

Tetiaroa Rat and Seabird Survey

7th – 13th July 2009

James Russell and Lucie Faulquier
University of California – Berkeley and
Société d'Ornithologie de Polynésie MANU

Summary

Four scientists visited Tetiaroa from July 7-13. The goal of this scientific mission was to determine the species and distribution of introduced rats on all motu, and monitor the status of breeding seabirds. Relict populations of Polynesian rats were found on most motu, being over-invaded by black rats on the north-western motu. Seabird colonies were generally associated with-rat free motu; small seabirds such as noddies and terns only breeding on rat-free motu, although larger seabirds such as frigates and boobies breed on rat-invaded motu. Introduced cats and rats are being eradicated from Onetahi, although rat reinvasion from Honuea is likely. Red-vented bulbuls were recorded for the first time on Tetiaroa. Introduced species are a major threat to Tetiaroa, and are most likely to arrive via Onetahi/Honuea, Rimatuu and Hiraanae. Polynesian rats should be eradicated from Reiono as soon as possible to facilitate seabird recovery, and both rat species should be eradicated from Honuea to prevent reinvasion of Onetahi. Biosecurity protocols are required to prevent new species arriving at Tetiaroa, or moving between motu. Some level of regulation on eco-tourism to Tahuna Iti ('bird island') should be introduced.

Introduction

Tetiaroa atoll (3366 ha; ; 17°05'S, 149°30'W), lies 50km north of Moorea and Tahiti in the Society Islands of French Polynesia (Fig. 1). The atoll consists of 12 vegetated motu (Fig. 2; Table 1) and an emerging sandbank (Motu One) east of Tahuna Iti, circling a large lagoon. Names of motu vary among reports and we follow the most recent consensus.

Table 1: Motu sizes.

Motu	Size (ha)
Onetahi	73.8
Honuea	28.0
Tiaruanu	163.4
Tauini	6.7
Auroa	3.9
Hiraanae	34.0
Oroatera	81.4
Aie	2.4
Reiono	21.4
Tahuna Rahi	0.5
Tahuna Iti	5.9
Rimatuu	88.3

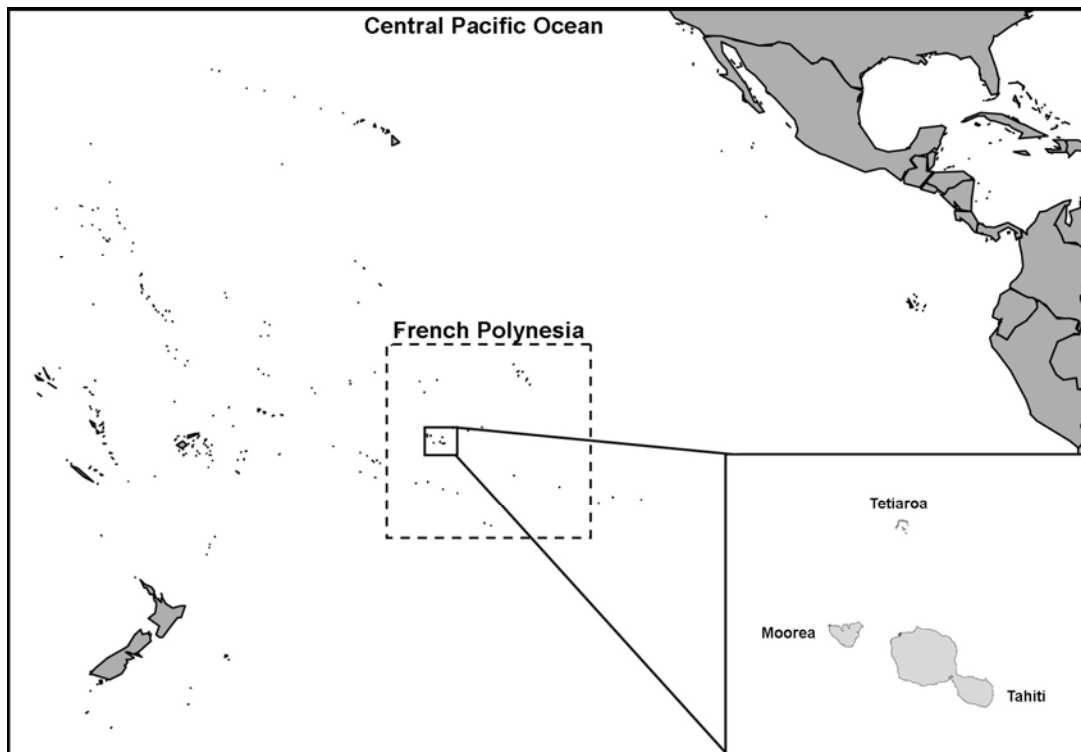


Figure 1: Tetiaroa 50km north of Moorea and Tahiti in the Society Islands of French Polynesia.

