining Investment (which have trebled itself since) to pay my Men for Collecting and nothing to Collect"*<sup>2</sup>

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<sup>2</sup> Spelling errors of the quotes presented have been corrected in this text, but capitalised letters remain as presented in original transcript letters.

From information received from the British Natural History Museum (BNHM) and the American Museum of Natural History (AMNH), which Rosthchild bequeathed and sold his Rarotonga bird collection to respectively (pers. comm J. Cooper), 20 birds were collected during the May-September 1895 trip. Data from the two museums indicates that 10 Rupe (*Ducula pacifica*), nine I'oi and one Karavia (*Eudynamis taitensis*) were obtained from Rarotonga in 1895.

A few years later, in 1898, ethnologist and writer, Percy S. Smith wrote of local informants claiming no landbirds remained on Rarotonga due to a severe hurricane a couple of years earlier. This was backed by his own observations. Rarotonga resident, Church Minister Rev. JKK Hutchin (1898) corrected this notion by providing Maori names on birds still alive. He lists Ivi as one of the species, but it is highly likely that this to be a spelling or typographical error for I'oi, as no such local bird name exist. The other two common native landbirds, the Rupe and Kukupa were also confirmed to be extant by Hutchin, while Kakerori was considered to have perished due to cats. Kakerori still existed as evident by four being collected after Hutchin's pronouncement in 1901 (pers. comm British Natural History Museum) and 1903 (pers. comm. Bishop Museum). Between 1901-1904, various individuals obtained 45 land and sea birds from Rarotonga. Of the 45, a total of 15 are I'oi. These collections confirm Hutchin's note that landbirds still existed on Rarotonga at the time. However, birdlife may have been less obvious previously based on Dannefaerd communications to Rosthchild and Hartnet. From the documents it is not certain if Dannefaerd's collecting efforts were before or after the hurricane.

Further evidence supporting Hutchin's clarification is from pioneer Botanist, Thomas Cheesman who in 1899 collected four I'oi specimens between the months of May to July. Thomas arranged many bird 'exchanges' while Curator of the Auckland Museum 1875-1905 (pers. comm B Gill). Two other unlabelled specimens with the same colouring and appearance as the four collected by Cheesman during his 1899 visit, are I'oi (Gill 1996). The six specimens are deposited at the Auckland Museum.

At the request of the Earl of Ranfurly, in March 1901, British Resident for the Cook Islands, Lt-Colonel Gudgeon, obtained three male I'oi specimens. The local name is recorded as Toi Karanga (Ogilvie-Grant 1905). This is most probably an error in spelling and should be I'oi Karanga. Later, the name of the bird became known as I'oi Karanga in reference to a local newspaper with the same name (see later in this text). In 1904, visiting ornithologist Scott-Wilson quoted Lt-Colonel Gudgeon saying there were few birds left on Rarotonga.

Alvin Seale, ichthyologist and then curator of fishes, Bishop Museum, embarked on an expedition to the Cook Islands in the early 1900s. In 1903, Seale deposited nine I'oi specimens with his museum. It is unclear how long he spent on Rarotonga. His collection of I'oi was the largest number of a landbird species he collected during his expedition. The Kakerori, Rupe, Karavia and seabirds material were also procured but in smaller quantities (Pers. comm. Bishop Museum).

While studying birds of Tahiti and the Society Group, ornithologist, Scott-Wilson in June 1904 stopped over on Rarotonga for three weeks. He noted I'oi to be fairly abundant (1907). After observing only three types of birds (I'oi, *Ducula pacifica* and *Ptilopus rarotongensis*), Wilson concluded that the island might have never had a large variety of species. It was his opinion those observed birds would become extinct in a few years time due to increasing plantations of banana and coconut (1907). Cats and ship rats were also on the island at the time, the former being introduced around mid 1800s (McCormack & Kunzle 1990). It is probable that he observed I'oi on the lowlands as he states: "...I observed only three or four different forms. As it only requires about four hours to make the complete circuit of the island in a carriage..." This suggests that he observed birds during his journey around the island. Fortunately, Scott-Wilson's prediction that the increasing coconut and banana plantations would wipe out existing birds did not come to pass, though habitat clearance for agricultural purposes may have been a contributing factor in directing them inland. Rarotonga has not lost a single native landbird even after the introduction of the Myna in 1906.

More than fifty years after Wilson's assessment, the next literature relevant to Rarotongan birdlife was produced. Turnbott (1977) regarded Rarotonga's two endemics, the Kakerori and I'oi to be very rare. While he resolved their populations to be small, he thought them well established. His brief six-day visit and his observations conducted mainly in the coastal area with several excursions into the forested area were inadequate to give an accurate assessment. Turnbott further concludes that the fact that two less specimens were collected in 1901 by Lt-Colonel Gudgeon (three males) compared to the first collection by Andrew Garnett in 1869 (5 specimens) indicated that within a space of 30 years I'oi population had declined. However, he fails to mention other collections made in 1895 (Dannefaerd), 1899 (Cheesman) 1903 (Seale) and 1904 (Wilson), which amassed 27 I'oi. Furthermore, two separate expeditions each collected more than the 1896 and 1901 excursions combined<sup>3</sup>. The lack of mention of

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<sup>3</sup> Nine I'oi material collected each in 1895 and 1903.

these collections could be attributed to little publicity given to the collections, and Turnbott not being aware of these.

