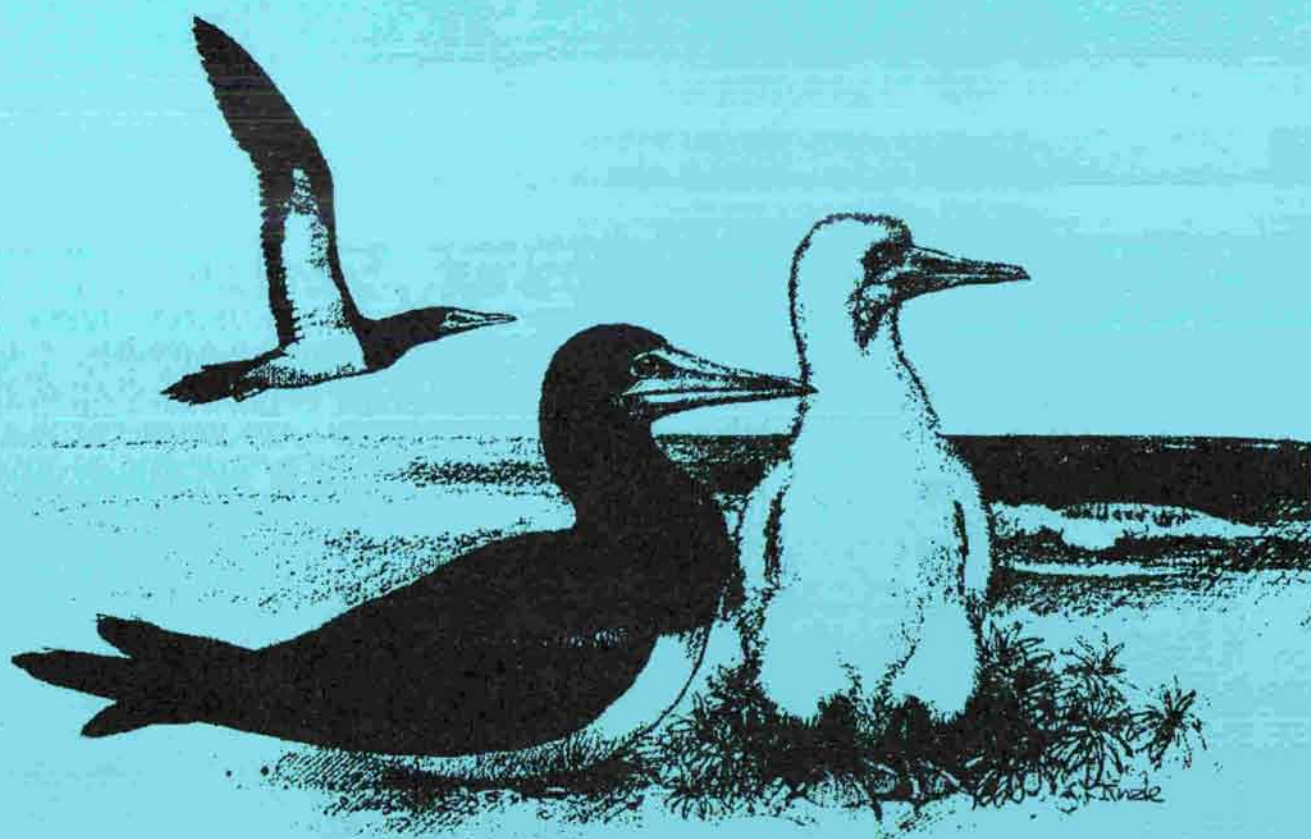




Takūtea Wildlife Sanctuary, Cook Islands



by Gerald McCormack

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Original Text: English

Published in March 1994 by:
South Pacific Regional
Environment Programme
P.O. Box 240
Apia, Western Samoa



Printed by:
Commercial Printers
Apia, Western Samoa

P 32/93 - 3C

Printed with financial assistance from the
United Nations Environment Programme (UNEP)

Cataloguing-in-Publication Data

McCormack, Gerald

Takutea Wildlife Sactuary, Cook Islands / by Gerald McCormack. - Apia, Western Samoa : SPREP, 1994.

iv, 24p. : ill. ; 29 cm - (SPREP reports and studies series ; no. 66).

Includes bibliographical references.

ISBN: 982-04-0066-X

1. Birds - Cook Islands - Takutea 2. Zoology - Cook Islands - Takutea I. South Pacific Regional Environment Programme II. Title III. Series

QL694.C6M33

598.299623



**COOK ISLANDS
NATURAL HERITAGE
PROJECT**

Illustrations: Judith Künzle and
Gerald McCormack

Design and Layout: Judith Künzle

Published in collaboration with:

Cook Islands Natural Heritage Project,
Prime Minister's Office,
Cook Islands

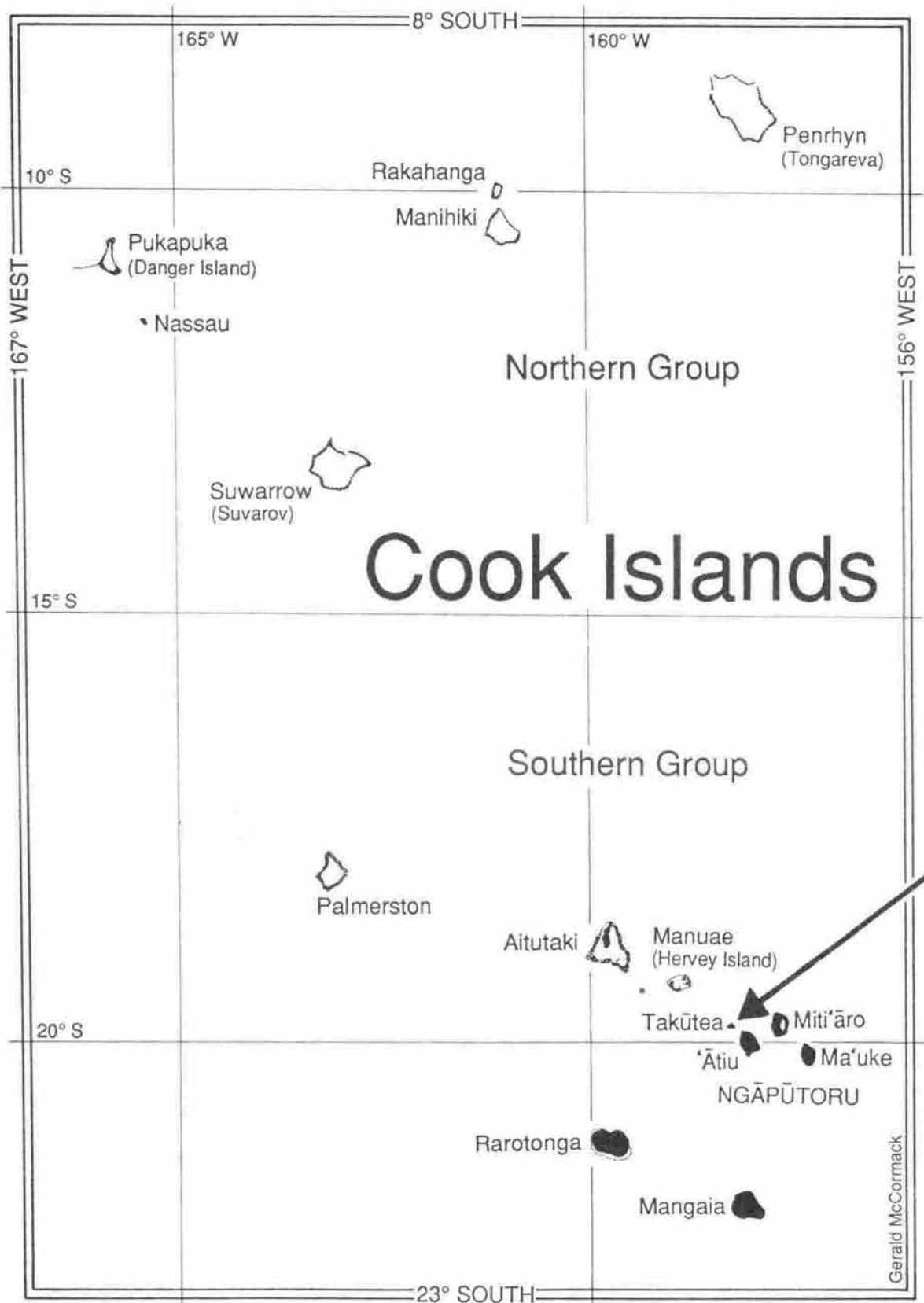
**Takūtea Wildlife Sanctuary,
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by

