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Authors
Pott, Madeleine
Griffiths, Richard
Burle, Marie-Hélène
et al.

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Protecting the Tuamotu Sandpiper (*Prosobonia cancellata*) One Island at a Time

Madeleine Pott and **Richard Griffiths**
Island Conservation, Santa Cruz, California
Marie-Hélène Burle
Centre for Wildlife Ecology, Simon Fraser University, Burnaby, British Columbia, Canada
Alexander Wegmann
Island Conservation, Honolulu, Hawaii

ABSTRACT: The majority of bird species endemic to French Polynesia are facing the threat of extinction from introduced mammals, particularly rodents. Relict populations of some species persist on uninhabited atolls, offering an opportunity to protect these species on their breeding grounds. With limited prior knowledge of the eradication environment, a campaign to eradicate *Rattus exulans* from three islets within the atoll of Tahanea, Tuamotu Archipelago, was undertaken in July 2011 to create additional nesting habitat for the endangered Tuamotu sandpiper (*Prosobonia cancellata*) – the *titi.* The three islets of Toreauta (5.3 ha), Toreauta Iti (0.7 ha), and Kotuetue (1.1 ha) are all located within expected rat swimming-distance. Trapping, chewblocks, and nighttime surveys were used to establish a baseline estimate of rodent activity and to confirm the project's success. The eradication involved two hand broadcast applications of rodenticide containing brodifacoum (25 ppm) on the islands of Toreauta and Kotuetue. Bait was broadcast at these sites at a density of 20 kg/ha during the first application and bait availability was monitored. Eight days later, and informed by the results of bait availability monitoring, an additional 10 kg/ha was broadcast. Baiting of the *Cocos nucifera* canopy was also completed. To ameliorate risk to resident *titi* on Toreauta Iti, makeshift bait stations were constructed of available materials and baited and maintained with 120 grams of bait for 14 days. Rodent activity in 2011 showed 22% of chewblocks with rodent sign and 17 rats observed during nighttime surveys. In 2012, one year after the eradication was implemented, rats were not detected with chewblocks or during nighttime surveys. Comprehensive application of bait to all potential rat habitats including the palm canopy and the inclusion of islets that could have provided a source of reinvasion contributed to the success of the campaign, while adaptively managing the baiting strategy lowered risks to non-target species.

KEY WORDS: brodifacoum, eradication, French Polynesia, invasive species, island, Polynesian rat, *Prosobonia*, *Rattus exulans*, rodent, tropical, Tuamotu sandpiper

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INTRODUCTION

The islands of French Polynesia amount to 3,800 km^2 of land spread across 2,500,000 km^2 – an area the size of continental Europe. French Polynesia was once home to dozens of endemic landbird species, but has lost 14 species since 1768 – one as recently as 1985. Of the 26 extant endemic landbird species in French Polynesia, 12 species are listed as Endangered or Critically Endangered by the IUCN (van der Vliet and Ghestemme 2013). In many cases, Polynesian species at risk of extinction are threatened by introduced invasive alien species, particularly rodents (McCormack and Künzlè 1996, Thibault et al. 2002, Thorsen et al. 2002, Kesler et al. 2012).

Polynesian birds are not alone in their vulnerability to rodent predation and competition; three species of introduced rat are thought to be responsible for the extinction of over 40 avian species and the suppression of many more (Towns et al. 2006). While the spread of invasive rodents to islands has tapered off since the mid-20th Century, the threat of rodent invasions to predator-free islands is a constant and real concern for land and resource managers (Atkinson 1985, Russell et al. 2008). In French Polynesia, there exists the unfortunate example of the island of Fatu Hiva (Marquesas Islands), where the introduction of an invasive rodents species in 2000 pushed the Fatuhiva Monarch (*Pomarea whitneyi*) from the status of Threatened to Critically Endangered in 12 short years and negated relocation efforts for the Endangered Ultramarine Lorikeet (*Vini ultramarina*) (van der Vliet and Ghestemme 2013). With many species restricted to a handful of predator-free islands or small populations clinging to survival despite the presence of predators, stopping the influx of invasive species alone may not prevent extinctions.