The sole guide to Cook Islands birds was published in 1980 and was written by David Holyoak. In 1973, Holyoak spent three months (July-Sept) in the Cook Islands surveying birds, and found I'oi to be fairly common. In a table providing a rough estimate of the numbers of Cook Islands bird species nesting on each island, I'oi is denoted with an XXX signifying 1000-10,000 birds (1980). In a separate paper with co-author Jean-Claude Thibault focussing on birds in the Cook Islands and French Polynesia, he regarded I'oi as frequent, estimating their population at between 1000-3000 birds (1984). These estimates were not based on any systematic survey, but rather on casual observations and an educated guess.

In 1984, Rod Hay undertook a review of bird conservation in the Pacific islands. The review studied the status of birds within the region with emphasis on species most at risk, habitats requiring protection and identifying projects to assist with research and issues. I'oi is cited under the chapter "Threatened". Hay makes comparisons with earlier accounts on how well the bird was doing, as reported by Wilson (1907) and Holyoak (1980). Hay concludes that I'oi was not abundant during his brief visit in 1984, estimating I'oi population pessimistically as being 100. Hay indicated that predators such as cats and ship rats might be the reason for low numbers. The introduced myna was not considered a major problem because of differences in habitat preference - the non-native being abundant in the cultivated coastal strip, while the native bound to the forest, eliminating possible competition. The bird was regarded as being distributed evenly through the forested interior of Rarotonga (Hay 1985).

In an article written by resident ethno-biologist, Gerald McCormack (1997), reviewing past ornithological research on the Cook Islands, he mentions that I'oi numbers may be as low as 500. He attributed their occupying large territories to their small population.

Interestingly, I'oi was used in the name of a local newspaper, *I'oi Karanga*. This newspaper was published in Rarotonga from 1898 to 1901 under the direction of Makea Ariki (one of the high chiefs of Rarotonga). Its principal aim was to denounce the British Resident of the time, Mr Moss, in the hope of removing him from his post. The naming of the paper is in reference to I'oi being considered a friend of the fugitive by warning through its call that someone is approaching. Part of a narration on its name on page two of the first edition revealed – "*as our name implies we repeat what we hear*".



Plate 2. The logo of the Ioi Karanga newspaper

Additional fragments of information can also be gleaned from the small amount of data accompanying collected I'oi specimens. Most specimen collection notes consist of descriptive information on I'oi. As far as it can be determined through literature research, Internet and personal communication with various museums, I'oi specimens are housed at six separate institutions in four countries (Germany, England, United States of America and New Zealand). There may be others specimens held in private or unpublicized public collections. A total of 38 I'oi specimens are held at the six institutions. Those that were traced are attributed to having been collected by eight collectors (Table 4).

Table 4 I'oi specimens collector, year, where housed and description

Collector/Year collected	Housed	Number collected, description/collectors information with specimen
Andrew Garret 1871	Museum Godeffroy, Germany	No reference notes Five?
Sigvard Dannefaerd 1895	Tring	Two
	AMNH	Seven
Thomas Cheesman 1899	Auckland Museum	Six
Lt-Colonel Gudgeon for the Earl of Ranfurly 1901	British Museum, Natural History	Three males
Alvin Seale 1903	Bishop Museum	Nine
Scott Wilson 1904	AMNH	Two
	Smithsonian	One
David Holyoak 1974	Tring	One
David Steadman 1984	Smithsonian Institute	Two  USNM 559603 Collected 15 March 1984. Cook Islands: Avana District; Rarotonga; Turangi Stream 1.5 mi west of Ngatangiis ( <i>Ngatangiia</i> ), elevation 10 - 15meters. Field Number RAR84-01. Specimen is an immature male. weight 94grams. Data with specimen. Left testis 2 x 1 mm; wing 126 mm; tail 78 mm, exposed culmen 24 mm; very fresh plumage; tail molting; Iris yellow; bill and feet black  USNM 559604 Collected 20 April 1984. Cook Islands: Avana District; Rarotonga, Avana Stream 2.7 km west (upstream) of Aru Tau ( <i>Ara Tapu</i> ). On coastal road. Field Number RAR84-09. Female. weight 78 grams. Ovary 6 x 5 mm, no enlarged ova; wing 122 mm; tail 80 mm; exposed culmen 23 mm; body feathers and rectrices molting; wing feathers fresh; Iris yellow; culmen, gonys, tarsus and toes black.

*Note: While some collection information was included with some specimens, I have only included here David Steadman's full collection notes. Spelling errors on local names were made and I have provided the correct spelling next to the mistake in italics and brackets.*

## 7 Possible Conservation Threats for Cook Island Land Birds

The native land birds of oceanic islands have evolved in the absence of humans, predators and diseases. The compactness of oceanic islands and small population of endemic birds make

them susceptible to pest introductions, habitat modification, hunting and natural impacts such as cyclones<sup>4</sup> (Sherley 2001).

Human colonization of the Pacific Islands has resulted in declining bird populations and the loss of some species, and this trend persists (Steadman 1995, Sherley & Hay 2000). The causes are familiar, over harvesting, loss of habitat and the introduction of competitive and predatory species. The Cook Islands has suffered considerable losses of avifauna. Through fossil evidence, Steadman (1991, 1995) gives a staggering account of extirpated and extinct Cook Islands birds. The casualties include rails, pigeons, swiftlets, kingfishers, seabirds, a starling and lorikeets (Steadman 1991, 1995, McCormack & Kunzle 1996, Olson 1986, Medway 2001).

Some examples of humans causing devastation to native birds include the Kura (*Vini kuhlii*) which vanished from the Cook Islands in pre-missionary times due to over-exploitation for their prized red feathers (McCormack & Kunzle 1996).