Gerald McCormack

Cook Islands Natural Heritage Project

Apia, Western Samoa
March 1994



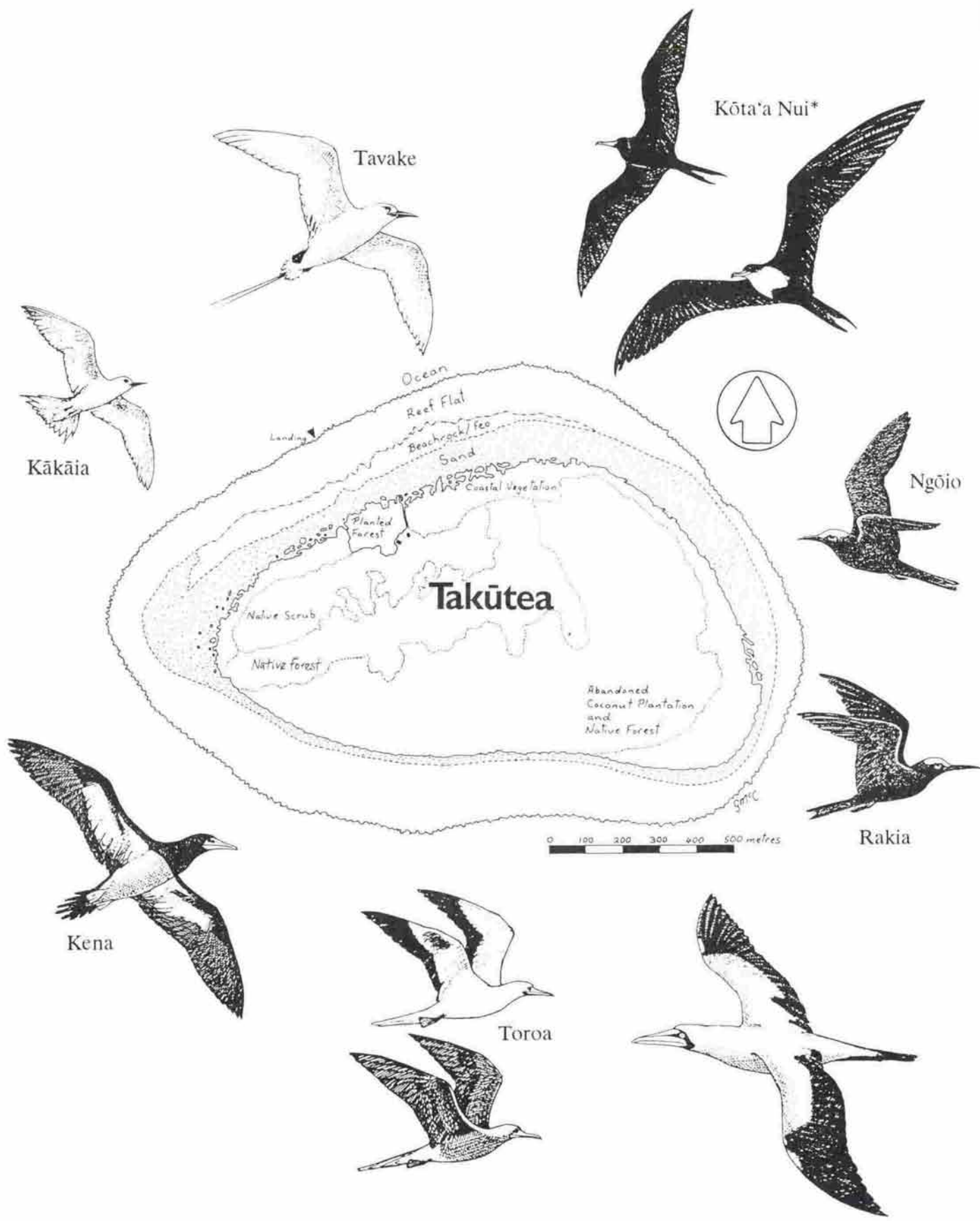
Gerald McCormack

SEA SCALE: 0 100 200 300 400 500 km

ISLANDS: enlarged 4 times

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Overview

This report is based on brief visits to Takūtea during 1986, 1989 and 1990. The second and third visits were to assist the students of 'Ātiu College to study the wildlife of the island.

The seabird colonies of Takūtea are the largest and most important in the Southern Cook Islands. The island supports the largest colony of **Tavake (Red-tailed Tropicbird)** in the Cook Islands, and three of the seven species which nest regularly on Takūtea do not breed elsewhere in the Southern Group. The **Lulu (Masked Booby)**, one of the rarest nesting seabirds in the Cook Islands, may sometimes breed on Takūtea.

Takūtea has been maintained as a "Wildlife Sanctuary" by the Aronga Mana of 'Ātiu, who have been the legal Trustees of the island since 1950. During 1988 the Trustees agreed in principal to the idea of entering into a "shared-management regime" with the Conservation Service, and having the island designated as a "nature reserve" under the Cook Islands Conservation Act. This move, which would have given more international recognition to the conservational status of Takūtea, cannot be achieved until the Conservation Act has been ammended to enable the establishment of "shared-management regimes" with traditional owners.

Recommendations

1. That the students of 'Ātiu College continue to visit Takūtea each July to collect further information on the breeding status of the seabirds.
2. That the Trustees continue to prohibit the capturing or killing of birds, and continue to prohibit the removal of tail-feathers from the **Tavake (Red-tailed Tropicbird)**.
3. That the students develop methods for estimating the number and ages of **Unga Kaveu (Coconut Crab)**. (See page 9 for further details.)
4. That the Trustees consider imposing a ban on the killing of female **Unga Kaveu (Coconut Crab)** until more is understood about the colony on Takūtea.
5. That the Trustees consider imposing a ban on the capturing of **'Onu (Green Turtle)** and on the taking of their eggs.
6. That the students estimate the number of **Teue (Bristle-thighed Curlew)** on Takūtea, and make accurate records of any with colour-bands on their legs. (See page 8 for further details.)
7. That a single team make a more detailed survey of the vegetation of Takūtea, and map the extent of the different plant communities. (See page 10 and 11 for further details.)

Background

The uninhabited island of Takūtea is a small (120 hectare) coral-cay 22 km north of 'Ātiu. It has the largest colony of **Tavake (Red-tailed Tropicbird)** in the Cook Islands, and three of the seven species which nest regularly on the island do not breed elsewhere within the Southern Cooks. An eighth species, the **Lulu (Masked Booby)**, may sometimes nest in very small numbers.

Takūtea was gifted to the British Crown in 1903 and has been referred to as a "wildlife sanctuary" since that time. In 1905 about 80 hectares (60%) was cleared and planted in **Nū (Coconut Palm)** to establish a copra industry. The plantations were maintained and the copra processed by regular visits of workers from 'Ātiu until the Second World War. In 1938 the island was freed of all trusts and reservations and its ownership opened for investigation. In 1950 the Aronga Mana of 'Ātiu were appointed "As Trustees for all the native land Owners of 'Ātiu and their descendents".

Takūtea is the most important seabird breeding island in the Southern Cooks because it is uninhabited, although in the early part of this century it was regularly visited by copra workers. In the last 50 years the island has been rarely visited and most of the forest has regenerated. Over the last few years the Trustees have taken an increasing interest in protecting the seabird colonies and have banned the killing of seabirds, including the **Kaparere (juvenile Red-tailed Tropicbird)** which was formerly a favourite food among visitors. The Trustees have also placed a ban on the removal of the red tail-feathers from adult **Tavake (Red-tailed Tropicbird)**. These feathers are prized for use in the headdresses of dancers.

Over the years there have been periodic enthusiasm to obtain a greater economic return from the island. For example, during 1968 Parua Ariki and his workers spent six weeks on the island harvesting the copra, thinning the coconut palms, planting a windbreak of 80 **Toa (Pacific Ironwood)** seedlings, and clearing 3.2 hectares of native forest to extend the copra plantation. During 1985 the cruise-ship Society Explorer visited Takūtea from 'Ātiu, and several thousand dollars were gained by the 'Ātiu community. The idea of taking tourists to Takūtea was advanced further during 1986 when the 'Ātiu Members of Parliament, Norman George and Mariri Paratainga, lead a party of 80 'Ātiu volunteers to mark-out and start hand-clearing an airstrip. When it was realised that this development would seriously disrupt the seabird colonies the project was cancelled.

During 1988, as Director of the Conservation Service, the author proposed to the Trustees that the "sanctuary" status of Takūtea could have more international recognition by gazetting it as a "Nature Reserve" under the Cook Islands Conservation Act 1986/87. The idea was to establish the reserve under a committee consisting mainly of the Trustees and any other people they wished to nominate. However, when a lawyer (Tim Arnold) was asked to prepare the necessary documents it was discovered that the establishment of such a committee could not be achieved under the existing legislation. As a result, during 1989, he prepared an amendment which would have paved the way for "shared-management regimes" of conservation areas. Unfortunately, this amendment has not yet been enacted, and the conservation effort of the Takūtea Trustees continues to lack the international recognition it deserves.

In mid-1988 I was approached by Professor Ron Crocombe to take a party of 'Ātiu College students to Takūtea to assist them to carry out a scientific study of the island. A year later, after several near-misses, we finally visited the island for three days (31 May - 2 June 1989), and a year later we extended the study with a four day visit (4 - 7 September 1990).

During the 1989 visit the students worked in four teams to study the **Tavake (Red-tailed Tropicbird)**, **Kena (Brown Booby)**, **Rakia (White-capped Noddy)** and the pattern of vegetation. With the seabird colonies we experimented with methods of estimating the total breeding population and with a method of estimating the ages of nestlings to map the breeding cycles.

During the 1990 visit the students were more efficient in assessing the size and breeding cycle of the **Tavake** and **Kena** colonies, and we trialled methods of assessing the **Kōta'a Nui* (Great Frigatebird)** colony which is located on the tree-tops.

The scientific information collected by the students will be especially useful to the Trustees when they make decisions on the use of the resources of Takūtea in relation to the preservation of the seabird colonies. In the future, the students should continue to monitor all the seabird colonies, and extend their investigations to include other aspects of the wildlife, such as **'Onu (Green Turtle)** and **Unga Kaveu (Coconut Crab)** which are still open to uncontrolled exploitation by visitors.

Māori orthography

The Māori language of the Cook Islands is derived from those of Eastern Polynesia, except for Pukapuka which has a Samoa-related language. Despite the Eastern Polynesia origin of plant and animal names, the physical isolation of the individual islands created a fertile ground for the divergence of names. For example, while all communities use the name **Tavake** for the **Red-tailed Tropicbird**, the **Brown Booby** is known specifically as **Kena** (Penrhyn), **Kapu** (Penrhyn) and **Noa** (Pukapuka), and non-specifically as **Toroa** (Southern Group). In other cases the variation is more subtle, as in the cognates for a common coastal shrub: **Nga'u**, **Ngahu**, **Ngasu**, **Ngashu** and **Ngayu**.

Where possible, this report uses traditional 'Ātiu names. Unfortunately, several of the Takūtea seabirds have no known 'Ātiu name or the 'Ātiu name applies to more than one species. In some such cases, a traditional name from another island was used: for example, **Lulu** the Pukapuka name for the **Masked Booby**. In other cases, a traditional non-species-specific name was affixed to make it species-specific: for example, **Kōta'a**, which applies to two species, was affixed to **Kōta'a Nui*** to refer specifically to the **Great Frigatebird**. The asterisk (*) marks affixed traditional names.