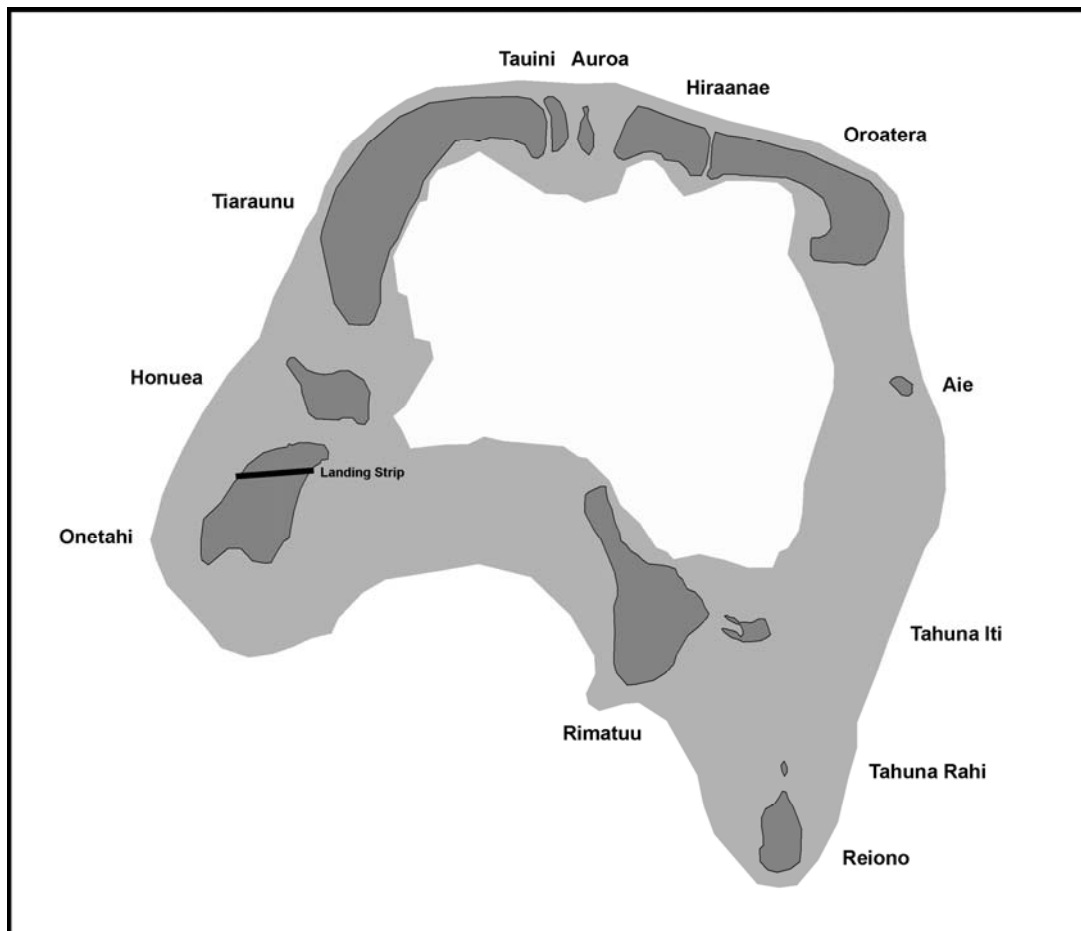


Figure 2: The 12 motu of Tetiaroa. Tahuna Iti is colloquially named the 'bird island'.

Archaeological sites from Polynesian activity are located across Tetiaroa. The first Europeans to 'discover' the atoll were three deserters from the H.M.S. Bounty in 1789 during the ship's 23 week stay in Tahiti. In 1904 King Pomare V gave the island to Canadian dentist Johnston Walter Williams. Dr. Williams found the island full of rats and introduced cats for their control, while developing coprah plantations across the atoll managed from a small village of workers on Rimatuu. When he died in 1937 his daughter, Madame Duran, inherited the atoll and continued to live on Rimatuu. In 1961 the actor Marlon Brando looked into buying the atoll, but the Williams family wasn't ready to sell. In 1965 they capitulated and, after obtaining government approval, Brando paid 17,492,000 French Pacific francs for most of Tetiaroa on October 17 1966 and bought the remainder the following January. The deal gave him only the terrestrial component of Tetiaroa, leaving the lagoon and the reef in the public domain. Brando transferred operations from Rimatuu to Onetahi, and in 1971 hired an architect, Bernard Judge, to build a small 'eco-hotel', meeting with scientists at the Smithsonian Institution in late 1972 to discuss his proposed development. Judge erected 13 modest thatched fares and Hotel Tetiaroa Village opened for business with its dozen bungalows on Onetahi in March 1973. Brando lived on the island occasionally until 1990, and died on July 1 2004 passing ownership to the Brando Trust through his estate. In 2005 a building permit was issued to Tahiti Beachcomber SA to develop 40 'eco-friendly' hotel units in the spirit of Marlon Brando's originally envisioned eco-hotel. Construction began in 2006 and was ongoing in 2009.