Another catastrophic occurrence for birds was the introduction of the ship rat (*Rattus rattus*), which has definite detrimental effects on the endemic and endangered Rarotonga Flycatcher or Kakerori (*Pomarea dimidiata*), and possibly other native birds. The once common Kakerori began its descent in numbers when ship rats were introduced probably around the mid 1880s (Robertson et al 1998). Studies revealed that their population decline was mainly because of predation at nests by ship rats (Robertson et al 1998, Robertson et al 1994). In 1989, Kakerori numbers stood at a low 29. In an attempt to bring about the recovery of Kakerori population, an ongoing intensive rat control program was implemented in that same year. The programme has obtained successful results with more than 250 birds being accounted for in 2009 (pers. comm E. Saul).

In 1906, the Myna bird (*Acridotheres tristis*) was introduced to Rarotonga for biocontrol (Cook Islands Natural Heritage Trust 2007). The Myna is now considered to be a pest and is thought by some to be responsible for driving native land birds into the hills. Despite the Myna's aggressive behaviour, none of the Cook Islands native land birds have been lost since it was introduced.

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<sup>4</sup> Although defined as natural, Cyclones and El Nino events have increased in frequency in recent years and have been linked to global warming brought about by the emission of greenhouse gases by the industrial nations

Avian diseases are also a potential threat to Cook Islands birds. Diseases such as pox and malaria have been suggested as one factor responsible for the depletion of native Hawaiian forest birds. The accidental introduction of the mosquito species, *Culex pipiens* - vector for transmitting the avian poxvirus and malarial protozoan into Hawaii in 1826, caused the demise of many lowland species of the Hawaiian Honey Eaters (Anon undated). Fortunately, Rarotonga currently has no known avian diseases. This conclusion was supported, when blood smears tests were taken from 18 Kakerori, six Mynas and one I'oi to assess disease risk of transferring Kakerori to other islands in the southern Cook Islands (Robertson 2000). The results verified the absence of blood parasites in the blood smears. Furthermore, whole blood counts revealed red cells, thrombocyte morphology and numbers as normal, thus signifying that none of these birds had blood disorders such as avian malaria (ibid). Despite the encouraging results there remains concern that harmful pathogens could be accidentally introduced by cage birds (McCormack 1997).

Natural disasters can have a drastic effect on oceanic islands birds with small population sizes. Robertson (2000) gives an example on Rarotonga. “*A severe storm in July 1998 and the spell of bad weather in early 1999, each of which probably killed many juveniles, highlights the vulnerability of kakerori to unusual weather events such as tropical cyclones, droughts or prolonged wet periods*”. In 2005, five tropical cyclones hit Rarotonga over a four-week period in March-April. Much of the interior forest of the island was severely damaged. Major casualties from these cyclones were young and old Kakerori (*Pomarea dimidiata*) in particular, 1–3 year olds and very old birds (> 20 years old) (Robertson and Saul 2006). To act as an insurance against extreme weather events and other threats, 30 Kakerori - classified by IUCN as endangered, were translocated between 2001-2003 to nearby ship rat free Atiu (ibid). This successful transfer shows that Kakerori can survive if ship rats are absent, and in a different environment to Rarotonga.

Today, most of the four indigenous Rarotongan land birds mainly inhabit the interior of Rarotonga. This was not always the case. For example, in the 1800s the Kakerori was common throughout the island including the lowlands (McCormack & Kunzle 1990). Kakerori's limited distribution on Rarotonga is attributed to ship rats. As available land becomes scarce in the lowlands, building of dwellings has commenced in the inland and is expected to continue. While banana and coconut plantations may have been a threat in the 1900s (Scott-Wilson 1907) future major modification of the inland could pose more of a risk for Rarotonga's native land birds.



## 8 Results

Observations during the fieldwork for this study, combined with other unpublished information, provided some useful insights into aspects of the ecology of the I'oi. These are presented below.

### 8.1 Morphology

I'oi is a medium sized bird (cf. 21cm), slightly smaller than the Indian Myna. The colour of the adult is dull dark grey-brown with a pale belly and whitish under-tail coverts and yellow eyes. Juveniles differ from adults by having brown eyes and no white feathering (Tiraa, Saul and Roberston unpub paper)<sup>5</sup>.

During August and September in 2008 and August 2009, staff of the Takitumu Conservation Area banded and measured nine I'oi. Table 5 lists the colour band combinations, location and measurements of the birds.

Table 5 Measurements of nine I'oi caught in the Takitumu Conservation Area

Date, time caught, development stage	Location	Col. Band	Bill (mm)	Head & Bill (mm)	Tarsus (mm)	Wing (mm)	Tail (mm)	Wt gms
10/8/08 mid pm Adult	LA ridge at LA 4/5	R/Y	-	-	-	-	-	77.5g
9/8/08 on dusk Adult	Tu 1/5 spur	W/R	21.8	52.4	38.0	119	75	79
9/8/08 on dusk Adult	Tu 1/5	B/Y	21.3	52.2	38.1	120	75	88
13/09/08 on dusk Adult	LA/Tu ridge	Y/G	21.6	52.5	37.4	123	76	88
8/08/09 on dusk Adult	To/Tu ridge	R/B	18.2	49.5	35.8	116	70	88
Adult on dusk	To/Tu ridge	R/W	19.3	50.8	32.5	112	72	77
Adult	To/Tu ridge	R/G	18.1	49.5	39.6	118	65	88
<b>Average measurement</b>			20.5	51.1	36.9	118	72	84

Colours are represented by letters: R = Red, B = Blue, Y = Yellow, G = Green, W = White

The colour letter on the left represents the colour on the left leg and visa versa for the right. For example, R/G means a Red band on the left leg and a Green on the right (Plate 3).