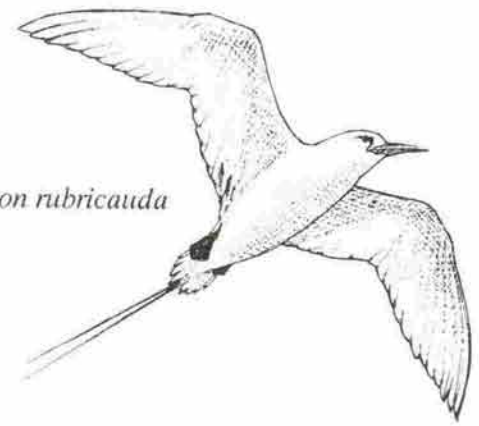
Acknowledgements

I thank the 'Ātiu Aronga Mana, Chief Administration Officer, Island Council, College Principal and his staff for their active support. I thank Ron Crocombe for persistently encouraging the project and for gaining financial support from the Institute of Pacific Studies of the University of the South Pacific and from the Australia Pacific Science Foundation. Most of the financial burden of the 1989 visit was shouldered by the Natural History Unit of Television New Zealand who included the project in their Wild South documentary "Cook Islands: Heaven on Earth?". The 1990 trip was made possible through a "charity charter" by Captain Tommy Sellen of MV *Sodero*. This visit was recorded on video by Bob Turner and Tommy Sellen, and is available as a production by Bob Turner called "Takūtea: 'Ātiu College Nature Survey 1990".

Special thanks to Rangī Moeka'a for his advice on Māori orthography, and to several local informants and overseas biologists, especially Vaine Moeroa Koronui ('Ātiu), Art Whistler (Hawai'i) and Bill Sykes (New Zealand).

Concerning the system to measure the rate of egg-laying I thank Cameron Kepler for his extensive support, and Eddie Saul for his comments after further trialling the system on Suwarrow.

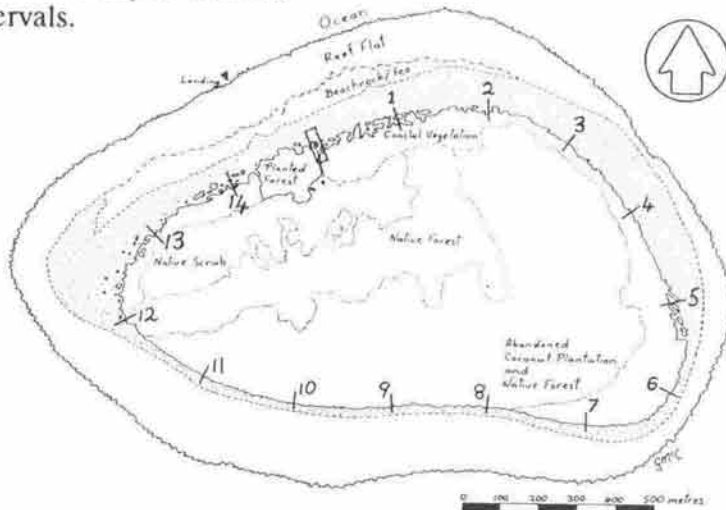
Tavake (Red-tailed Tropicbird) *Phaethon rubricauda*



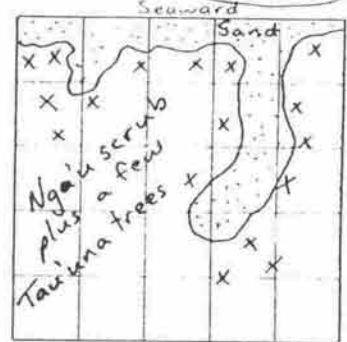
The **Red-tailed Tropicbird** nests in small numbers on the inland cliffs on Mangaia and Rarotonga; in small numbers under coastal shrubs on Aitutaki, Manuae, and most Northern Group atolls; and in large numbers under coastal shrubs on Palmerston, Suvarrow and Takūtea.

It is known throughout the Cook Islands by the species-specific name **Tavake**.

Map showing the location of the 14 samples at 250m intervals.

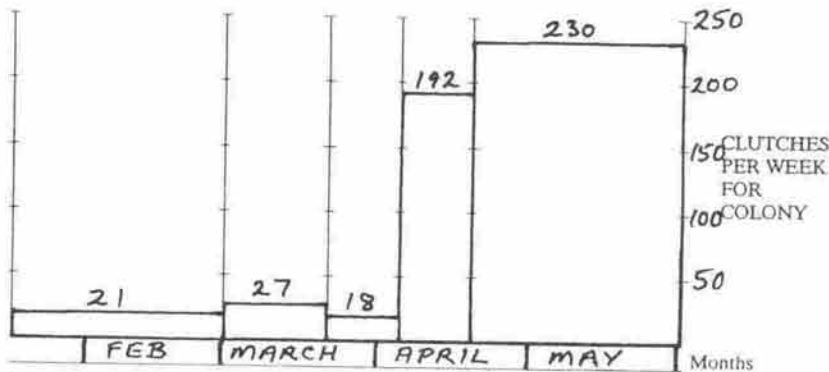


Plot #4 Sample



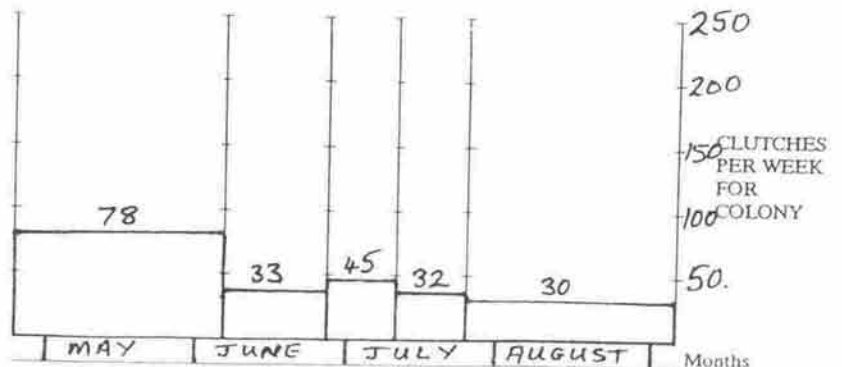
17 nests.

The number and location of nests in a typical 25x25m sample.



1989

Graphs showing the number of egg-clutches laid-per-week during the 13 weeks prior to the 1989 and 1990 surveys. (see Appendix for Method.)



1990

- 1989: It was estimated that there were 2,000 active nests, of which about 1,700 (85%) were within 25 metres of the outer edge of the vegetation. Most nests contained an egg or downy chick which indicated that most egg-laying had occurred during April and May. It was estimated that 741 eggs were laid during April, and a further 928 during May: 37% and 46% respectively of all active nests.
- 1990: Fourteen perimeter plots were used to estimate a population of 900 active nests. Half the nests contained a Kaparere (juvenile), and it was estimated that about 292 of these had developed from eggs laid during May. The visit was too late in the year to count the young which had developed from eggs laid during April.

Comment:

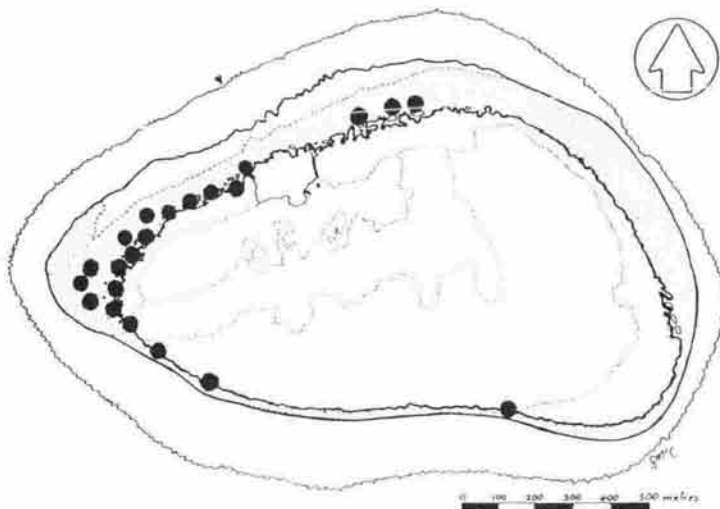
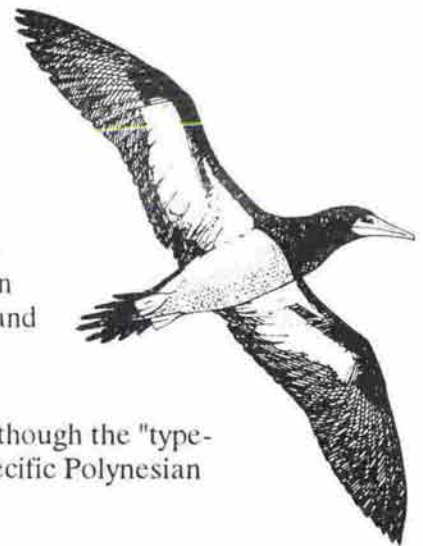
As the young which developed from April eggs in 1990 had already fledged we are unable to obtain a full picture of the 1990 breeding cycle. However, we are able to compare the numbers of eggs laid during May 1989 and May 1990, and it shows that there was only 30% as many laid during May 1990 as laid during May the previous year.

In conclusion, the surveys show that considerably fewer **Tavake** nested on Takūtea during 1990 than during the previous year. Further surveys are needed to understand the changes which occur from year to year. The best time to survey the population is during July which enables the egg-laying over the most important months of April and May to be assessed.