Scientists visited Tetiaroa throughout the 20th century. Ernest Quayle collected specimens from 19-21 November 1921 on the Whitney expedition (Quayle 1922). The archaeology was assessed in the early 1960s (exact date unrecorded) by Pierre V erin, Raoul Tessier and Henri Picard (V erin 1962) and in December 1972 by Yosihiko Sinoto and Patrick McCoy (Sinoto and McCoy 1974). The avifauna (predominantly seabirds) was assessed from 1972-1975 by Jean-Claude Thibault (Thibault 1976), and in 1992-1993 by Philippe Raust and Albert Varney (Raust and Varney 1992; Raust 1993). The ecology of the atoll, focusing on vegetation, was assessed by Marie-H el ene Sachet and Francis Raymond Fosberg in 1973-1975 and 1982-1983, resulting in an exhaustive plant list for each motu (Sachet and Fosberg 1983). Further botanical visits and a revised plant list were made by Jean-Fran ois Butaud in 2003 and 2006 (Butaud 2006). In March 2006, as part of the proposed 'eco-hotel' development, a multi-disciplinary team of scientists visited the island (Butaud 2006; Salducci 2006) and a literature synthesis of the ecology of Tetiaroa was undertaken (S.N.C. Pae Tai - Pae Uta 2006).

Rats

Despite the scientific missions of the 20th century the distribution and species of rat(s) on Tetiaroa have never been properly verified beyond casual observations. In the 1960s only Polynesian rats (*Rattus exulans*) were described on the atoll, but a tree-dwelling species (presumably black rats *R. rattus*) exploded in numbers 'recently' in the 1970s. We determined the species of rat present on each motu through a combination of kill-trapping, observation, and inference based upon the presence of breeding seabirds (Table 2; Fig. 3).

Table 2: Distribution of rat species on Tetiaroa. TN = trap nights.

Motu	<i>R. rattus</i>	<i>R. exulans</i>	TN
Onetahi	(✓)	✓	30
Honuea	✓	✓	45
Tiaraunu	✓	✓	50
Tauini	✓	✓	10
Auroa	✓	✓	15
Hiraanae	✓	✓	25
Oroatera	✓	✓	10
Aie	–	–	40
Reiono	–	✓	50
Tahuna Rahi	–	–	20
Tahuna Iti	–	–	75
Rimatuu	–	✓	65
Total	7	9	435

