A successful Pacific rat *Rattus exulans* eradication on tropical Reiono Island (Tetiaroa Atoll, French Polynesia) despite low baiting rates

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SUMMARY

We successfully eradicated rats from Reiono Island despite reducing the interval between bait applications from the recommended 10-21 days to 7 days, and reducing bait availability from the recommended >4 nights, to 2 nights. We focused on meeting the eradication principle of exposing all rats to poison bait by ensuring complete bait coverage across the island. Relative to current practice our approach saved 3,032 kg of bait and 168 person-days of labour on a 22-ha island, or US$42,626 in bait and accommodation costs. In line with other recent cases, the Reiono eradication suggests that using moderate baiting rates and short baiting intervals can lead to significant financial and logistical savings. Yet, baiting strategies should be tailored to the risk environment of each project.

BACKGROUND

Eradication of invasive rodents (Pacific rat *Rattus exulans*, Norway rat *R. norvegicus*, ship rat *R. rattus* and house mouse *Mus musculus*) from islands has become an increasingly common conservation management tool resulting in the recovery of many native vertebrate populations (Williams et al. 2013, Jones et al. 2016). Rodent eradications by aerial or hand-broadcast methods require precise treatment of the entire island. Over-engineering projects reduces risk and hence failure. Furthermore, the lower success rate of eradications in the tropics has driven eradication managers to be even more cautious in the last decade. Current guidelines for tropical islands (Keitt et al. 2015) recommend at least two bait applications spaced 10-21 days apart ensuring bait availability for 4+ nights following each application. While such a conservative approach may contribute to a higher success rate, it also carries potential disadvantages such as a) increased cost and logistical complexity of projects, potentially becoming unaffordable (e.g. increased cost of bait and extended duration of operation), and b) increased risk to non-target species due to the use of higher baiting rates. Better understanding of the minimum resource requirements to achieve eradication would drive improvements in cost and logistics, at no cost to success rate.

While conducting research on potential causes of eradication failure on tropical islands using an experimental rat eradication (Samaniego et al. 2020), we deviated from current practice and reduced both time between bait applications (from 10-21 to 7 days) and time of bait availability (from 4+ to 2 days) in part to explore the 'minimum resource requirements' for eradication.

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Reiono Island (22 ha) in Tetiaroa Atoll, French Polynesia experiences a wet tropical climate and is covered by evergreen forest dominated by *Pisonia grandis* and *Cocos nucifera*. Land crabs (coconut crab *Birgus latro*, hermit crabs *Coenobita* spp., and burrowing crabs *Geograpsus* spp. and *Ocypode* spp.) are abundant all year round. Our scientific studies conducted prior to the eradication operation estimated high rat densities (95% CI: 65-153 rats/ha) in June 2018 (Figure 1), two months ahead of baiting in August, and the camera work in August registered videos of rats every day by every camera (Samaniego et al. 2020).

ACTION

The eradication plan was largely based on current guidelines (PII 2011, Keitt et al. 2015) and informed by a placebo bait trial (Samaniego et al. 2020). We used Pestoff 20R™ bait in two hand-broadcast applications of 16 kg/ha (i.e. 32 kg/ha total), 7 days apart, on 21st and 28th August 2018. August was chosen because it is usually the coolest and driest month of the year in Tetiaroa, which are desirable conditions for rodent eradications particularly on tropical islands with land crabs (Samaniego et al. 2019). We experienced light rain throughout the month and a heavy downpour at the end of the day of the second application. A 20 × 20 m grid (550 points) was physically marked across the island. The accuracy of the grid was checked and corrected, as accuracy was necessary to ensure evenness in bait distribution. GPS signal was poor due to the dense canopy, so we marked trails and the grid largely with string and compass. Even with good GPS signal, the 3-5 m accuracy for civil purpose GPS would have introduced important deviations. The baiting team consisted of an experienced eradication practitioner, a field assistant, the local head ranger and 9 volunteers.

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Figure 1. Rat images from the YouTube video *A successful Pacific rat eradication on tropical Reiono Island*. Left: Pacific rat foraging outside its burrow during the day. Right: five rats foraging at night.