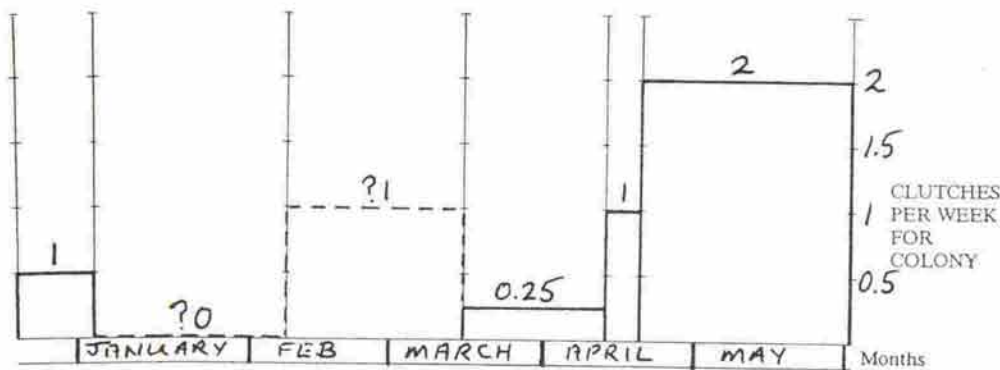
Kena (Brown Booby) *Sula leucogaster*

The **Brown Booby** nests on the ground in the open or under **Tau'unu** (**Heliotrope Tree**) trees on the upper part of sandy beaches. It nests in moderate numbers on Suwarrow, and in small numbers on Penrhyn and Takūtea. On Takūtea the main colony was at the western end of the island.

The people of 'Ātiu use the collective-name **Toroa** for all boobies, although the "type-species" is the **Red-footed Booby**. It is suggested that for a species-specific Polynesian name the **Brown Booby** could be known by its Manihiki name: **Kena**.

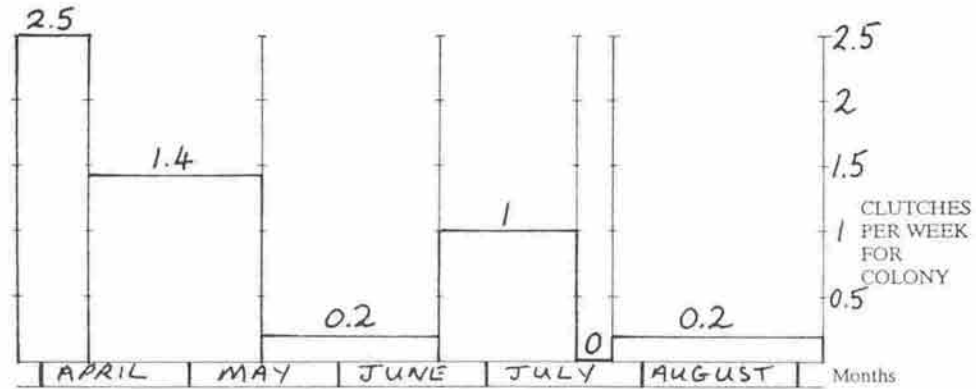


The location of the 22 nests found during the 1989 survey.



Graphs showing the number of egg-clutches laid-per-week during the 17 weeks prior to the 1989 and 1990 surveys. (Method in Appendix)

1989



1990

1989: 22 active nests were found of which 15 (68%) contained eggs or naked nestlings initiated during April and May. Unfortunately there was some uncertainty over recording the development stages of the older nestlings which meant we were not sure when they were laid.

1990: 18 active nests were found of which 12 (67%) contained nestlings initiated during April and May.

Comment:

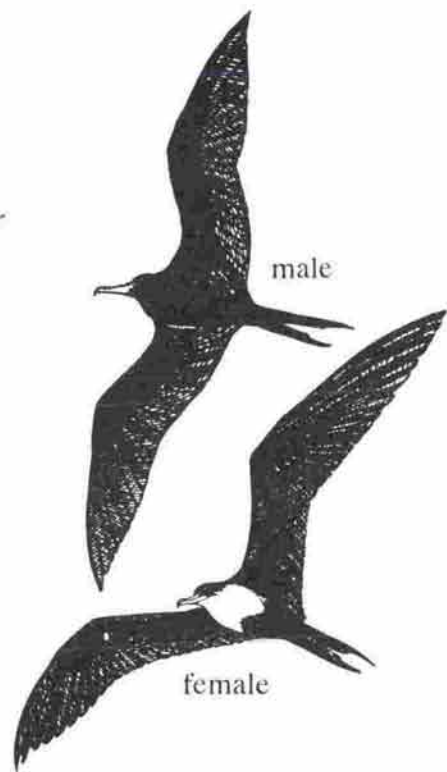
Kena take a month longer than **Tavake** to leave the nest: 17 weeks compared to 13 weeks. Therefore, at the time of our September visit **Kena** nestlings from eggs laid during April were still present.

The study showed that although the **Kena** colony was small it was relatively stable throughout 1989 and 1990. Although over 65% of the egg-laying occurred during April and May, the data showed that the peak during 1989 was in May, while the peak for 1990 was a month earlier. During each year there was some evidence of a second peak of breeding activity: in December 1989, and between mid-June and mid-July 1990. Further research is required to clarify the breeding cycle of the **Kena**.

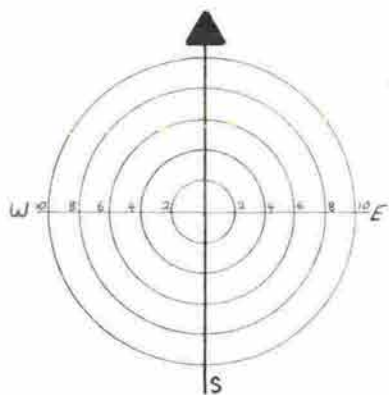
Kōta'a Nui (Great Frigatebird) *Fregata minor*

This species of frigatebird breeds in small numbers only on the uninhabited islands of Suwarrow and Takūtea: on the former it nests in the Ngangie (*Pemphis*) scrub, while on the latter it nests on the tops of Pukatea (*Pisonia*) trees.

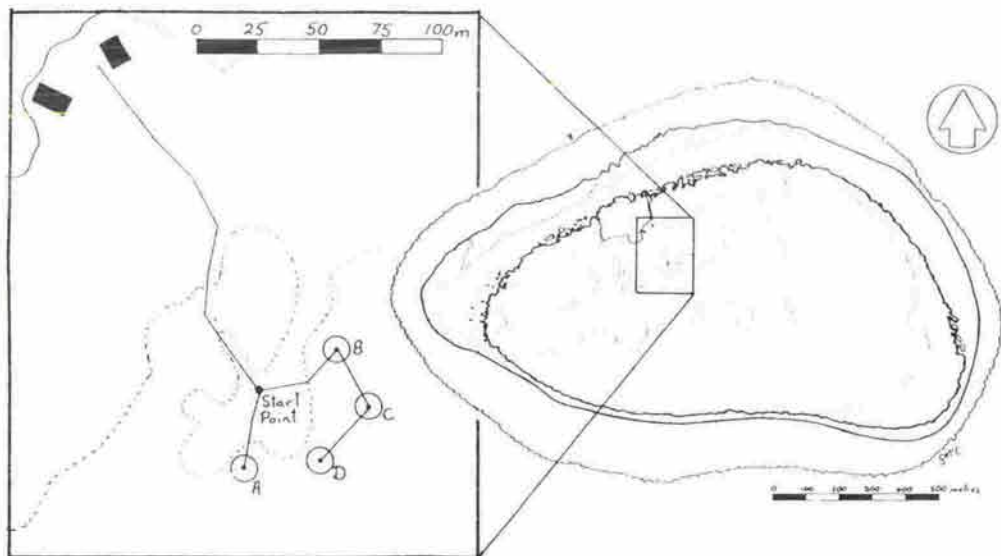
No island in the Cook Islands has species-specific names for the two species of frigatebird, although some have separate names for the white-breasted females and the red-throat-pouched males. It is suggested that the collective name, Kōta'a be affixed to provide species-specific names: Kōta'a Iti* for the Least Frigatebird, and Kōta'a Nui* for the Great Frigatebird. The asterisk (*) following the name indicates that the name as been recently modified and is not traditional.



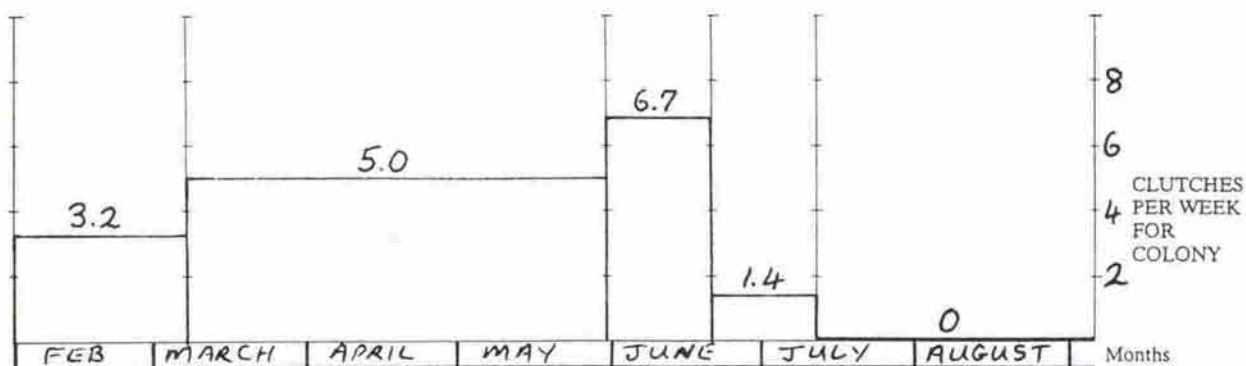
The grid on which the number and location of nests should be recorded from each observation point.



The location of the four observation points established during 1990.



Graph showing the number of egg-clutches laid-per-week during the 6 months prior to the 1990 survey. (Method in Appendix)



1990

- 1989: The position of the colony was located but not quantified because of the difficulty of locating and safely sighting the nests which are usually more than 4 metres above the ground on the tops of **Pukatea (Pisonia)** trees.
- 1990: Two methods of quantifying the population were trialled and one showed promise. The number of active nests was estimated at about 100, with almost all the young being more than two months old. The data showed that most egg-laying occurred during a four-month period from March to June.

Comment:

The method involving the establishment of fixed observation points worked well and these were marked for future use. As the young are slow to develop the nest data can indicate the level of egg-laying up to seven months before the day of the census. Several more visits will be required to measure the exact size of the breeding population and the details of peaks in the egg-laying cycle.

