Ship rat *Rattus rattus* eradication on Pein Mal Island, Federated States of Micronesia, Pacific Ocean

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SUMMARY

As part of a larger project attempting to reduce predation pressure from introduced rats *Rattus* spp. on native fauna and flora on several islands off Pohnpei main island (Pacific Ocean), a rat eradication program was undertaken on the small island of Pein Mal (2.17 ha) where ship rats *R.rattus* were present. The island was systematically hand-broadcast with rodenticide bait at a pre-determined application rate of 50 kg/ha over one day. Radio-tracking revealed that rats spent a significant amount of time in the forest canopy. Therefore, to ensure that rats living in the canopy had a good chance of encountering bait, bait clusters (bolo baits) were made and catapulted into one third of the palm trees on the island. Mangrove forest surrounds the shore of Pein Mal where rats were also present. Throughout this habitat to ensure rat access to the rodenticide, a bait station grid was established with bait stations nailed to tree trunks approximately 2 m above the high water mark.

Pre-bait application trap success (rat captures/trap nights) was 39%. Post-bait application trap success (as recorded 10-14 days after bait application) was 0%. Pre-bait application wax indicator success was 53%. Post-bait application wax indicator success was 0%; subsequent monitoring 6-months later detected no rats. No non-target species appeared adversely effected by the bait.

BACKGROUND

Considered the "emerald" of Micronesia, Pohnpei, including its surrounding smaller islands, is a lush, green oceanic island formed five million years ago by turbulent volcanic activity. The islands are home to a wide variety of natural marine and terrestrial habitats including barrier reefs, lagoons, mangrove forests and upland forests. It is one of the wettest places on earth, with an average annual rainfall in excess of 1,000 cm (400 inches). Pohnpei's dwarf cloud forests are altitudinally among the lowest in the world at 450 m, and the volcanic bowl of the island boasts the largest intact lowland tropical forest in the world. These habitats support a remarkable abundance of unique flora and fauna, with 16% of species being endemic, including the Serehd or Pohnpei lory *Trichoglossus rubiginosus*, and the tiny Pohnpei mountain skink *Emoia ponapea*. Unfortunately, over the past 25 years, deforestation for agricultural purposes has reduced the interior rainforest of Pohnpei by more than 25%, and as well as habitat loss and degradation, native plant and animals are being further threatened through predation and competion from introduced non-native species, e.g. alien rats *Rattus* spp., feral pigs *Sus scrofa*, feral cats *Felis catus* and Philippine sambar deer *Cervus mariannus*. Tropical oceanic islands represent some of Earth's most biologically unique ecosystems, yet the very remoteness that fuels high levels of endemicity and fantastic species radiations also renders such systems vulnerable to invasive species (Mooney & Cleland 2001, Rodriguez *et al*. 2006). Invasive mammal eradications are a proven, effective method of restoring damaged ecosystems and preserving biodiversity (Towns & Broome 2003, Zavaleta *et al*. 2001)

Within the scope of a larger study, The Conservation Society of Pohnpei (CSP) and Island Conservation (IC) selected three of five small islands for rat eradication which constituted the Pohnpei Rat Eradication

Research Project: Dekehtik (2.63 ha), Pein Mal (2.17 ha) and Nahkapw (1.58 ha) (Fig. 1). A fourth island, Nahpoli, was selected as a control where no rat eradication attempt was undertaken. Island selection was based on the following criteria: presence of rats, lack of human habitations, a distance of no less than 0.5 km from Pohnpei, and accessibility to the project team undertaking the work.

This case study describes attempts to eradicate ships rats *R.rattus* on Pein Mal Island.

ACTION

Study area: The rat eradication attempt took place in January and February 2007 on Pein Mal (2.17 ha), one of several small islands adjacent to Pohnpei (Fig. 1.), Federated States of Micronesia, Pacific Ocean. Pein Mal, like the other two islands (Dekehtik and Nahkapw) where rat eradication was also undertaken (Wegmann A. *et al*. 2008a, Wegmann A. *et al*. 2008b) is low, flat and hosts a dense forest of coconut palms *Cocos nucifera* and broad-leaf tropical trees. However, unlike the other two islands, Pein Mal is encircled by a dense mangrove forest. The island lies 500 m from Pohnpei. Only one rat species, *R.rattus*, was observed on Pein Mal.