<sup>5</sup> It is likely the four birds described by Garrett (see 6.1) as having “dark slate” coloured eyes were in fact juveniles.

Location key: LA = Lower Avana, Tu = Turoa, To = Totokoitu. The areas are identified through notable landforms such as streams and ridges in the three valleys of Avana, Turoa and Totokoitu that comprise the TCA.

All birds measured were adults and except one were caught on dusk. The average wing was 118mm and the typical weight of I'oi is 84 grams. Plate 4 shows the approximate location of the banded birds within the TCA.



Plate 3 Takitumu Conservation Area staff, Ed Saul with a coloured banded I'oi (R/G)  
Photograph courtesy of Linda Nia

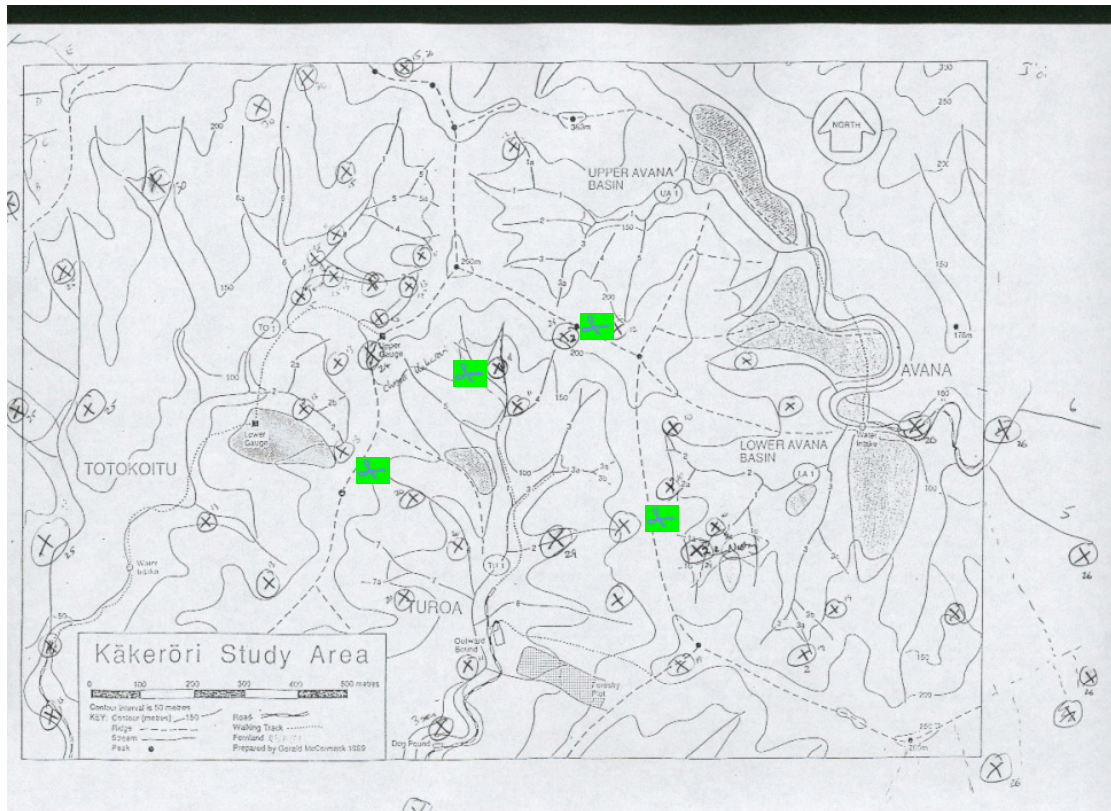


Plate 4 Approximate locations highlighted in green of banded I'oi in the TCA

## 8.2 *The call of the I'oi*

The I'o'i call is a continuous tone, variable in pitch and length (Saul unpublished field notes). I'oi pairs have been heard to call each other in chorus using a combination of high and low notes (ibid).

## 8.3 *Nesting*

I'oi make their nest in cavities of trees primarily found inland of Rarotonga (Plates 5). They fill their nests with bits of straggly, flexible vegetation. On one occasion, strips of blue plastic used for track markers were seen protruding from a nest. This indicates that other than vegetative matter, other appropriate material if readily available is sometimes used as material for a nest.

In 1999, at the foothills of Totokoitu valley a pair of I'oi was observed nesting in a Turina (*Hernandia moerenhoutiana*) tree. The adult pair fed at least 3 boisterous nearly fledged chicks that were seen when they lifted their heads out of the hole to receive food. This indicates that I'oi can lay more than one egg per clutch. The following year (2000) this nest was utilized again for breeding. It is uncertain if they were the same adult pair as the

previous year, though in all likelihood they were. Outside of the breeding season birds have been seen in the general area of their nest tree, implying that pairs hold territories.

In late August 2001, a pair of I'oi was observed nesting in the hollow of a Karaka tree (Plate 6) at the foothill of the Avana valley. The nest cavity was about 2m directly above the sloped ground. By mid October the nesting was completed and a fully independent fledgling was seen flying in the canopy above the nest. The following table summarizes observations made on this nest.

Table 5 Observation on I'oi nest

<b>Date:</b>	<b>Observations:</b>
29 August 2001	Adults in turns spent about 5-20minutes inside nest cavity then changed over (Incubation Period)
13 September 2001	Bird frequently alternating visits and spending shorter periods inside the nest. Longer breaks off the nest by both birds. Considerable calling between birds when both away from nest (chick stage)
20 September 2001	Repeated visits to and from nest. One bird sighted with a cylindrical, elongated about 4cm long, brownish object in mouth and flew into nest.
18 October 2001	No activity at the nest, but in the canopy above was a fledgling, fully feathered and flying, which was NOT being fed by its parents.
1 November 2001	No activity at the nest site and no sighting of fledgling. Distant calls of adult birds heard.