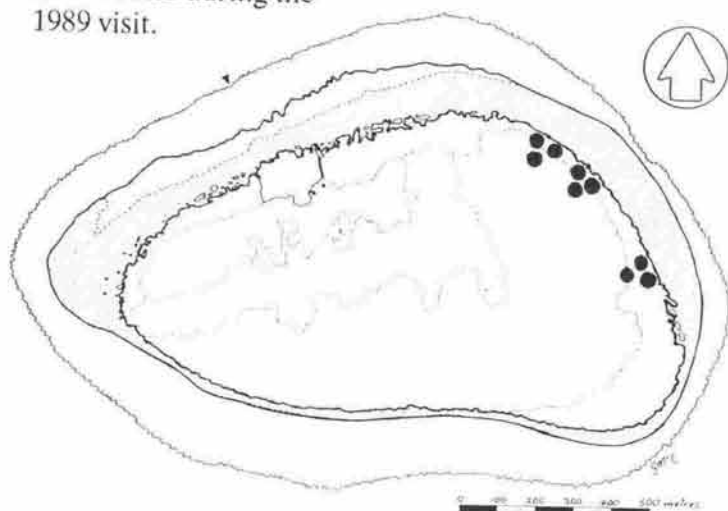


Rakia (White-capped Noddy) *Anous minutus*

The **White-capped Noddy** (also known as the **Black Noddy**) is the most common seabird on most of the atolls of the Northern Group. However, within the Southern Group it nests only in a very small colony on Takūtea and in another very small colony on Motukitū on Aitutaki.

As there is no traditional 'Ātiu name for this species it is suggested that it be known by its species-specific Penrhyn name: **Rakia**.

The location of the 26 nests found during the 1989 visit.



1989: 26 empty nests were found in two relatively distinct colonies in the northeast section of the island.

1990: only 3 empty nests were found.

Comment:

The absence of **Rakia** in 1990 was surprising (and disappointing). The nests were not merely overlooked, as the leader of the 1990 search had been previously involved in the 1989 search.

Toroa (Red-footed Booby) *Sula sula*

While the **Red-footed Booby** is the most common booby throughout the Northern Group, it does not nest on any of the inhabited islands of the Southern Group. However, it does nest in small numbers, within the frigatebird colony, on Takūtea.

The **Red-footed Booby** is unusual in having two colour morphs, which means that adults can be one of two different colours. The most common colour is brown with a white tail (the **Brown Morph**), while the uncommon colour is white with a black band along the hind-section of the wing (the **White Morph**). On Takūtea, during the early 1970s, it was estimated that about 15% of the birds were White Morphs, while in the Northern Cooks the percentage is much lower, at about 3%.

Although the name **Toroa** is not species-specific in the Southern Group this name is the specific Manihiki name for the **Red-footed Booby**, and on 'Ātiu this same species is considered to be the "type-species" for the non-specific name **Toroa**.

Comment:

No attempt was made to quantify the breeding population of **Toroa** and determine the percentage of White Morphs. Both activities will be undertaken at the same time as the study of the **Kōta'a Nui*** (**Great Frigatebird**) during future visits.



Lulu (Masked Booby) *Sula dactylatra*

The **Masked Booby** is one of the rarest seabirds nesting in the Cook Islands. There is a small but persistent colony on Suvarrow, which sometimes contains up to about 20 nests.

In April 1986 the author saw a **Masked Booby** beside a nest on the north side of Takūtea which was later deserted - probably because of accidental human interference. A juvenile was also seen flying over the island. Unfortunately, there was no evidence of **Masked Booby** nesting during the 1989 and 1990 visits.

This species has a name only on Pukapuka, where it is known as the **Lulu**.



Kākāia (White Tern) *Gygis alba*

and **Ngōio (Brown Noddy)** *Anous stolidus*

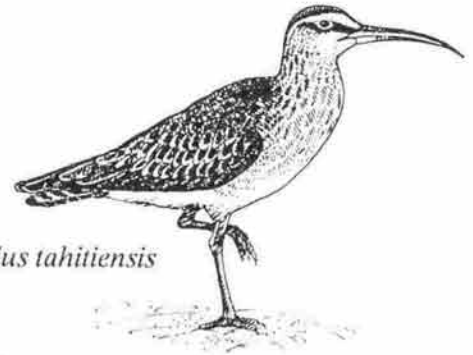
Neither of these common species develop compact nesting colonies. They nest on most islands of the Cook Islands, and are relatively tolerant of human interference.

Although no specific effort was made to assess the populations of these species it should be noted in passing that both nest in moderate numbers in trees on Takūtea.



Teue (Bristle-thighed Curlew) *Numenius tahitiensis*

This species nests during the northern summer in Alaska and "winters" the northern winter (the southern summer) on islands in the Pacific. Recent studies indicate that the total breeding population may consist of less than 7,000 pairs, and that the species could become "at risk" of extinction.



The species is seen in small numbers on the Northern Group atolls, and it is rare on the inhabited islands of the Southern Group, with the exception of Palmerston atoll where they are quite common. On each of the three visits to Takūtea the author estimated flocks of between 50 and 200 birds, making the island one of the most important curlew areas within the Cook Islands.

Unfortunately the best time to study the seabirds, namely July, is not the ideal time to study the curlews. Most adult curlews would be on Takūtea from October to April, while those present during the curlew breeding season (the southern winter) would typically be one-year-old birds.

Nevertheless, on all future visits every effort should be made to estimate the number of curlews and to look carefully for colour-bands on their legs. The colour-bands combinations should be carefully recorded and sent to Robert E. Gill, Jr., Biologist, U.S. Fish and Wildlife Service, 1011 E. Tudor Road, Anchorage, ALASKA 99503, U.S.A.

Unga Kaveu (Coconut Crab) *Birgus latro*

Gastropod shells, especially of the 'Ariri (Rough Turban, *Turbo setosus*), are typically used by adult terrestrial hermit-crabs to protect their abdomens. While **Unga Kaveu (Coconut Crab)** are in the same family as the hermit-crabs, they do NOT use gastropod shells, except for when they are thumbnail-sized.

The most reliable method of estimating the age of a coconut crab is the length of its thoracic groove (TG), and some important growth stages include:

10mm TG Maximum size of crabs using gastropod shell (about 3 years old)

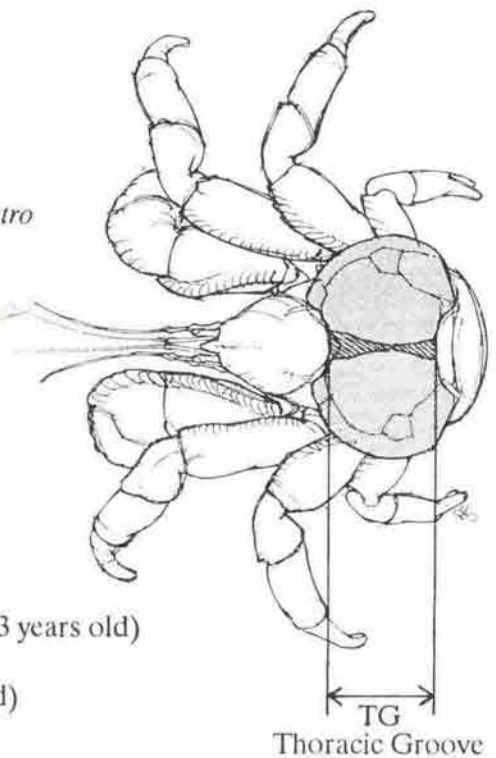
30mm TG Smallest sexually mature female (about 7 years old)

40mm TG Most females are sexually mature (about 12 years old)

50mm TG Largest females (about 40 years old)

80mm TG Largest males (about 40 years old)

(During the 1990 visit one crab had a 78mm Thoracic Groove)



Unga Kaveu breed during the summer months when mature females may each develop 50,000 to 150,000 eggs. They carry the developing eggs under their abdomens for about 4 weeks and then release them in the sea, where they immediately hatch into free-swimming larvae. Typically egg-release occurs at night within three days of new moon near the time of high tide. It is thought that egg-release at this time gives the larvae the best chance of avoiding predators on the reef-flat, and of being washed out to sea.

The oceanic larvae develop through four stages during the next four weeks before turning into the amphibious stage (glaucothoe) which inhabit minute gastropod shells and migrate to the beaches to live in the sand along the high tide mark. After about four weeks in the amphibious stage they develop into juvenile coconut crabs, which look like adults except that they protect their abdomens with small gastropod shells. The juveniles grow in spurts by changing their exoskeleton and when still very small (5-10mm Thoracic Groove) they abandon the protective shells and move landward.

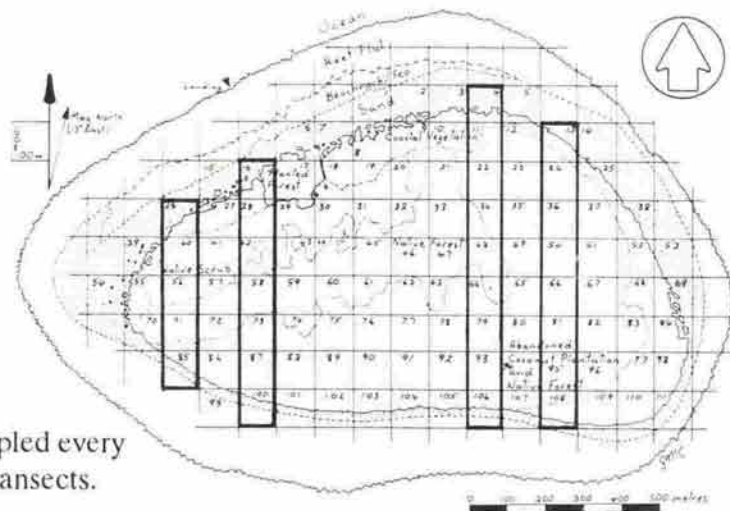
Although female crabs produce enormous numbers of eggs, most of the larvae die at sea, and of the few which return to the sandy beaches, most die young. This very low level of recruitment, coupled with slow maturation (about 10 years), makes the species very vulnerable to over-exploitation.