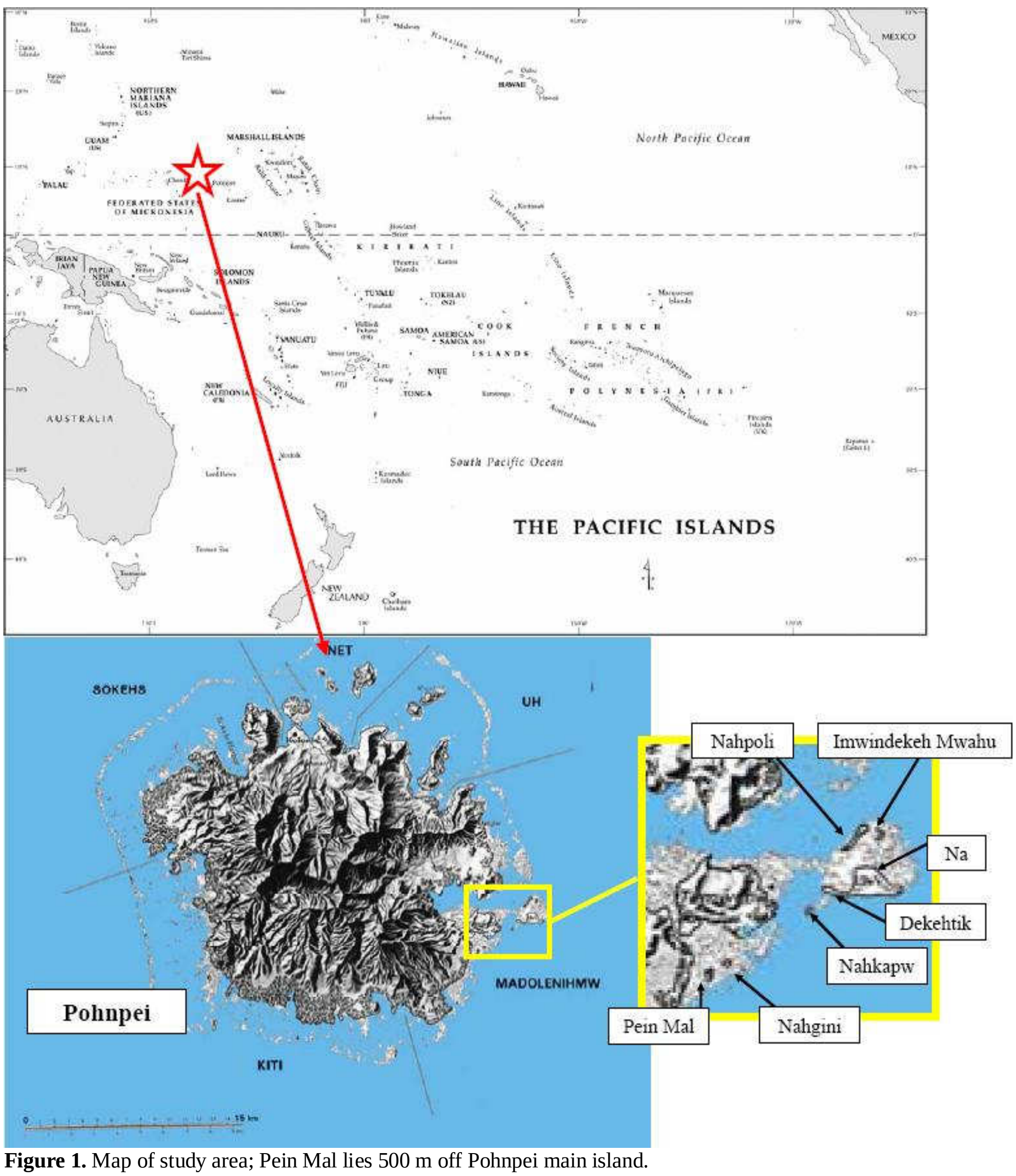

Figure 1. Map of study area; Pein Mal lies 500 m off Pohnpei main island.

Pre-treatment trial: Prior to applying active rodenticide bait on the treatment islands, an inactive (placebo) bait replicate was used in a bait application calibration study on Imwindekeh Mwahu (1.18 ha). This placebo was hand-broadcast across the entire island and the bait uptake rate was measured (Fig. 2). From this calibration study, a general application rate of 50 kg/ha to be applicable for the other islands was inferred.

Treatments: On 30 January, a single application of active rodenticide bait containing 25 ppm brodifacoum (PI-25, Bell Laboratories, Inc, Madision, Wisconsin) was systematically hand-broadcast on Pein Mal at an application rate of 50 kg/ha. PI-25 was chosen as it is highly palatable to *R.rattus* and is structurally resilient in a wet tropical environment. Bait was applied using a 6-person baiting line where each person was spaced 5 m apart, and walked parallel transects across the width of the island, stopping every 5 m to apply bait to successive 5 m x 5 m (25 m²) areas. The entire island was treated with a single application of bait applied over 1-day. To detect the upper limit of the bait consumption rate, 10 fixed 5 m x 5 m (25 m²) plots with a bait application density of 100 kg/ha were also randomly established throughout the emergent land area of the island. Additionally, random 2.83 m radius (25 m²) circle plots were sampled once per day for 6 days post bait application; bait density estimates from these plots were used to keep track of the amount of uneaten bait on the ground.