Since the 1960s, resource managers have been using rodent eradications on islands as a means of protecting vulnerable island species and creating additional habitat (Howald et al. 2007). Benefits to native plants, mammals, insects, and birds have been observed subsequent to eradications, often resulting in lasting positive impacts to island ecosystems (Towns and Broome 2003, Bellingham et al. 2010). Predator-free islands have also been used as translocation sites for species extirpated from islands or otherwise threatened in the rest of their range (McLean and Armstrong 1995, Hooson and Jamieson 2003, Butchart et al. 2006, Reynolds and Klavitter 2006).

Despite immense opportunity to realize conservation benefits to endangered species in French Polynesia through the removal of invasive rodents, very few rodent eradications have been conducted there and far fewer eradications have been successful (Island Conservation 2014). With the entirety of French Polynesia situated

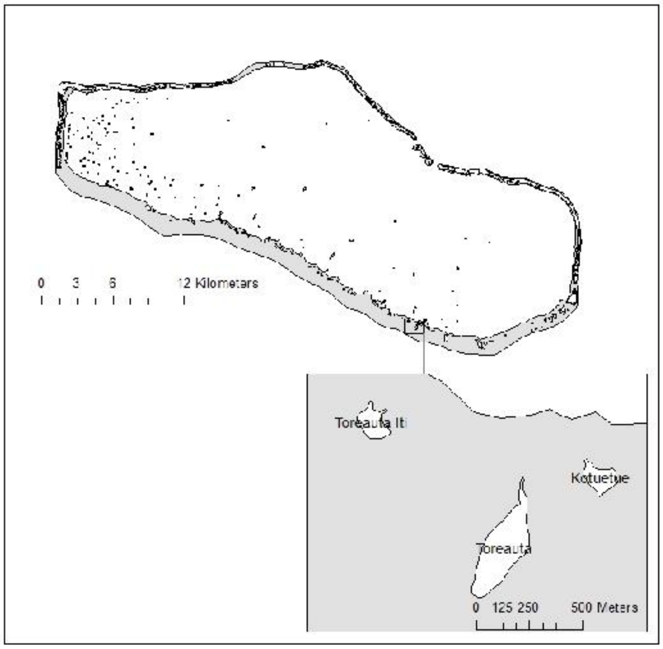

Figure 1. A map of Tahanea Atoll, Tuamotu Archipelago.

within the tropics, eradication practitioners face many of the operational challenges common to rodent eradications on tropical islands. Rodent eradications in the tropics have a three times greater failure rate than eradications attempted in temperate climates – 18% failure and 5% failure, respectively (Varnham 2010). The reasons for these challenges are multifold and not yet fully known or understood, but year-round availability of food, high numbers of bait competitors (e.g., crabs), close proximity of rodent source populations, and the three-dimensional environment of the coconut palm (*Cocos nucifera*) canopy are thought to be some possible explanations (Howald et al. 2004, Abdelkrim et al. 2005, Wegmann et al. 2011). Recognizing these challenges, a number of recent tropical rodent eradications have sought to address many of these factors through meticulous research and planning, including Isabel (2009), Henderson Island (2011), Palmyra Atoll (2011), and Wake Atoll (2012) (Samaniego-Herrera et al. 2010, Cuthbert et al. 2012, Wegmann et al. 2012, Island Conservation 2013).

One Polynesian species currently under threat is the IUCN Endangered Tuamotu sandpiper (*Prosobonia cancellata*) or "*titi*," whose current population is estimated at 1,300 individuals, and is thought to have been widely distributed across much of Eastern Polynesia (Walters 1993, BirdLife International 2012, van der Vliet and Ghestemme 2013). [According to the criteria established by Tobias et al. (2010), the species name for the Tuamotu sandpiper is currently under revision and will likely be changed to *P. parvirostris*. In order to remain consistent with the name presently accepted by the IUCN Red List and BirdLife International, the name *P. cancellata* is retained here (BirdLife International 2012, 2014)]. With the introduction of invasive predators such as cats and rats, the species has seen its global distribution shrink dramatically and is currently restricted to as few as 6 distant, dispersed, uninhabited atolls in the Tuamotu Archipelago (Seitre and Seitre 1994, Pierce and Blanvillain 2004, Cibois et al. 2012). *Titi* have not been found to successfully breed on islands where black rats (*Rattus rattus*) are present and it is thought that the smaller Polynesian rat (*R. exulans*) might also limit *titi* breeding success (Seitre and Seitre 1994, Pierce and Blanvillain 2004).