Another tree in which I'oi have been observed nesting is the **Koka** (Pers. comm E Saul). There are most likely to be other types of trees in which I'oi nest, but have not yet been observed. The eggs of the birds have not been examined therefore no egg description exists. I'oi are not known to nest in the lowlands and this could possibly be explained by their nesting trees requirements.



Plate 5 I'oi at the entrance of nest. Photograph courtesy of Gerald McCormack



Plate 6 I'oi nest in the Karaka tree at the foothill of the Avana valley

#### 8.4 Diet

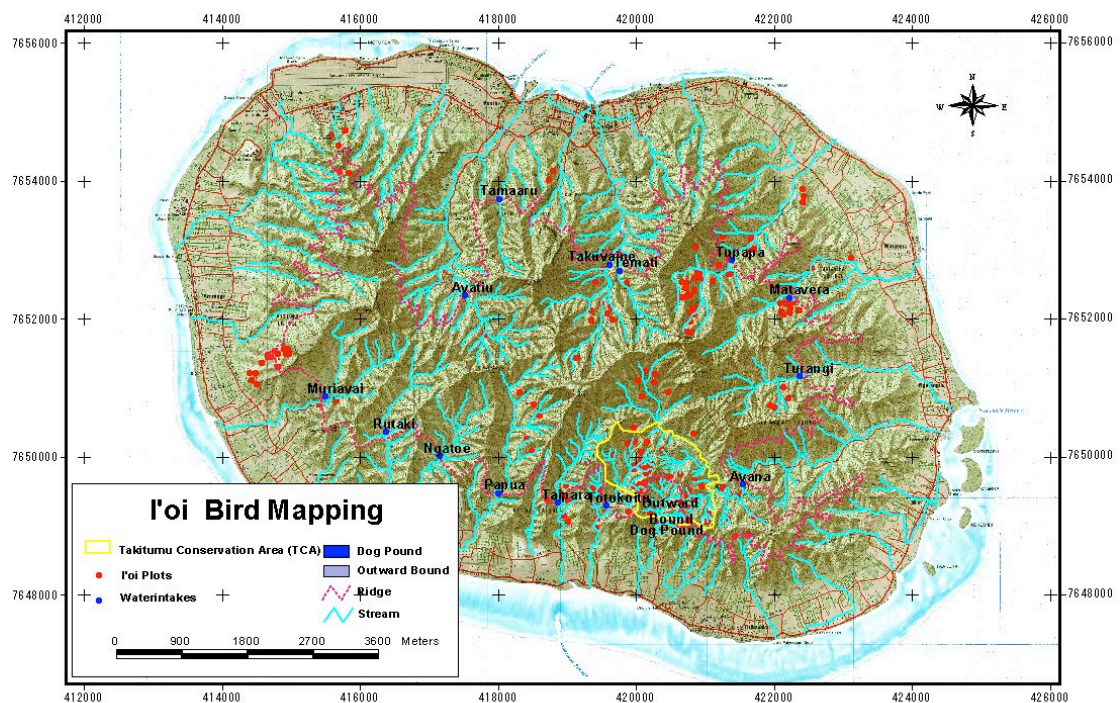
I'oi eat berries, insects and drink nectar. They have been seen to eat the berries of Koka (*Bischofia javanica*) Karaka (*Elaeocarpus tonganus*), Mata'oi (*Cananga odorata*), Mati (*Ficus tinctoria*) and Turina (*Hernandia moerenhoutiana*) (McCormack 1993, Pers. comm E. Saul). Other eating observations include gleaning a caterpillar about 3cm long from a Matira

leaf and a small, unidentified insect gathered from the underside of a Mato (*Homalium atria*) foliage (Pers. comm H. Robertson). I'oi have been recorded drinking nectar from the bright orange Neinei (*Fitchia speciosa*) flower, which flowers in the winter months (Mcormack 1933).

### 8.5 Distribution and abundance

I'oi are widespread throughout Rarotonga, ranging from approximately 30m to 400m elevation. They were mainly noted in the sloped interior forest of the island. Figure 1 records where I'oi were heard and seen.

Figure 1 Map recording I'oi heard and seen at selected study sites



A monitoring survey noting I'oi heard and seen from two vantage points, one in the TCA and the other in Matavera valley (Figure 2), recorded similar average number of birds seen (Table 6). The Matavera Valley site consists mainly of secondary and disturbed vegetation. A large portion of area surrounding the vantage point is covered in the invasive Mile a minute vine (*Mikania micrantha*) (Plate 7). The TCA vantage point contains a mixture of native and introduced plant species. Compared to Matavera, less area is covered with the Mile a minute vine. There was a significant difference in the number of I'oi calls heard between the two sites, with less being heard in Matavera. This was most likely due to there being many noisy Myna birds in the Matavera area, making it difficult to hear I'oi calls.