Some Pacific countries realising that coconut crabs are easily over-exploited have started to implement regulations to control harvesting. The regulations usually include protection during the reproductive season (southern summer) and protection of young crabs (under 45mm Thoracic Groove).

Recommendation

It is recommended that the students carry out a thorough survey of the **Unga Kaveu (Coconut Crab)** on Takūtea, as a basis for future conservation regulations. In the meantime, the Trustees should consider prohibiting the killing of female crabs.

Vegetation



1989:

The vegetation was sampled every 100 metres along four transects.

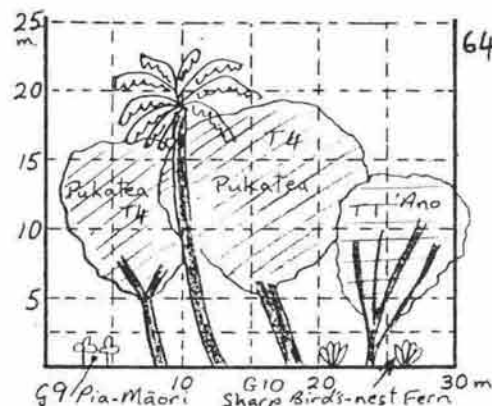
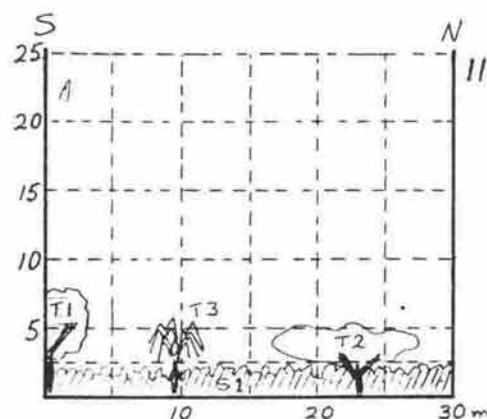
Typical samples of the two dominant plant communities were as follows:

1. Nga'u Teatea* - Tau'unu Scrubland

Extensive Nga'u Teatea* (White Half-flower, S1) scrub with interspersed areas of scrubby Kōpara (Timonius), Kōpū Varu (Native Chaff-flower) and Totototo (Beach Spurge). The scattered trees were usually Tau'unu (Heliotrope Tree, T1) and 'Ara Tai (Pandanus Tree, T3).

2. Pukatea - 'Ano - Nū Forest

Pukatea (Pisonia, T4), 'Ano (Guettarda, T1) and Nū (Coconut Palm) were dominant trees in the mixed forest which covered about half the island. In more open areas Kōpara (Timonius), Kōpū Varu (Native Chaff-flower), Totototo (Beach Spurge) and Nga'u Teatea* (White Half-flower) formed a scrubby ground-cover. In areas with a complete canopy, the ground-cover was more scattered and often included Pia Māori (Polynesia Arrowroot, G9), Kōta'a Tua-koi* (Sharp Bird's-nest Fern, G10), Tūroutou Nui* (Coarse Sword-fern) and Tūrei Mangamanga (Unscented Maire).



The abundance of each species in terms of their frequency of occurrence in the 27 samples were as follow:

Trees

67% Pukatea (*Pisonia*, *Pisonia grandis*), 63% 'Ano (*Guettarda*, *Guettarda speciosa*), 56% Nū (Coconut Palm, *Cocos nucifera*), 26% 'Ara Tai (Pandanus Tree, *Pandanus tectorius*), 26% Tau'unu (Heliotrope Tree, *Tournefortia argentea*), 7% Puka (Lantern Tree, *Hernandia nymphaeifolia*), 4% Nono (Indian Mulberry, *Morinda citrifolia*), 4% 'Orongā (*Pipturus*, *Pipturus argenteus*), and small patches of Tamanu (Pacific Mahogany, *Calophyllum inophyllum*), 'Au (Tree Hibiscus, *Hibiscus tiliaceus*) and 'Utu (Fish-poison Tree, *Barringtonia asiatica*).

Shrubs, herbs and ferns

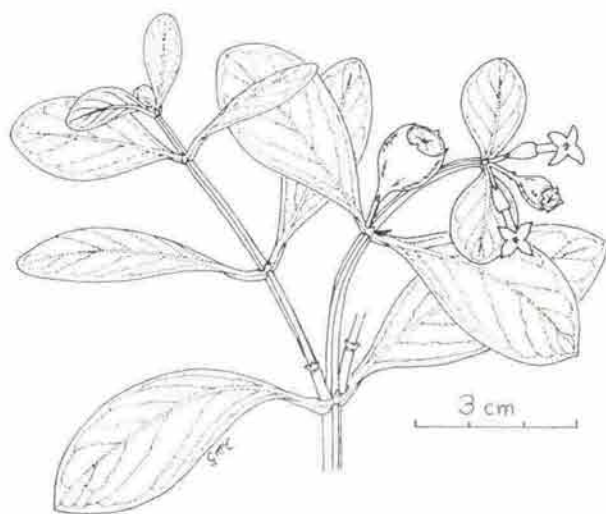
37% Kōta'a Tua-koi* (Sharp Bird's-nest Fern, *Asplenium australasicum*), 30% Kōpū Varu (Native Chaff-flower, *Achyranthes velutina*), 30% Nga'u Teatea* (White Half-flower, *Scaevola sericea*), 26% Kōpara (Black-fruit Shrub, *Timonius polygamus*), 19% Tūroutou Nui* (Coarse Sword-fern, *Nephrolepis biserrata*), 19% Ngau¹ (Triumfetta Vine, *Triumfetta procumbens*), 19% Pia Māori (Polynesia Arrowroot, *Tacca leontopetaloides*), 19% Naunau (Native Peppergrass, *Lepidium bidentatum*), 14% Tūrei Mangamanga (Unscented Maire, *Phymatosorus grossus*), 11% Tainoka (Cassytha, *Cassytha filiformis*), 11% Totototo (Beach Spurge, *Chamaesyce atoto*), 7% Runa (Pink Boerhavia, *Boerhavia tetrandra*), 7% Mokopito (Heliotrope Flower, *Heliotropium anomalum*), 7% Bird's-beak Grass (*Thuarea involuta*), 4% Kēketa (Beach Pea, *Vigna marina*), and 4% Grand Morning-glory (*Ipomoea violacea*). Plants found in relatively small restricted areas included: Ngangie (Pemphis, *Pemphis acidula*), Ngangie Akamoe² (Suriana, *Suriana maritima*), Puā'utu (Capparis, *Capparis cordifolia*), Lepturus Grass (*Lepturus repens*), Love Grass (*Eragrostis tenella*), Hairy Spurge (*Chamaesyce hirta*) and Piripiri (Beggar's-ticks, *Bidens pilosa*).

1: Ngau is a Ma'uke name. 2: Ngangie Akamoe is a Miti'āro name.

Romanzoff Shrub (*Hedyotis romanzoffianus*)

During 1990 the **Romanzoff Shrub** was found along the northern edge of the island, in a similar place to its location during 1986. This shrub is not found on any other island in the Southern Cooks, and is rare in the Northern Cooks.

The **Romanzoff Shrub** belongs to the Gardenia Family and is similar in appearance to the very common **Kōpara** (Black-fruit Shrub) found throughout Ngāpūturu and on Takūtea. The only traditional name recorded for the **Romanzoff Shrub** is **Polopolo** on Pukapuka, a cognate of **Porō** which on most islands refers to the weedy **Black Nightshade** (*Solanum americanum*). However, on 'Ātiu **Porō** refers to the **Garland Redberry** (*Solanum viride* 'Anthropophagorum'), a cultivated plant with red fruit used in garlands ('ei).



Two species of bird's-nest fern

The other special find on Takūtea during 1990 was the **Kōta'a Tua-rua** (Smooth Bird's-nest Fern, *Asplenium nidus*), which was found near the **Great Frigatebird** colony. The common and widespread bird's-nest fern on Takūtea is the **Kōta'a Tua-koi*** (Sharp Bird's-nest Fern, *Asplenium australasicum*).

The name **Kōta'a Tua-rua** is a traditional name from Mangaia referring to the double-sided projection of the midrib of *Asplenium nidus*, while the name **Kōta'a Tua-koi*** has been affixed to refer to the sharp underside of the midrib of *A. australasicum*.



Recommendation

That a single team should more-fully survey the vegetation and map the extent of the different plant communities. Enlarged, coloured, aerial photographs have been obtained to facilitate this activity on a future visit.

Annex:

Measuring the Rate of Egg-laying in Seabird Colonies.

Introduction

The most important information to obtain about a seabird colony is the number of birds laying eggs at each time of the year, i.e. the rate of egg-laying. This information is difficult to obtain for seabird colonies which live on remote, rarely-visited islands, such as Takūtea and Suwarrow.

The first task during a visit, is to make an estimate of the total number of active nests for each species. In doing this, it is important that the sampling method for each species allow for the varying density of nests in different parts of the colony.

This paper describes a system to estimate the ages of a hundred nestlings from their feather development. When this data is combined with the estimated number of nests active during the visit, we can estimate the minimum rate of egg-laying for several months BEFORE the visit. The estimate is a minimum because an unknown number of eggs or nestlings may have been destroyed before the time of the visit.

The method has been simplified so it can be used by a wide range of people including college students, and standardised so that the data collected by different groups at different times is comparable.

History and Development

In 1962 Dorward collected detailed information on the plumage stages of **Brown Booby** and **Masked Booby** nestlings on Ascension Island. He suggested that "This scheme could be used for making a quick estimation of the age-composition of the chicks in a colony Thus an approximate date of a laying peak could be calculated more precisely than from vague records such as 'mostly well-grown chicks'." In 1963, Stonehouse and Stonehouse used eight plumage stages of **Ascension Frigatebird** nestlings to construct a graph of the rate of egg-laying over two breeding seasons. In 1969 Cameron Kepler prepared graphs of the egg-laying of the **Masked Booby** colony on Kure Atoll in the Hawaiian Leeward Chain.