In an effort to create additional, predator-free breeding habitat within Tahanea Atoll, home to the third most important breeding cite of the *titi* (M-H. Burle, pers. comm.), a rat eradication was conducted on one island, Toreauta, within the atoll. Free of rats, Toreautu will provide additional breeding habit to the *titi* as well as expanding the number of contiguous rat-free islands within the atoll. The project team did not have the opportunity to visit the island prior to planning the eradication and possessed limited local knowledge. The eradication methods used on this island provide some insight into how future rodent eradications might be planned on small islands with eradication environments similar to that at Tahanea and when the eradication site has not been extensively assessed prior to the implementation of the eradication.

METHODS

Locality

Tahanea Atoll is located at -16.90° -144.75° within the Anaa-Faaite Commune of the Tuamotu Archipelago of French Polynesia. The atoll is uninhabited but occasionally visited by the nearby community of Faaite Atoll. There are approximately 175 raised coral islands and islets – *motu* – within Tahanea, totaling 930 hectares (see Figure 1). The maximum elevation of these low-lying islands is approximately 5 meters above sea level and the vegetation is characterized by a mixed broadleaf/canopy of *Pisonia grandis*, *Cordia subcordata*, and *Guettarda speciosa* as well as patches of shrubland consisting of *Scaevola tacada* and *Chamaesyce forbergii*. The atoll was once used to harvest the drupes of coconut palms (*Cocos nucifera*) and some islands still have a substantial palm canopy in addition to native vegetation. The islands targeted for rodent removal were Toreauta (5.3 ha) – where rats had been detected – and Kotuetue (1.1 ha), where rats had not previously been detected but which is located within swimming distance of Toreauta. These *motu* are located on the southern edge of the Atoll, between two rodent-free *motu* extensively used by the *titi* population. The island of Toreauta was of particular importance because of the presence of habitat deemed high quality for *titi* breeding and foraging. Upon arrival at Tahanea, it was discovered that a second *motu* was located in proximity to Toreauta. Named Toreauta Iti, it is separated from Toreauta by 700 meters of shallow water and sand bars. It was decided that Toreauta Iti should be treated with eradication methods to ensure that all potential rodent populations were eradicated simultaneously.

Eradication Strategy

Without prior knowledge of the eradication environment on Tahanea, the eradication team came prepared to make on-the-ground decisions. The eradication team consisted of one (paid) member of the Faaite community, one PhD student, and one eradication practitioner trained in hand broadcast of bait. A total of 745.8 kg of rodenticide (Brodifacoum-25W Conservation, brodifacoum 0.0025%) formulated into 2-g baits was brought out to the atoll. An additional 22.6 kg were packaged into canopy baits or "bait bolas" – two small cotton bags filled with 12.5 g of bait each, connected by 30 cm of twine for a total of 25 g per bola (see Wegmann et al. 2014 for further details). These quantities were designed to allow for two hand broadcast applications on Toreauta and Kotuetue of up to 40 kg/ha each as well as two applications of bait to the palm canopy, plus an additional 15% of contingency bait. The actual application rate was determined once the non-target consumer (crab) population had been assessed.

The eradication was achieved through the hand broadcast of bait pellets over Toreauta and Kotuetue in two applications spaced 8 to 10 days apart. The rodenticide was hand broadcast at 20 kg/ha on a 20-m × 20-m grid of baiting transects during the first application and at 10 kg/ha during the second application. The second application rate was reduced due to the continued widespread availability of bait pellets across the island within bait availability transects. Due to the high numbers of *titi* on Toreauta Iti and its immediate proximity to another *motu* housing a significant portion of the atoll's *titi* population, eradication personnel chose to employ a bait station approach rather than broadcast bait. A total of 17 bait stations on a 20-m × 20-m grid were improvised out of found objects, natural materials, and corrugated plastic material to prevent *titi* from accessing the 120 g of rodenticide placed inside each station. Within two days of ground baiting, canopy baits were slung into every stand-alone coconut palm and every third interconnected palm crown with full coverage of the canopy on Toreauta and Kotuetue.

Non-Target Mitigation

As omnivorous shorebirds, it was expected that *titi* were at risk of poisoning from the rodenticide, either through the direct consumption of pellets or through the consumption of arthropods feeding on pellets. In an attempt to minimize the possibility of *titi* mortality as a result of the eradication, 16 *titi* were captured from the three islands and held in captivity for the duration of the eradication. The details and results of captive holding attempts will be published at a later point (M-H. Burle et al., unpubl.).