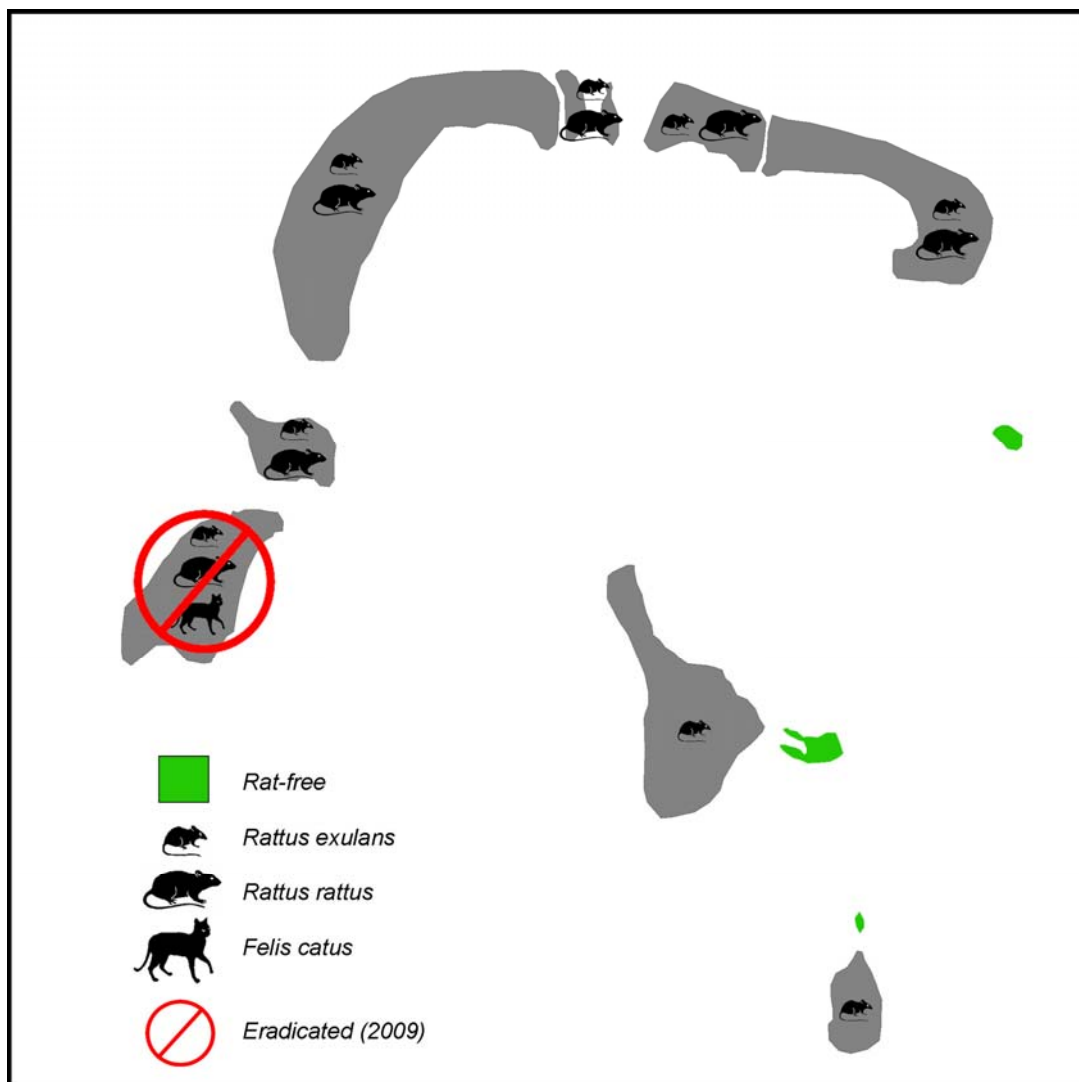


Figure 3: Distribution of introduced mammals on Tetiaroa (2009).

Cats were reportedly introduced to Tetiaroa after 1904 by Dr. Williams, however by the 1970s Jean-Claude Thibault found cats only remained on Onetahi. Fourteen semi-wild cats were removed from Onetahi in early 2009 by trapping. Rat eradication commenced in June 2009 with a grid of elevated bait stations and hand-spread wax baits. Only one juvenile Polynesian rat was trapped on Onetahi as the concurrent rat eradication program had substantially reduced rat numbers. Black rats were neither trapped nor observed on Onetahi but are assumed to have been present. Polynesian rats were observed in abundance in the late afternoon on Hiraanae and Oroatera but were not trapped. Where rats were absent, traps remained untriggered with their coconut bait intact.

Most rats caught were reproductively active adults, indicated by enlarged testes in males and uterine scars and/or embryos in females. At least 18% of rats trapped were missing part of their tails. Genetic samples were obtained from all rats trapped and will be used to determine the extent of gene-flow between motu (Fig. 4).