In 1978 Cameron Kepler used the data available on the rates of development to estimate the rate of egg-laying for several species on Monito Island in Puerto Rico. He also used the system on Jarvis Islands (1984) and Caroline Island (1990).

The system described here, based on that of Kepler, has been simplified and standardised as follows:

- a. The days of each plumage stage have been rounded into weekly intervals to simplify the calculations. This is realistic in that the exact duration of each stage is dependent on the availability of food, and the judgement of the end-points of stages is not exact.
- b. A single system is used for the three booby species. The main difference being that the tree-nesting **Red-footed Booby** spends less than a week as a non-flying juvenile, while the larger, ground-nesting species spend two weeks in this stage.
- c. A single system is used for the two frigatebird species. At present there is insufficient data to indicate that these two similar-sized species should be treated differently.
- d. The growth stages are illustrated to make recognition easier. As in the tables and graphs, the growth stages are sequenced right to left, because the stages are interpreted looking back in time from the survey date: old nestlings were laid further back in time than younger ones.
- e. The method of processing the raw data and relating it to the estimated breeding population at the time of the visit has been standardised in a Calculation Table.

- f. Standardised graph formats have been prepared for the three groups of seabirds on Takūtea.

Method

1. Record the age-stage of the eggs or nestlings in 100 nests. Watch for the clumping of age-groups within the colony and sample to avoid bias in your analysis. Don't hesitate to take several 100-nest samples in different parts of the colony or island.

Within the table use the codes from the tops of the columns to show the stage. Do NOT use "ticks" or "crosses". When there is more than one egg or nestling record the age-stage of the oldest individual ONLY. If you are also interested in the number of young in each nest you can jot this to the right of the "EGG" column.

See Figure 1 for the details of the age-stages for each group of seabirds, and Figure 2 for a completed sample worksheet.

2. a) Add the number of nests in each age-stage column to obtain a subtotal at the bottom of each. Note: where a nest had more than one young, only the oldest is counted.
b) Add the subtotals to obtain the totals for each age-stage in the Calculation Table.
3. If you recorded the age-stage of EVERY nest in the colony, proceed to step 4 below. If not, multiply the number in each age-stage in the sample by the estimated total number of nests and divide by the number of nests sampled.
4. Divide each age-stage total by the length of the stage in WEEKS to obtain a measure of the RATE OF EGG-LAYING for the stage, in CLUTCHES PER WEEK for the whole colony.
5. Select a suitable vertical scale for the graph and make a bar graph to show the rate of egg-laying throughout the months BEFORE YOUR VISIT. If the colony has been previously surveyed use the same vertical scale to enable direct visual comparison of the graphical results. A horizontal scale of DAYS (in 2-day intervals) is provided to enable you to construct a horizontal scale of the months before your particular survey date.

Literature Cited

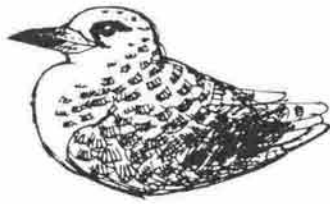
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Figure 1: Details of the age-stages.

Red-tailed Tropicbird

Total for all stages: 19 weeks

Egg(s): LASTS: 6 weeks. Code: E.



Juvenile

Down feathers gone except for wisps on neck, lower back and flanks.

Not yet flying.

LASTS: 6 weeks.

Code: J.



Wings or Tail

Dark tail-feathers or primary wing-feathers (on outer section) visible.

LASTS: 3 weeks.

Code: W.



Scapulars

Dark scapular (shoulder) feathers visible above down feathers. Dark wing and tail feathers NOT visible.

LASTS: 2 weeks.

Code: S.



Down Feathers Only

partly or completely covered in white down feathers. Dark shoulder feathers NOT visible.

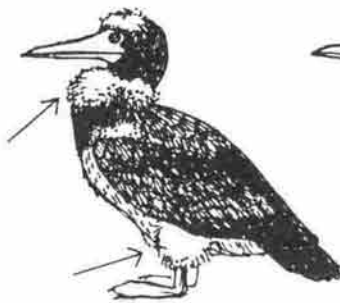
LASTS: 2 weeks.

Code: D.

Boobies

Total for all stages: 23 weeks

Egg(s): LASTS: 6 weeks. Code: E.



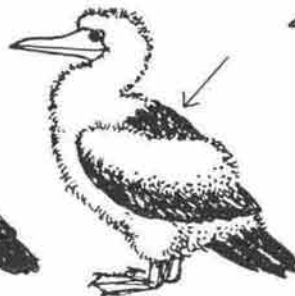
Juvenile

A few down feathers may persist on the neck, flanks and forward angle of the wing.

Not yet flying.

LASTS: 2 weeks.

Code: J.



Scapulars

Dark scapular (shoulder) feathers visible above down feathers.

LASTS: 5 weeks.

Code: S.



Wings or Tail

Dark wing-feathers visible outside down feathers. Tail feathers visible later during this stage.

LASTS: 5 weeks.

Code: W.



Down Feathers Only

Partly or completely covered in white down feathers. No dark feathers visible.

LASTS: 4 weeks.

Code: D.



Naked

Without any down feathers.

LASTS: 1 week.

Code: N.

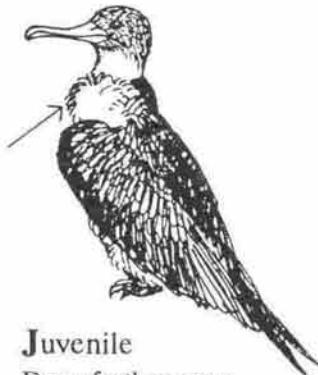
Frigatebirds

Total for all stages: 31 weeks

Egg(s): if adult is sitting on nest DO NOT DISTURB. Record it as an E.

LASTS: 8 weeks (egg 7 weeks and naked nestling 1 week)

Note: If the first two stages are indistinct, record the chicks as SQUATTING (↓) or STANDING (↑), which may approximate the two stages.



Juvenile

Down feathers gone except for on the throat and breast.

Not yet flying.

LASTS: 5 weeks.

Code: J.



Wings or Tail

Dark wing-feathers or tail-feathers visible above down feathers.

LASTS: 12 weeks.

Code: W.



Scapulars

Dark scapular (shoulder) feathers visible above down feathers. Wing and tail feathers NOT visible.

LASTS: 3 weeks.

Code: S.



Down Feathers Only

Partly or completely covered in white down feathers. No dark feathers visible above the down feathers.

LASTS: 3 weeks.

Code: D.

Figure 2: A completed sample worksheet for the Red-tailed Tropicbird.

Rate of Egg-laying Worksheet (Tropicbirds)

Species RED-TAILED

Observer(s) Anna + team.

Island Takūtea

Date 5 Sept. 1990

Weather Sunny.

Time: start 08.00 finish 11.30hrs

	Juvenile	Wings or Tail	Scapulars	Down only	Egg
	J	W	S	D	E
1	J				
2		W			
3					E
4	J				
5	J				
6	J				
7	J				
8	J				
9	J				
10					E
11					E
12	J				
13					E
14	J				
15					E
16					E
17					E
18					E
19	J				
20	J				
21					E
22	J				
23			S		
24				D	
25	J				
Sub-total	13	1	1	1	9

	J	W	S	D	E
26	J				
27	J				
28		W			
29		W			
30	J				
31	J				
32					E
33	J				
34	J				
35					E
36	J				
37					E
38	J				
39					E
40				D	
41	J				
42				D	
43					E
44	J				
45	J				
46	J				
47	J				
48	J				
49					E
50			S		
Sub-total	14	2	1	2	6

	J	W	S	D	E
51	J				
52	J				
53			S		
54			S		
55		W			
56					E
57	J				
58	J				
59	J				
60	J				
61			S		
62			S		
63	J				
64	J				
65	J				
66	J				
67		W			
68				D	
69				D	
70	J				
71			S		
72					E
73			S		
74	J				
75		W			
Sub-total	12	3	6	2	2

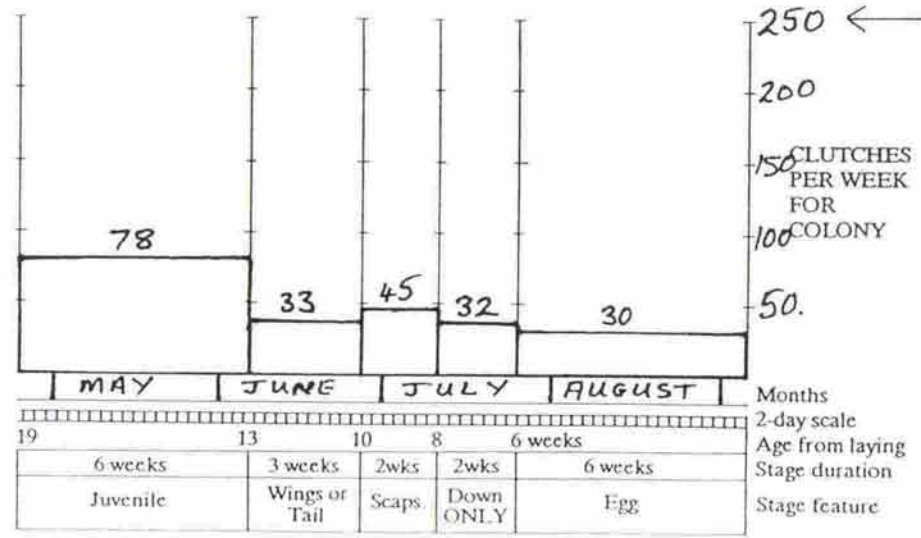
	J	W	S	D	E
76	J				
77					E
78	J				
79	J				
80				D	
81					E
82					E
83				D	
84		W			
85		W			
86	J				
87	J				
88	J				
89		W			
90	J				
91			S		
92			S		
93	J				
94	J				
95		W			
96	J				
97	J				
98	J				
99	J				
100		W			
Sub-total	13	5	2	2	3

← Step 1
← Step 2a

If POPULATION of active nests is greater than the SAMPLE, give estimated total here:
 14 perimeter plots = 68 nests
 Total est. perimeter = 721
 + 0.25 interior nests
 Grand Total = 901 nests.