Eradication Monitoring

In June 2011, prior to the eradication, trapping, chewblocks, and nighttime surveys were used to identify and confirm the presence of invasive rodents on Toreauta as well as provide a baseline for post-eradication monitoring. Victor® M201 snap traps were nailed to coconut trees (30 cm above the ground) and covered by a trap protector (corrugated plastic structure held in place with cable ties and wire) to prevent non-target interference with traps and baited with fresh coconut and peanut butter. In addition to each trap, a chewblock (corrugated plastic containing a hardened mixture of peanut butter and sugar) was nailed to each tree. Traps and chewblocks were checked for rodent presence or rodent incisor marks and, where necessary, replaced daily for 5 days. Traps and chewblocks were placed on nearby Kotuetue and chewblocks alone were placed on Toreauta Iti. Nocturnal surveys (1800 to 2200 hours) were also conducted in order to detect the presence of rats.

Post-eradication monitoring conducted in August 2012, relied solely on chewblocks and nighttime surveys to detect rats. Chewblocks were deployed over the course of 10 nights and each checked 5 times.

RESULTS

Hand broadcasting during the first application on Toreauta and Kotuetue resulted in bait densities of 18.4 and 19.6 kg/ha for these *motu*, respectively. Monitoring of bait availability subsequent to the first application of bait led to a lowering of the application rate for the second application, with final rates of 8.9 and 10.1 kg/ha, respectively (Figure 2). A total of 194 and 195 palm trees (first and second application, respectively) were baited on Toreauta and 73 and 94 trees were baited on Kotuetue (first and second application, respectively). A total of 2.04 kg of rodenticide was used in bait stations on Toreauta Iti.

Trapping in 2011 confirmed the presence of *R. exulans* on Toreauta only. A total of 78 trap nights in 2011 yielded a 46% capture success and an overall detection rate of 22% on chewblocks. In 2012, 187 chewblock checks revealed no sign of rat incisor marks. Prior to the eradication, a total of 17 rats were observed during 2.6 person-hours of nocturnal surveys on Toreauta. In 2012, no rats were observed during 0.9 hours of nocturnal surveys.

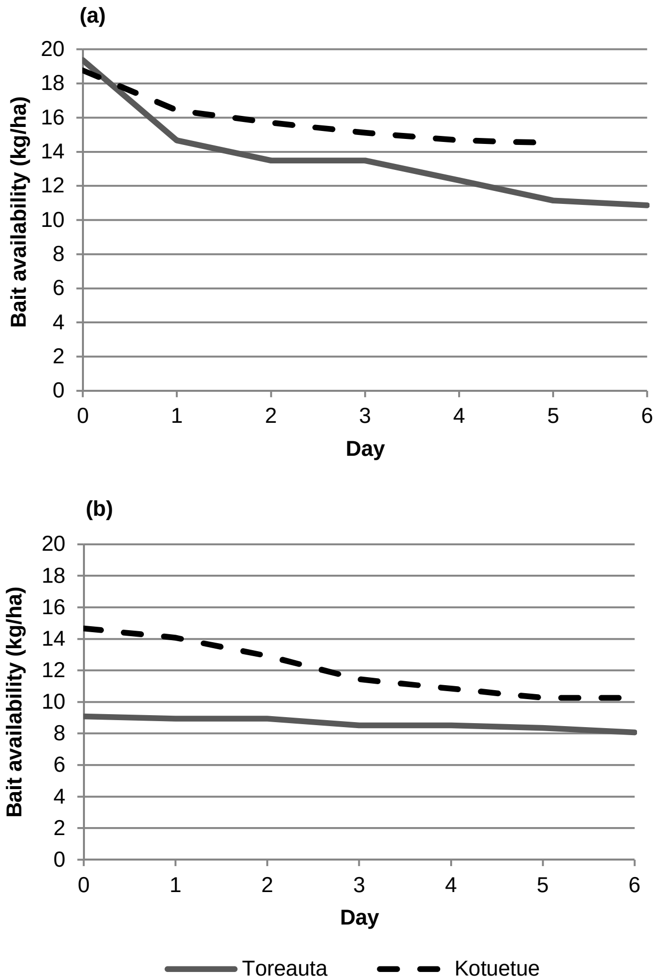

Figure 2. The availability of rodent baits (kg/ha) during the days following the first (a) and second (b) applications of rodenticide to Toreauta and Kotuetue.