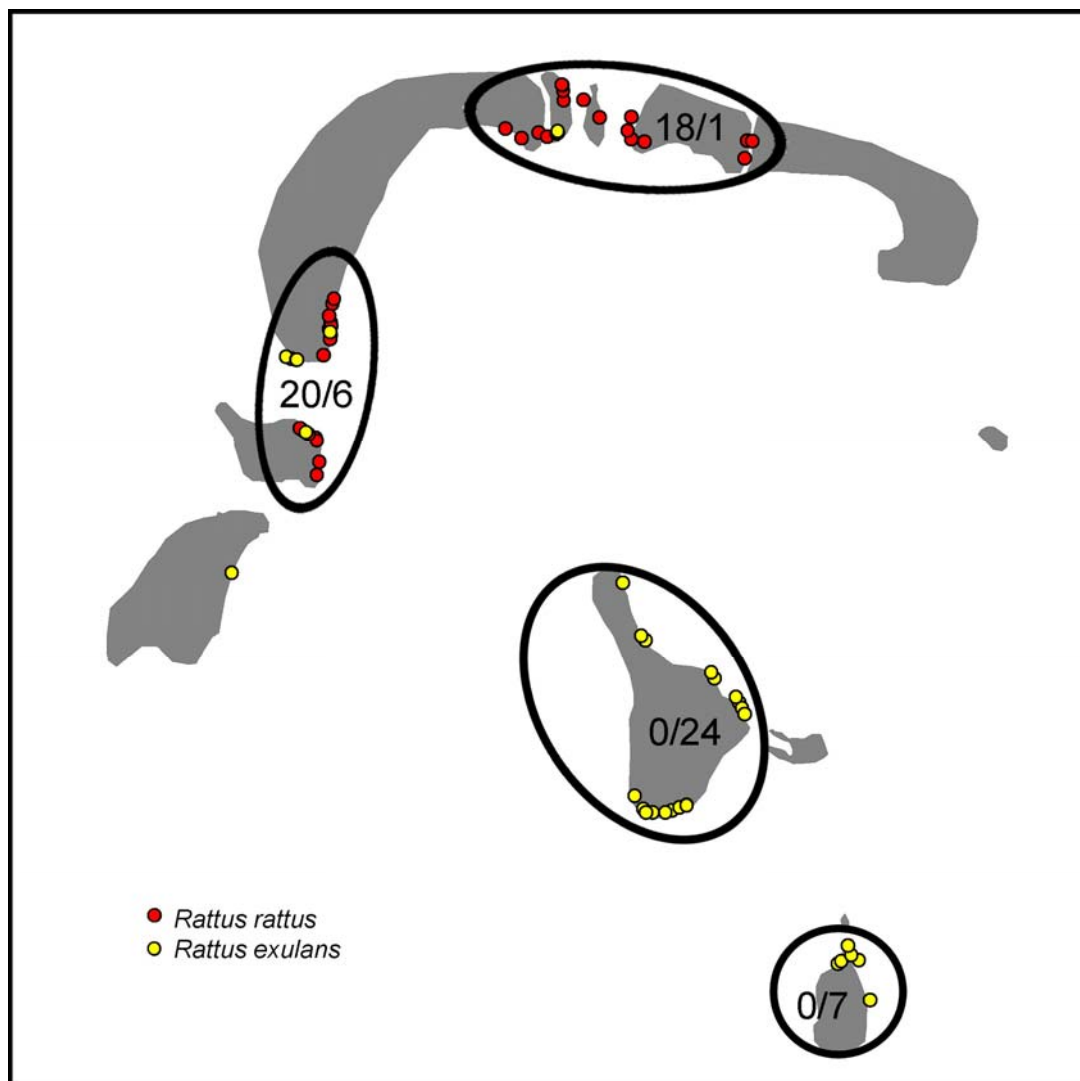


Figure 4: Trapping locations and genetic sample sizes (excluding Onetahi) for rats on Tetiaroa.

The populations of Polynesian rats (particularly on Rimatuu and Reiono) are likely to be relict populations with little genetic exchange for many centuries. Despite small channel crossings (tens of metres) Polynesian rats are apparently absent from both Motu Iti and Motu Rahi. Throughout the north-western motu black rats, as the larger and more dominant species, are over-invading Polynesian rats. These black rats are very large (Table 3), most likely benefiting from the abundance of fallen coconuts they open, and the presence of enhanced nutrient inputs under large seabird colonies. Black rats on Tetiaroa are likely to represent one large-meta-population. Eradication of black rats from only one motu will likely lead to their reinvasion rapidly (within years) from nearby motu. Over-invasion by black rats may also alter the behaviour, density and trophic level of Polynesian rats in food-webs.

Table 3: Average morphological measurements of adult Polynesian and black rats on Tetiaroa. HBL = head-body length, TL = tail length.

Species	Sex	<i>n</i>	Weight (g)	HBL (mm)	TL (mm)
<i>R. exulans</i>	M	10	77	150	152
	F	13	61	139	150
<i>R. rattus</i>	M	9	240	209	233
	F	14	192	206	233

Seabirds

The only well-documented bird survey of Tetiaroa was undertaken from 1972-1975 by Jean-Claude Thibault. Throughout all periods of the year he recorded the distribution and breeding status of seabirds on all motu (Table 4). We found colonies of small seabirds such as noddies and terns were only breeding on rat-free islets. Larger seabirds such as frigatebirds and boobies were breeding in the presence of either species of rat. On Tahuna iti and Tahuna rahi, which hold the largest number of seabirds, we did exhaustive counts for all seabird species except for brown noddies that were censused by 30 quadrats (5 × 5 m), and the total number of pairs was then estimated by extrapolation to the entire area of the motu (Table 5). All stages (adults incubating eggs, juveniles and small chicks) were present, except for *Sterna lunata* for which we only noted the presence of two juveniles. Since most of these species breed all-year round, numbers may differ at other times of the year. On other motu, we only recorded the presence of abundant species, generally on the lagoon-side (Fig. 5). Tahuna Iti ('Bird island' / « île aux oiseaux ») is a strong-hold for breeding seabirds (10 000 pairs of six species of seabirds) due to its combination of various habitats including some original forest and expansive coastal beaches, however it is vulnerable to invasion by Polynesian rats from neighbouring Rimatuu. The larger seabirds are most threatened by persistent human disturbance. We confirmed breeding of the grey-backed tern (*Sterna lunata*) (two juveniles on the beach of Tahuna iti). An unknown dead *Pterodroma* species was found on the eastern beach of Rimatuu. The Pacific reef egret (*Egretta sacra*) was wide-spread over all motu of the atoll. The migratory wandering tattler (*Tringa incana*) and Pacific golden-plover (*Pluvialis fulva*) were also common, and a single bristle-thighed curlew (*Numenius tahitiensis*) was seen on Aie.