The goal of baiting every potential rat territory was in practice treated as baiting every square metre of the island. This was the effort required to meet the eradication principle of exposing all rats to poison bait under the local conditions of high land crab interference (i.e. crabs consuming bait). Each bait application consisted of a thorough distribution of bait across the grid and an additional, overlapping application along the perimeter, covering 100% of all vegetated areas in one day. Sandy beaches with no vegetation remained unbaited to minimise potential non-target impacts. Rats use sandy beaches as foraging grounds, but their burrows are located in vegetated parts of the island. No bait was applied in the forest canopy despite the abundance of coconut palms, as this was considered unnecessary (i.e. we assumed all rats forage on the ground regularly). Bait was applied using a 10-person baiting line where each person was spaced 20 m apart, walking parallel transects and stopping every 20 m to apply bait to successive 20 m × 20 m (400 m²) areas. Baiters kept in sight of each other and recorded stops on checklists. The amount of bait per stop per person was measured using calibrated cups to hold 128 g, five cups per stop (640 g/400 m²), i.e. four throws covering ~10 m around the marker (e.g. facing each main cardinal point), then a fifth around the marker (Figure 2).

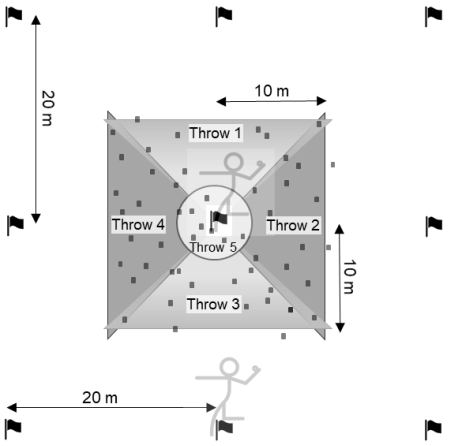

Figure 2. Hand broadcast of bait pellets aiming to uniformly cover the entire island.

A short video of the project produced with footage from trial cameras is available on YouTube: A successful Pacific rat eradication on tropical Reiono Island. Zero non-target impacts were recorded.

The absence of rats was formally evaluated in November 2018 (11 weeks after the eradication operation) using camera trapping and a Rapid Eradication Assessment, based on intensive pre-eradication mark-recapture studies (Samaniego et al. 2020). In addition, local operators, visiting the island most days, were asked to report any rat sign.

CONSEQUENCES & DISCUSSION

The Reiono eradication succeeded despite deviation from current practice and having other less than favourable conditions: high rat abundance, presence of juvenile rats, abundance of natural foods, high land crab interference and presence of coconut palms (Samaniego et al. 2020). Our operation used 32 kg/ha and a baiting team for 1 week. Had we followed current practice in a conservative manner, we would have spaced the applications 3 weeks apart and used 130 kg/ha based on trials, similar to the baiting rate applied on ecologically similar Palmyra Atoll: 164 kg/ha in 2 applications, justified by pre-eradication studies and the cost associated with a potential failed eradication (Wegmann et al. 2012). Our operation on Reiono would have then required an extra 3,032 kg of bait and 168 person-days. Therefore, we saved US$42,626 in bait and logistical cost on a 22-ha island by reducing baiting rate and time in the field. Other projects could additionally save in personnel and helicopter costs this way.

One week after the first bait application (i.e. on the day of the second bait application), both rat videos and our direct observations of rats had fallen to zero. Eleven weeks after the bait application, Rapid Eradication Assessment indicated a high probability of rat eradication success (95% CI: 97%-99%), and the camera monitoring yielded no videos of rats (Samaniego et al. 2020). Until February 2020, all reports from local operators reported no sign of rats. All evidence suggests Reiono has been rat free since August 2018.

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Along with other recent cases (>15 tropical islands ranging 10-550 ha; Samaniego et al. 2018, 2019), we confirm that breeding rodent populations on islands with land crabs can be removed with moderate baiting rates and short baiting intervals as long as comprehensive bait coverage is achieved, potentially reducing costs and complexity. Nevertheless, baiting strategies should be determined on a case by case basis. For example, on Palmyra the eradication operation aimed to minimize the risk of failure, whereas on Reiono we deliberately accepted a greater risk to explore the minimum resource requirements for eradication. We encourage detailed documentation of future eradication operations to keep refining best practice based on evidence.

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