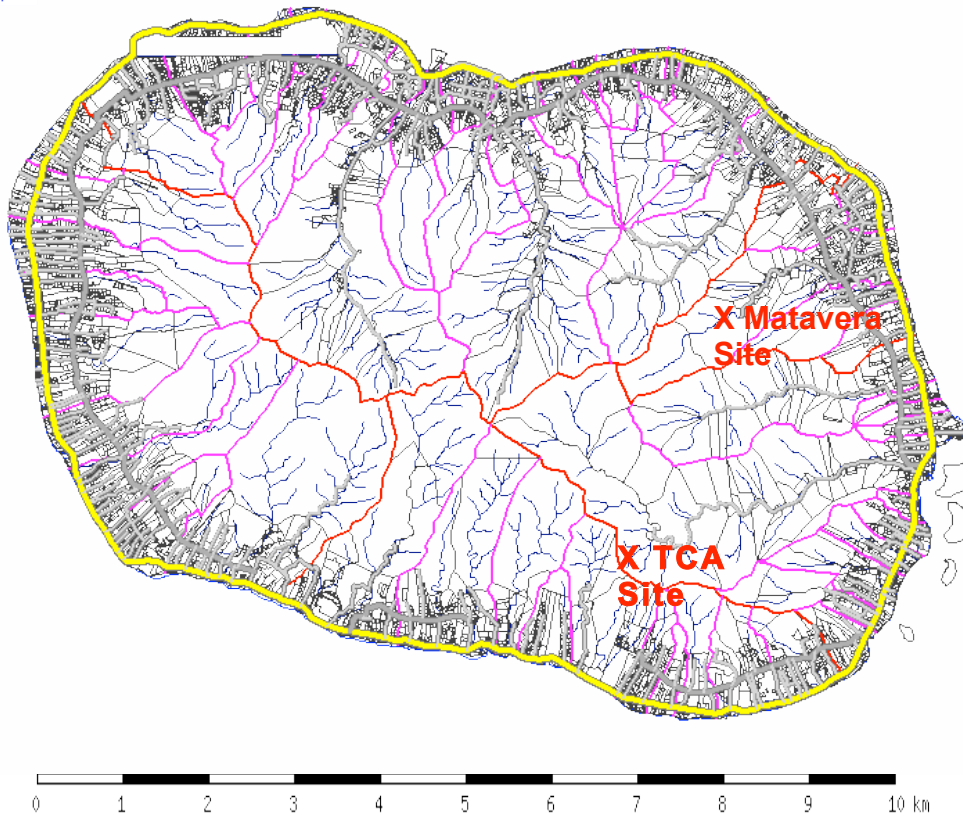


Figure 2. Map of Rarotonga showing the locations of the 2 major study sites

Table 6 The average number of birds seen and heard/hour in the TCA and Matavera valley

Vantage point	Average Seen/hour		Average Heard/hour	
	AM	PM	AM	PM
TCA	4	5	25	24
Matavera	3	5	10	8



Plate 7 Matavera Valley looking from the vantage point. The invasive Mile a Minute vine can be seen covering trees in the foreground.

The 5-minute stationary counts indicate that the daytime activity of I'oi was greater in the early morning and late afternoon. I'oi are less active during the middle of the day by approximately by half (Figure 3).