Table 4: Distribution of seabirds on Tetiaroa (1972-1975)

Species	Onetahi	Honuea	Tiaraunu	Tauini	Auroa	Hiraanae	Oroatera	Aie	Tahuna	Tahuna	Motu	Reiono	Rimatuu
									Iti	Rahi	One		
<i>Sula leucogaster</i>									×	×			
<i>Sula sula</i>			×	×	×	×	×	×	×	×		×	
<i>Fregata minor</i>				×	×		×	×					
<i>Fregata ariel</i>								×					
<i>Sterna fuscata</i>									×				
<i>Sterna bergii</i>									×	×	×		
<i>Anous stolidus</i>	×	×	×	×	×	×	×	×	×	×	×	×	×
<i>Gygis alba</i>								×	×	×			

Table 5: Census counts of the numbers of pairs of seabirds on Tahuna Iti and Tahuna Rahi except for

* where extrapolated from 5 × 5 m quadrats

Species	Tahuna Iti	Tahuna Rahi
<i>Sula leucogaster</i>	24	1
<i>Sula sula</i>	26	44
<i>Anous stolidus</i> *	9912	640
<i>Onychoprion fuscatus</i>	15	0
<i>Sterna bergii</i>	29	0
<i>Sterna lunata</i>	2	0

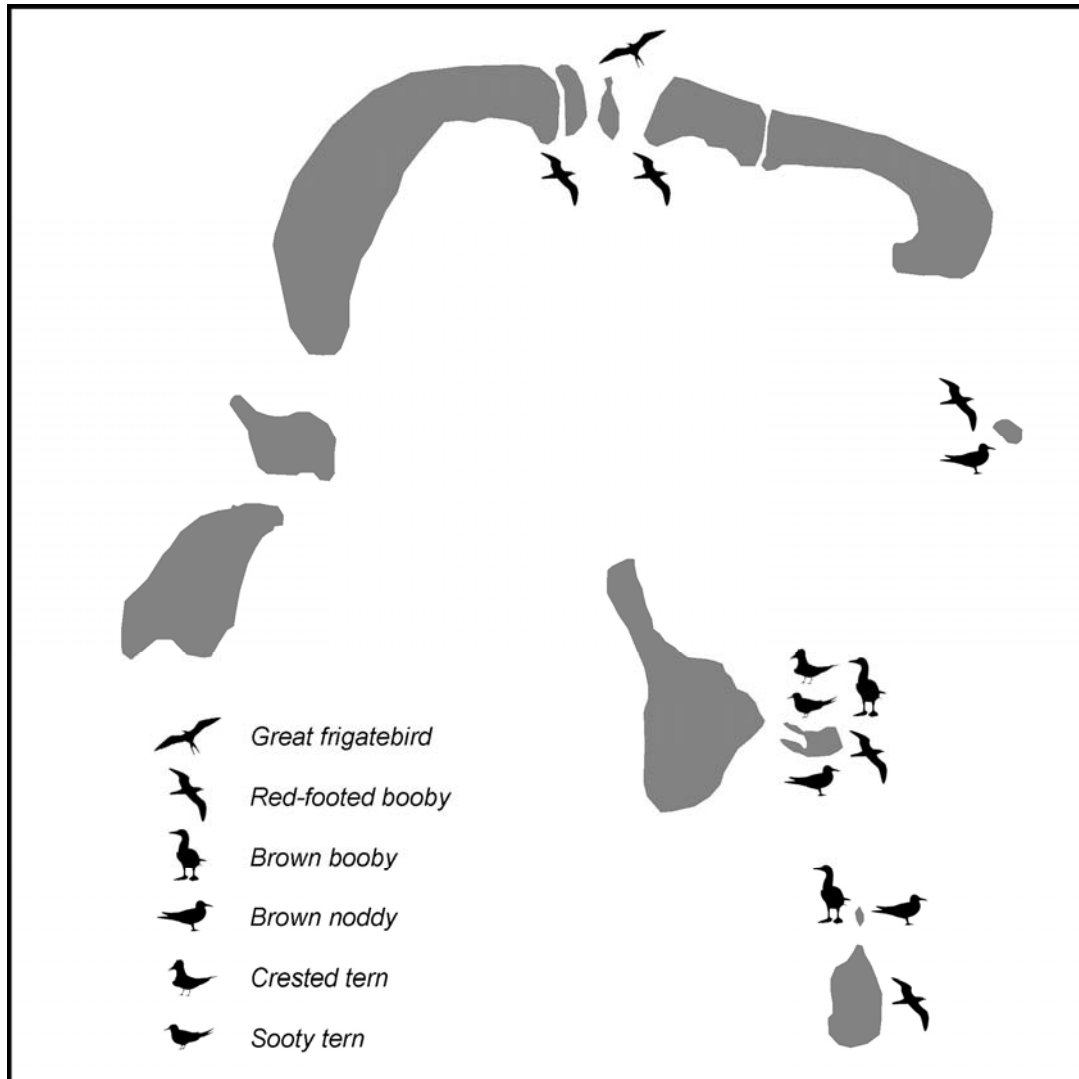


Figure 5: Distribution of abundant seabirds on Tetiaroa (2009)

Conservation and Restoration

Terrestrial conservation on Tetiaroa requires simultaneous consideration of introduced mammals, birds, and weeds along with copra and native vegetation management, and seabird conservation. The vegetation on Onetahi (particularly in the north) has been greatly altered by previous inhabitants. This island currently has the lowest ecological values (prior to introduced mammal eradication). The vegetation on the five smaller islets (< 10 ha) is of important value as these islands were not heavily planted in coconut trees. The island with the highest floral ecological value is Reiono, and with the highest seabird ecological value is Tahuna Iti. The risk of rats arriving on Tahuna Iti and Tahuna Rahi is high, and given these are seabird breeding refuges, management action is required. Tourist operators note that the sandbank of Tahuna Iti has been moving much closer to Rimatuu over the last decade. Eradicating Polynesian rats from Reiono, the most pristine island in Tetiaroa, would allow seabirds to recolonise (particularly smaller seabirds), creating an ‘insurance policy’ against any possible invasion of Tahuna Iti, and serving as an excellent mitigation tool for development in other parts of the atoll (e.g. on Onetahi). The risk of rats reinvading Reiono (and Tahuna Rahi) is low given its isolation from the other islands.

A flock of 5 - 6 red-vented bulbuls was observed on Tahuna Iti, also having been heard on Rimatuu in March 2006. Colonisation was likely by self-dispersal from Tahiti or Moorea. Eradication of this small population of bulbuls before they become established should be considered a priority management action.