Figure 2. Hand broadcasting of ground bait on Pein Mal, January 2007.

During the course of the project, radio-collared *R. rattus* (n = 7; see Monitoring, below) were found to spend a significant amount of time in the forest canopy. In an attempt to ensure that rats living in the canopy would encounter bait, waxy bait clusters attached to biodegradable string were fabricated (bolo baits) (Fig. 3). The bolo baits were catapulted into about one third of the coconut palm trees (approximately 350 trees) on the island (Fig. 4).

Figure 2. A bolo bait.

Figure 3. Bolo bait being catapulted into the forest canopy.

Radio-collared rats also spent a significant amount of time foraging and residing in the mangrove forest swath that surrounds the shore of Pein Mal. To make sure that rats occupying this habitat had access to the rodenticide bait, a 15 m x 15 m bait station grid was established throughout the mangrove forest - wax-based bait stations were nailed to tree trunks approximately 2 m above the high water mark (Fig. 5).

Figure 5. Mangrove bait station on Pein Mal Island, January 2007.

Effect of bait on non-target species: During the course of the project three methods were used to assess any associated effect of the rat bait on non-target species, including bats, birds and land crabs. The researchers performed pre- and post-application index of abundance surveys, in combination with observations and carcass searches to assess if there were direct effects of the rodenticide bait on native wildlife.

Monitoring: To monitor eradication efficacy, three methods were used: live-trapping, wax chew blocks, and radio-telemetry. Live trap transects paired with wax chew blocks were randomly established and opened prior to and post bait application to monitor trap success and the condition of any captured rats. Traps and chew blocks were opened for three nights prior to bait application. Ten days after the bait application, all traps and indicator blocks were opened for an additional 4 nights. Seven randomly trapped rats were also fitted with radio-collars in order to track rat movement for behavioral studies, and to help identify the circumstance of mortality if applicable.

CONSEQUENCES

Ship rats were detected in live traps on the island prior to bait application. Pre-bait application trap success (rat captures/ trap nights) was 39%. Post-bait application trap success was 0%. Continued rat detection on the reference island (Nahpoli) indicated that the concurrent lack of rat detection on Pein Mal was in response to the eradication efforts. Pre-bait application wax indicator success was 53%. Post-bait application wax indicator success was 0%. Rat eradication indicator success on Pei Mal is summarized in Table 1.

All seven radio-collared rats on the island were alive and active prior to bait application; all seven were subsequently found dead within 6 days of the hand-broadcast bait application. At 6 months post-bait application, the live trap and wax indicator stations were reactivated and kept open for 3 days; no rats were detected.

Effect of bait on non-target species: Non-target species interference with traps was considered moderate to high (11%). Landbirds, shorebirds and bats that forage on land could potentially be at risk of exposure to applied bait. However, 206 person hours spent searching for carcasses failed to detect any dead or moribund non-target species. Land crabs, not affected by the bait used, commonly interfered with the live traps and bait, accounting for nearly all of the interference events observed.

Conclusions and discussion: Pein Mal's terrestrial habitats are varied and include dense ground vegetation, a tall mixed-species tree canopy, and surrounding mangrove swamp around the coastal margins. Three bait delivery methods were thus employed in an attempt to ensure that every rat on the island had a good chance of access to bait:

i) Bait bolos were shot into 1/3 of the island's coconut palm crowns;

ii) Bait stations were uniformly deployed throughout the mangrove swamp;

iii) Bait pellets were hand broadcast on all stretches of the island's emergent land area.

Table 1. Rat eradication indicator success on Pein Mal.

Bait period and indicator technique	**% trap/ indicator success or rat survival**
Pre-bait application trap success	39%
Post-bait application trap success	0%
Pre-bait application wax block indicator success	53%
Post-bait application wax block indicator success	0%
Pre-bait application radio-collared rat survival	100%
Post-bait application radio-collared rat survival	0%

Multiple baiting methods like this might be necessary in order to maximize likelihood of eradication success, when treating more complex island ecosystems such as on Pein Mal.

Whilst one application of 25 ppm brodifacoum bait at an application rate of 50 kg/ha proved sufficient to remove all rats from Pein Mal, it is common practice to treat an island with two bait applications separated by 2 to 3 weeks. The two-application practice reduces the risk of missing weaning rats that were not otherwise exposed to bait during the first broadcast. A tight project schedule prevented us from conducting two applications on Pein Mal.

While adherence to proven practices can increase the probability of success for a given eradication project, each project will entail idiosyncratic ecological conditions, non-target and environmental risks, and regulatory stipulations. Each eradication project should be viewed as an opportunity to amend tested methodologies to best fit the situation.

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