DISCUSSION

Eradication practitioners targeting invasive rodents on islands whose eradication environments are unknown can improve their chances of success by adopting techniques used in other successful eradications and planning for the unexpected. Results of post-eradication monitoring on Toreauta suggest that the flexibility to adaptively manage the operation in an unfamiliar environment and the use of additional techniques when hand broadcasting bait can increase the chance of eradication success while reducing the risks to non-target bait consumers. The success of the rodent eradication on Toreauta provides conservationists and eradication practitioners within French Polynesia and the region with a model for implementing small-scale rodent eradications within and across atolls.

The atolls and archipelagoes of French Polynesia are characterized by a scattering of islands: some large, some small, some low in elevation, some high in elevation, some densely vegetated, some less so. With such possible variety, it can be a challenge for eradication practitioners to address all the eradication components required to ensure project success. In addition, target islands may not be readily accessible or there may not be much knowledge of the eradication environment and/or practitioners might not have the resources to perform pre-eradication site visits or studies. The first reported rodent eradication in French Polynesia dates back to 1986, when an eradication was undertaken in the Marquesas on the small island of Teuaua (350 m from the larger island of Ua-Huka). That eradication was unsuccessful and subsequent attempts to remove rodents from the island have also been unsuccessful (Island Conservation 2014). Since 1986, a series of eradications have followed suit across many of the archipelagoes within French Polynesia: Tuamotu, Marquesas, and Gambier, with variable success (Island Conservation 2014). Eradication practitioners have chalked up the failures to a number of reasons including: inadequate bait application and insufficient bait (Vahanga Atoll, 2002); proximity of nearby source populations and possible human-facilitated reinvasion (Mangarev 2003, Rangiroa Atoll 2007-2009), volunteer eradication staff (Vahanga Atoll), and crab interference or excessive bait consumption by crabs (Vahanga Atoll) (Pierce et al. 2006, Albar et al. 2010, C. Blanvillain, pers. comm., G. Wragg, pers. comm.). None of these challenges are unique to French Polynesia, but these unsuccessful eradications provide those developing eradication operations in the region with a set of factors to consider during the planning phases.

The eradication on Toreauta managed to avoid many of the pitfalls experienced during similar, previous projects conducted in the region by 1) paying a local community member to participate in the eradication, 2) provisioning the operation with adequate bait, 3) assessing the crab community prior to baiting, and 4) extending the treatment of all likely rat territories (including the palm canopy). The outcome on Toreauta was not without antecedents; it built on the successes and failures of many other eradications in the tropics and many years of research (e.g., Palmyra Atoll, Pohnpei islands) (Howald et al. 2004, Buckelew et al. 2005, Wegmann et al. 2007). While this project does not provide a recipe for successful rodent eradications, it does provide a basis for planning small eradications, especially where: there is an imminent threat to endangered species from invasive rodents; a rapid eradication is needed in response to rodent incursions; or there is conservation value in eradicating rodents from small, individual *motu* within an atoll.

Differences in crab communities, rodent behavior, island structure, and operational logistics will continue to test practitioners, as will eradications targeting multiple rodent species or those with significant potential non-target mortality. However, the small size of islands – and consequently of operations – will allow practitioners to adaptively manage projects and address the response of the eradication environment to the application of the rodenticide in real-time.

As the expertise in tropical rodent eradications grows, so do eradication ambitions. There is a patent need to identify how we can ensure success on islands with multiple rodent species, islands of high elevation and complex three-dimensional environments, using other eradication methods, or on islands with a human population. With so many species threatened by invasive species and so many potential islands, French Polynesia is an ideal location to continue growing our understanding of rodent eradications in tropical ecosystems while achieving important conservation gains.

Post-eradication surveys of Toreauta in 2012 indicate that the island is free of invasive predators; a continuous 26-kilometer swath of about 17 *motu* is rat free and available to the *titi* of Tahanea Atoll. Eradication planning and techniques used in this operation were effective in eliminating the *R. exulans* population from the *motu* of Toreauta. While the rodent eradication on Toreauta was a relatively small operation expected to provide some small benefit to the endangered Tuamotu sandpiper, it is a project which successfully demonstrated that with limited knowledge of the eradication environment and with effective community and partner relations, rodent eradications on small remote tropical islands can be achieved.

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