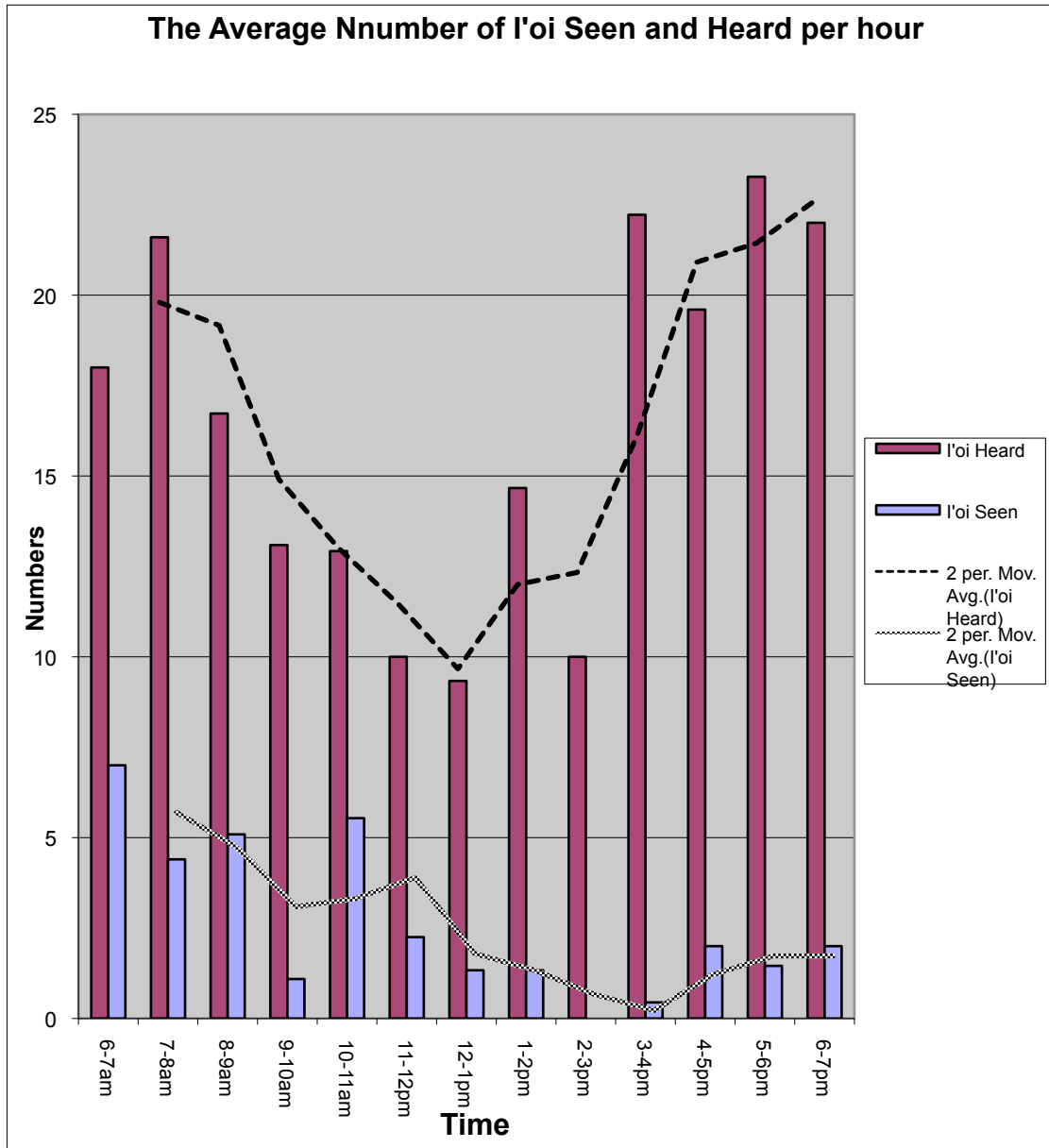
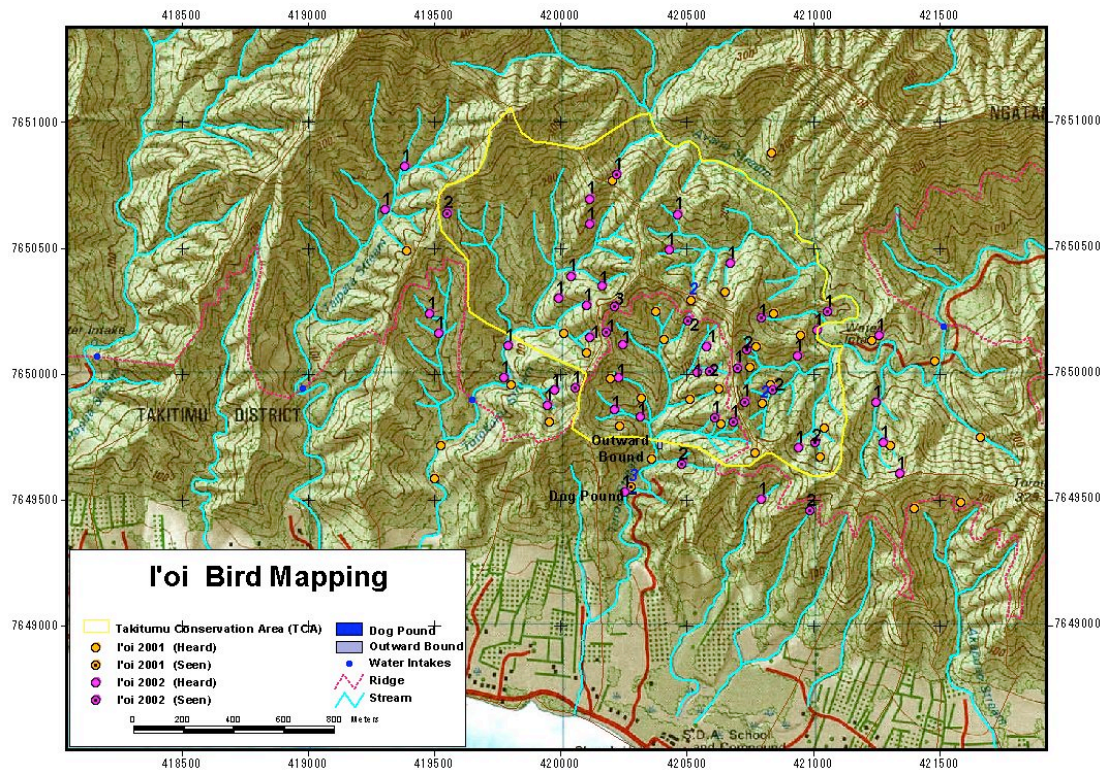


Figure 3 The Average number of I'oi seen and hear per hour

From the topographical map (New Zealand Department of Survey and Lands 1985), suitable vegetated habitat appears to be mainly that area 30m above Sea Level. Below 30m is cleared for human habitation and cultivation. The total area above 30m contours is 43.45 sq. km. Forty-two birds were noted in 2002 in the TCA, an area of 155ha (Figure 4). This is equivalent to 0.271bird/hectare. By extrapolating this information for the total available habitat, an approximate population estimate of 1200 birds can be derived. As all birds would not have been noted, even in this more intensively surveyed TCA area, this figure should be viewed as a conservative estimate of the population.

Figure 4 I'oi heard and Seen in 2001 and 2002 in the TCA



### 8.5 Local Awareness

The questionnaires revealed that with the exception of those in the 60+ aged category the majority of people had never heard or seen an I'oi. A photo of I'oi was shown and the call was described and imitated to the interviewees after the relevant questions. The following briefly summarizes the results.

Twenty-eight 60+ years olds were interviewed. Of those, 23 individuals indicated that they had heard of I'oi while the remaining five could not recall the bird. However, not all respondents who knew I'oi had observed it, with 18 of the 23 having seen the bird.

In the 40-60 year olds category, 27 people were interviewed. Eleven respondents said that they were aware of I'oi. In some cases, people had heard of the bird, but had not seen it, with seven indicating they had seen I'oi.

Of the 20-40 aged group, there was only four out of 29 respondents saying “yes” to hearing about I’oi. The results were similar on the sighting front - five individuals have seen I’oi. One individual who had not heard of I’oi recognized it when a photo was shown. The youngest teenage group revealed that of the 36 interviewed, five had heard of I’oi and three had seen it.