Introduced species are the greatest threat to the ecosystems of Tetiaroa. Although Tetiaroa may appear 'pristine' due to the absence of human development, the ecosystem is undergoing a gradual and insidious deterioration as introduced species continue to arrive at and degrade the atoll. The two species of rats have already limited the distribution of seabirds which use Tetiaroa as their last stronghold in the Society Islands. Introduced plant species on Onetahi and Rimatuu are naturally spreading, and it will only be a matter of time until they arrive at other islands. New species are arriving, some noticed (e.g. red-vented bulbuls) but many more likely unnoticed (e.g. insects). There are three main invasion vector pathways through which this is occurring (in decreasing risk);

- 1) Onetahi/Honuea through recent development activities over the past 40 years. The channel between these two motu is small and shallow. Black rats would easily be able to cross this from the dense population on Honuea to the eradicated population on Onetahi. In addition, large machinery arriving at Honuea then drives around the island to Onetahi. Large machinery is a major vector for invasions (e.g. through soil attached to wheels). Because the machinery remains on the reef and then drives around the coast in the water, some of this risk is reduced due to salt-water washing, however it is likely that new species will be arriving on both islands, and they should be treated as one 'management' unit.
- 2) Rimatuu through previous Polynesian inhabitants and eco-tourism trips to Tahuna Iti since the late 1980s. Almost daily trips now occur where tourists are taken to Rimatuu where they land with food supplies and plastic containers, before hiking around the coast to Tahuna Iti, where some groups then cross to visit the 'bird island'. Food supplies are also a major invasion vector (e.g. insects, small rodents) and the unregulated landing of tourists poses a non-negligible risk of new species arriving. The presence of an extant population of Polynesian rats may repel novel rodent invaders (e.g. mice) but black rats can over-invade. Equipment remains on Rimatuu as tourists wade over to Tahuna Iti, reducing invasion risks to Tahuna Iti to almost zero, however the ongoing visits of tourists creates a persistent disturbance to nesting seabirds, eventually leading to abandonment (e.g. frigatebirds no longer nest on this area of Tetiaroa). Tourist operators displayed some knowledge of seabird behaviour and disturbance, however a greater level of regulation (e.g. operator registration) is probably required for this operation which has been going on for approximately ten years.
- 3) Hiraanae is regularly visited by fisherman, where a small camp is present. These fisherman may disturb the nesting seabirds here, and may also act as vectors for the introduction of new species, particularly plant species. Ongoing monitoring is required.