	J	W	S	D	E
TOTALS for each age-stage in SAMPLE	52	11	10	7	20
If POPULATION is greater than SAMPLE $\times \frac{\text{POPULATION}}{\text{SAMPLE}} = \frac{901}{52} = \times 9.01$	469	99	90	63	180
÷ (WEEKS for each age-stage)	6	3	2	2	6
= CLUTCHES PER WEEK FOR COLONY	78	33	45	32	30

← Step 2b
← Step 3
← Step 4



Rate of Egg-laying Worksheet (Tropicbirds)

Species _____

Observer(s) _____

Island _____

Date _____

Weather _____

Time: start _____

finish _____

	Juvenile	Wings or Tail	Scapulars	Down only	Egg
	J	W	S	D	E
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					
21					
22					
23					
24					
25					
Sub-total					

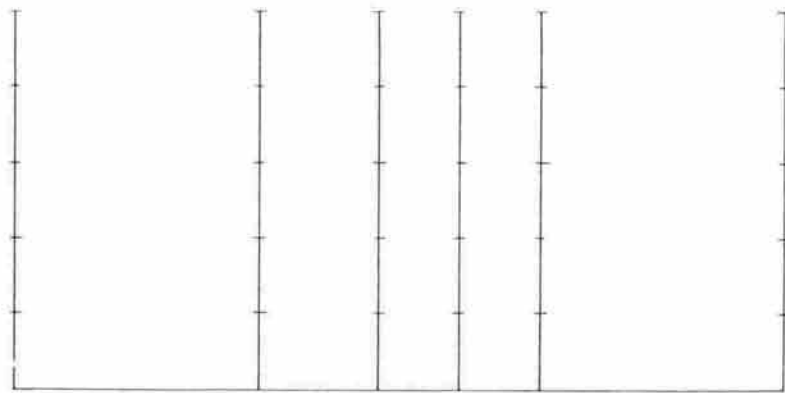
	J	W	S	D	E
26					
27					
28					
29					
30					
31					
32					
33					
34					
35					
36					
37					
38					
39					
40					
41					
42					
43					
44					
45					
46					
47					
48					
49					
50					
Sub-total					

	J	W	S	D	E
51					
52					
53					
54					
55					
56					
57					
58					
59					
60					
61					
62					
63					
64					
65					
66					
67					
68					
69					
70					
71					
72					
73					
74					
75					
Sub-total					

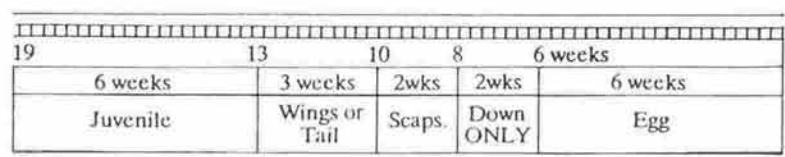
	J	W	S	D	E
76					
77					
78					
79					
80					
81					
82					
83					
84					
85					
86					
87					
88					
89					
90					
91					
92					
93					
94					
95					
96					
97					
98					
99					
100					
Sub-total					

If POPULATION of active nests is greater than the SAMPLE, give estimated total here:

	J	W	S	D	E
TOTALS for each age-stage in SAMPLE					
If POPULATION is greater than SAMPLE					
x $\frac{\text{POPULATION}}{\text{SAMPLE}} =$					
÷ (WEEKS for each age-stage)	6	3	2	2	6
= CLUTCHES PER WEEK FOR COLONY					



CLUTCHES PER WEEK FOR COLONY



Months
2-day scale
Age from laying
Stage duration
Stage feature

Rate of Egg-laying Worksheet (Boobies)

Species _____

Observer(s) _____

Island _____

Date _____

Weather _____

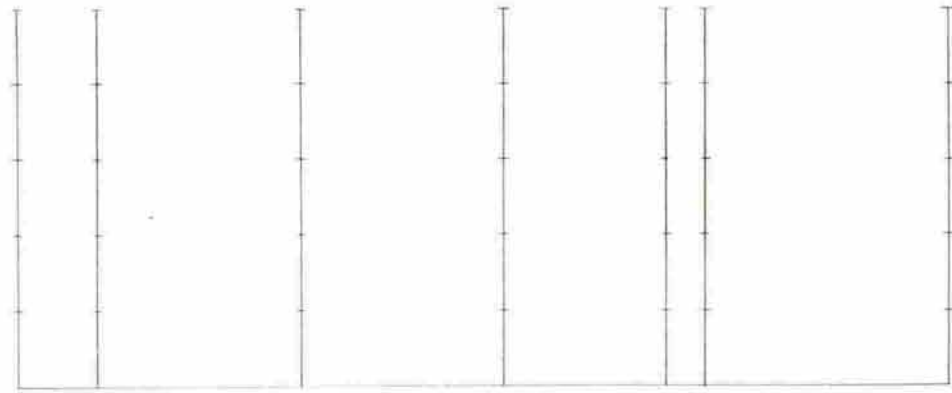
Time: start _____

finish _____

	Juvenile	Scapulars	Wings or Tail	Down only	Naked	Egg		J	S	W	D	N	E		J	S	W	D	N	E		J	S	W	D	N	E
1							26							51							76						
2							27							52							77						
3							28							53							78						
4							29							54							79						
5							30							55							80						
6							31							56							81						
7							32							57							82						
8							33							58							83						
9							34							59							84						
10							35							60							85						
11							36							61							86						
12							37							62							87						
13							38							63							88						
14							39							64							89						
15							40							65							90						
16							41							66							91						
17							42							67							92						
18							43							68							93						
19							44							69							94						
20							45							70							95						
21							46							71							96						
22							47							72							97						
23							48							73							98						
24							49							74							99						
25							50							75							100						
Sub-total							Sub-total							Sub-total							Sub-total						

If POPULATION of active nests is greater than the SAMPLE, give estimated total here:

	J	S	W	D	N	E
TOTALS for each age-stage in SAMPLE						
If POPULATION is greater than SAMPLE						
$\times \frac{\text{POPULATION}}{\text{SAMPLE}} =$						
\div (WEEKS for each age-stage)	2	5	5	4	1	6
= CLUTCHES PER WEEK FOR COLONY						



CLUTCHES PER WEEK FOR COLONY

23	21	16	11	7	6 weeks
2 wks	5 weeks	5 weeks	4 weeks	1w	6 weeks
Juven.	Scapulars	Wings or Tail	Down ONLY	Naked	Egg

Months
2-day scale
Age from laying
Stage duration
Stage feature 19

Rate of Egg-laying Worksheet (Frigatebirds)

Species _____

Observer(s) _____

Island _____

Date _____

Weather _____

Time: start _____ finish _____

	Juvenile	Wings or Tail	Scapulars	Down only	Egg/Naked
	J	W	S	D	E
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					
21					
22					
23					
24					
25					
Sub-total					

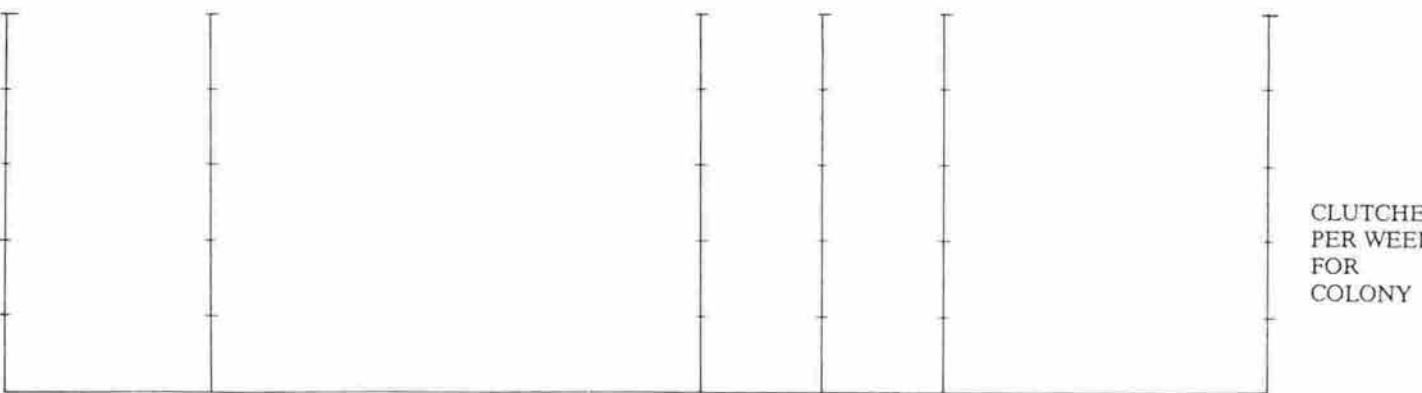
	J	W	S	D	E
26					
27					
28					
29					
30					
31					
32					
33					
34					
35					
36					
37					
38					
39					
40					
41					
42					
43					
44					
45					
46					
47					
48					
49					
50					
Sub-total					

	J	W	S	D	E
51					
52					
53					
54					
55					
56					
57					
58					
59					
60					
61					
62					
63					
64					
65					
66					
67					
68					
69					
70					
71					
72					
73					
74					
75					
Sub-total					

	J	W	S	D	E
76					
77					
78					
79					
80					
81					
82					
83					
84					
85					
86					
87					
88					
89					
90					
91					
92					
93					
94					
95					
96					
97					
98					
99					
100					
Sub-total					

If POPULATION of active nests is greater than the SAMPLE, give estimated total here:

	J	W	S	D	E
TOTALS for each age-stage in SAMPLE					
If POPULATION is greater than SAMPLE $x \frac{\text{POPULATION}}{\text{SAMPLE}} =$					
\div (WEEKS for each age-stage)	5	12	3	3	8
= CLUTCHES PER WEEK FOR COLONY					



31	26	14	11	8	7 weeks
5 weeks	12 weeks	3 weeks	3 weeks	1w	7 weeks
Juvenile	Wings or Tail	Scapulars	Down ONLY	Naked	Egg
DO NOT DISTURB					

Months
2-day scale
Age from laying
Stage duration
Stage feature