The graph below shows the percentage of people from the different age groups that have seen or heard of I’oi. The last column represents overall total seen and heard of I’oi.

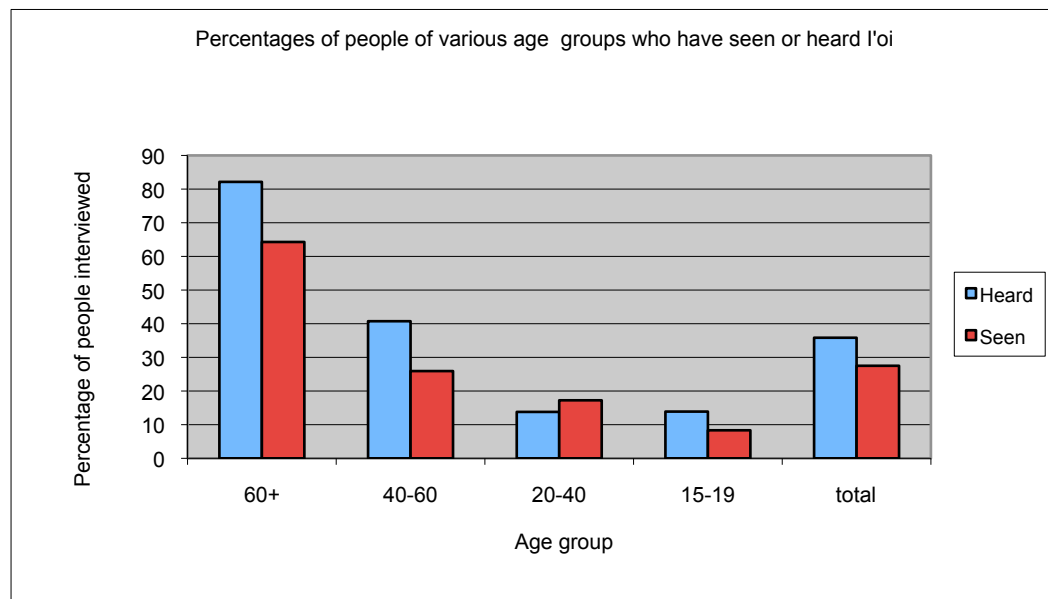


Figure 5 percentages of people per age group that have seen or heard I’oi

## 9 Discussion and Conclusions

From historical and recent accounts, I’oi is not a conspicuous bird. Their numbers appear to have declined from the early 1800s when I’oi were considered common on the coastal areas (Wyatt Gill 1885). Since the 1970s, I’oi numbers were generally considered to be declining into the hundreds (Turnbott 1977, Hay 1986, McCormack 1997). I’oi were seen to frequent the coastal areas in large numbers in the past (Wyatt Gill 1885), but a significant presence in this area is not apparent today. It is not unusual to observe small groups of about 10-20 in flight over inland areas.

From the literature, specimen collections and this study, I’oi can be found from as low as 30m above Sea Level. This study has shown that they are widespread throughout Rarotonga inhabiting inland forest vegetation, disturbed or otherwise. In Ngatangia, there is a block of land near the coastal road named after the bird. Historically in Rarotonga, land was named

after a common feature of that block or after a historical event (Pers. comm M. Tongia). The former implies that this land was so named because I'oi may have been commonly found on the block.

During this research only a small number of informants stated they have seen or heard I'oi on rare occasions at lower elevations, in their gardens around coastal areas. It is unclear why I'oi are rarely observed in the coastal area. We can only surmise a number of possible factors. These include the reduction of favored trees, the introduction of the myna bird in 1906, which spend a large part of the day near people, higher number of predators on the lowlands, for example cats and rats, and loss of habitat.

The population estimate of more than one thousand birds derived from this study implies they are not endangered under the IUCN red list category. This study supports Holyoak and Thibault (1984) population estimate of I'oi being somewhere between 1000-3000.

The similar number of I'oi seen between the two vantage points of Matavera and the TCA suggest that I'oi are adaptable to habitats containing non-native vegetation. This also suggests that the rat control measures undertaken in the TCA from September to December every year do not make a difference in the distribution and abundance of I'oi. The I'oi nests that were observed had a long narrow entrance into the nest cavity, which may be a factor in keeping out large rats. The bigger size of I'oi may also be an advantage, in comparison to the smaller Rarotonga Flycatcher, which is impacted by ships rats. The larger size I'oi are likely to be more successful at repelling rats. Though the few trees that I'oi have been noted to nest in are native, the number of nests observed during this study were insufficient to confirm their preference for native trees or otherwise.

In 2002 the remains of an I'oi were found. It is suspected that a cat may have been responsible for killing this bird. This study did not conclusively identify threats to I'oi. (Plates 8 and 9).

Plate 8 the legs and feet remains of I'oi found in the TCA



Plate 9 Wings of I'oi



The I'oi has fallen into relative anonymity especially for Rarotongan residents 40 years and under. The older people knew more about I'oi than the younger generations. This may reflect lifestyle changes, as the older generations interacted more with their environment than those of younger generations.

Further banding of birds should be carried out to ensure accuracy and refinement of population estimates. There have been recent successful actions to translocate Endangered birds (Kura and Kakerori) to safer islands in the Cook Islands. Using the precautionary principle, to ensure the continued survival of I'oi, consideration should be given to translocating the bird to another island in future, after a suitable feasibility study and impact assessment has been undertaken.

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