Biosecurity of any kind is conspicuously absent on Tetiaroa. Biosecurity refers to methods commonly used at 'border control' (e.g. Customs) to prevent new species arriving. Biosecurity should focus on regulating visitors to the islands (i.e. every

visitor is known and recorded) and focusing visits to defined areas (e.g. landing spots). This way the risk of new species arrivals is concentrated to known locations. Many tools are now available to assist in biosecurity on islands (e.g. quarantine rooms where new materials and food are unpacked). In addition, regular surveillance and monitoring for problematic species is required (e.g. six monthly rat-traps on rat-free islands and monitoring of the spread of weeds).

Recommendations

The following **urgent** recommendations are made:

- Eradicate Polynesian rats from Reiono as an insurance policy for breeding seabirds, to restore its ecological values, and to mitigate concurrent development on Onetahi.
- Eradicate Polynesian and black rats from Honuea to prevent reinvasion of Onetahi
- Instigate rigorous biosecurity procedures, particularly on Onetahi/Honuea which should be treated as one management unit
- Undertake ongoing weed monitoring and eradication as required
- Introduce regulation of ecotourism to ‘bird island’ (Tahuna Iti)
- Eradicate red-vented bulbuls prior to their establishment

Acknowledgements

Thanks to Matthieu Aureau and Liz Flavall for their support in the field, and Nicolas Leclerc of Te Mana o te Moana for logistical support. Thanks to Richard Bailey and the Brando Trust for permission to visit Tetiaroa and the crew of Here Iti III for transport. Thanks to Frank Murphy and Neil Davies of the GUMP station for facilitating the mission, and the Seabird Predator (SEAPRE) Research Coordination Network (RCN) for funding this exchange visit.

Bibliography

Butaud, J.-F. (2006) Inventaire floristique et définition des enjeux de conservation de l'atoll de Tetiaroa. Unpublished report, Pirae, French Polynesia. 16p.

Salducci, J.-M. (2006) Mission ornithologique sur l'atoll de Tetiaroa, du 8 au 10 mars 2006. Unpublished report, Société d'Ornithologie de Polynésie, Papeete, French Polynesia. 4p.

Heller, M. (2005) Trouble in paradise; Marlon Brando's private Tahitian island became a symbol of the turmoil that marked the reclusive actor's final years. Not even his death has changed that. *Los Angeles Times Magazine*, October 23 112.

S.N.C. Pae Tai - Pae Uta (2006) Synthèse et compilation de documents scientifiques en vue du classement de l'atoll de Tetiaroa - Commune de Arue. Direction de l'Environnement, Papeete. 41p.

Raust, P. and Varney, A. (1992) Rapport de visite sur l'île de Tetiaroa le 03 septembre 1992. Unpublished report, Société d'Ornithologie de Polynésie, Papeete, French Polynesia. 4p.

Raust, P. (1993) L'avifaune marine de Tetiaroa. Unpublished report presented at « Connaissance et Protection des Oiseaux », organised by the Société d'Ornithologie de Polynésie, 9, 10 and 12 November 1993, Papeete, French Polynesia. 9p.

Sachet, M. H. and F. R. Fosberg (1983) An ecological reconnaissance of Tetiaroa Atoll. *Atoll Research Bulletin No. 275*. 67p.

Sinoto, Y. and P. C. McCoy (1974) Archaeology of Teti'aroa Atoll, Society Islands. Interim Report No. 1. Department of Anthropology, B. P. Bishop Museum, Report 74-2. 31p.

Teissier, R. (1962) Note sur l'île Tetiaroa. *Bulletin de la Société d'Etudes Océaniques* 12 (3) (No. 140): 97-102.

Thibault, J.-C. (1976) L'avifaune de Tetiaroa (Archipel de la Société. Polynésie française). *L'oiseau et la Revue française d'ornithologie* 46 (1): 29-45.

Varney, A. (1993) Rapport de mission sur l'avifaune de Tetiaroa. Unpublished report, Délégation à l'Environnement, Papeete, French Polynesia.

Vérin, P. (1962) Prospection archéologique préliminaire de Tetiaroa. *Bulletin de la Société d'Etudes Océaniques* 12 (3) (No. 140): 103-124.