POHNPEI RAT ERADICATION RESEARCH AND DEMONSTRATION PROJECT

Pohnpei, Federated States of Micronesia - 16 January to 7 March, 2007

Alexander Wegmann[1*], Roseo Marquez[2], Gregg Howald[3], Jennifer Curl[1], Joel Helm[1], Chandra Llewellyn[1], Patterson Shed[3]

[1] Island Conservation, Center for Ocean Health, University of California, 100 Shaffer Road, Santa Cruz , California 95060 USA

[2] Conservation Society of Pohnpei, Kolonia, Pohnpei, **P**.O. Box 2461, Kolonia, Pohnpei, FM 96941

[3] Island Conservation Canada, 680-220 Cambie Street, Vancouver, British Columbia, V6B 2M9, Canada

***Correspondence**
Island Conservation
Center for Ocean Health
University of California
100 Shaffer Rd, Santa Cruz CA 95060 USA
831-459-1476 (V), 831-459-3383 (F)
alex.wegmann@islandconservation.org

OPERATIONAL SUMMARY

Location	Federated States of Micronesia, small islands adjacent to Pohnpei; less than 20 ha of emergent land (Dekehtik Island 2.63 ha; Imwindekeh Mwahu Island 1.18 ha; Nahkapw Island 1.58 ha; Nahpoli Island 4.12 ha; Pein Mal Island 2.17 ha.)
Primary target pest species	Pacific Rat (*Rattus exulans*) and Black Rat (*Rattus rattus*)
Secondary target species	Feral Cats (*Felis catus*)
Timing	January-February 2007.
Vegetation type	Broadleaf forest, mangrove forest, copra plantation
Climate characteristics	Aseasonal, Intertropical Convergence Zone (ITCZ)
Community interests	Uninhabited islands owned by local families
Historic sites	None known; some islands adjacent to Nan Madol
Project Coordinator	Patterson Shed - Conservation Society of Pohnpei
Operational Managers	Roseo Marquez – Conservation Society of Pohnpei, Alex Wegmann - Island Conservation
Start and end date	Research/Demonstration Eradication: Start January 15 – End February 25, 2007;
Eradication Methods	1. Hand-broadcasting using granular brodifacoum bait, 2. bait-station
Biodiversity/conservation outcomes	Secure habitat for at-risk bird populations, and enrichment of native lizard, invertebrate and plant communities, building local and regional capacity for conservation projects
Target benefit species	Birds: Micronesian Pigeon *Ducula oceanica;* Micronesian Starling; *Aplonis opaca;* Pohnpei Lory *Trichoglossus rubiginosus;* Caroline Is. Reed Warbler;*Acrocephalus syrinx;* Micronesian Kingfisher *Halcyon cinnamomina;* Micronesian Honeyeater *Myzomela rubratra; Pohnpei Flycatcher Myiagra pluto* White tern *Gygis alba*; Black Noddy *Anuos minutus*; Brown Noddy; *Anuos stolides*; White-tailed Tropicbird *Phaethon lepturus* Mammals: Caroline Flying Fox *Pteropus molossinus*, Sheath Tailed Bat *Emballonura sulcata* Terrestrial Invertebrates: Coconut Crab *Birgus latro*; Hermit Crab *Coenopita perlatus, C. brevimanus*; Land Crab *Geocarcoidea sp.* Plants: *Allophylus ternatus; Cordia subcordata, Ficus prolixa; Guetterda speciosa; Hernandia sonora; Neisosperma oppositifolia; Pisonia grandis*, *Terminalia litoralis, Rizophora* sp**.**
Socio-economic benefits and capacity development	Providing employment (eradication operation and subsequent surveillance and biosecurity measures, taining and skills-sharing; developing quarantine and contingency procedures, new partnerships and initiatives in island invasives management
Management history	No previous organized invasive species management attempted at project locations

TABLE OF CONTENTS

POHNPEI RAT ERADICATION RESEARCH PROJECT

Executive Summary (Introduction)

Considered the “emerald” of Micronesia, Pohnpei is a lush, green island formed five million years ago by turbulent volcanic activity (Figure 1). The island is home to a wide variety of natural habitats including barrier reefs, lagoons, mangrove forests and upland forests. It is one of the wettest places on earth, with an average rainfall in excess of 400 inches/year. Pohnpei’s dwarf cloud forests are among the lowest in the world at 450 meters 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, sixteen percent of which is found nowhere else on earth. The Serehd (Pohnpei Lory), a brilliant red bird with hints of green and gold, and the Pohnpei mountain skink, a tiny coppery lizard, are both completely unique to the island. Outside the reefs of Pohnpei, scientists recorded the largest grouper spawning aggregation in the Indo-Pacific region. Recent assessments have revealed new coral and fish species on Pohnpei’s reefs, as well as coral species range extensions.

Unfortunately, the unique habitats of Pohnpei are disappearing at an alarming rate and will continue to do so unless preventive measures are taken. In the past 25 years, the intact interior rainforest of Pohnpei has been reduced by more than 25 percent, and native plant and animal species are being threatened by introduced non-native species.

Through the Pohnpei Rat Eradication Research and Demonstration Project, The Conservation Society of Pohnpei (CSP), Island Conservation (IC), and the Pacific Invasives Initiative (PII) are working together to enhance the biosecurity of Pohnpei’s island ecosystems, and that of other similar ecosystems throughout the Pacific. This research and demonstration project will help NGO and government conservation organizations develop the capacity to plan, fund, and implement subsequent rat eradications in threatened island ecosystems. CSP, IC, and PII also partnered with the following organizations to carry out this pioneering conservation project: the Pacific Invasives Learning Network, The Nature Conservancy, the Pohnpei State Government, the Micronesia Conservation Trust, Micronesians in Island Conservation, local government officials, and local landowners.
The project objectives were:

1. Provide an eradication training opportunity for conservation practitioners from Yap, Kosrae, Guam, Fiji, Samoa, and French Polynesia Pacific island nations.

2. To convey an eradication *process* rather than teach an eradication *recipe* to the greater Pacific Island conservation community because each island eradication scenario will entail idiosyncratic environmental, ecological, logistical, and cultural factors.

3. Convey the results of the training and opportunity to other island managers in other parts of the Pacific through a symposium held immediately on conclusion of the demonstration/eradication opportunity.

At the closure of the Pohnpei rat eradication research project, CSP, IC, PII, and New Zealand's Department of Conservation conducted an invasive species symposium that focused on current and future invasive species management needs throughout Micronesia. NGO and government agency project leaders from the Republic of the Marshall Islands, Kosrae, Pohnpei, Chuuk, Yap, Guam, and Palau attended the symposium. The results of the symposium will not be reported here.

The demonstration component of the project was split into two sections: Section 1 = 23 January to 6 February, Section 2 = 12 February to 26 February, with 6 participants in the first section and 5 participants in the second section. Participants were directly involved in a series of rat eradications on small islands adjacent to Pohnpei. Eradication experts worked side-by-side with the participants to ensure all were exposed to an array of eradication methodologies, and participants frequently contributed their knowledge of tropical ecosystems and rat eradication practices. This rat eradication research and demonstration project introduced and tested a suite of techniques that are applicable, in a general sense, to rat eradications on low, small tropical islands. Such techniques can be scaled up or down, or changed accordingly to meet the needs of subsequent eradication projects.

During the project, participants learned how to:

- Conduct a pre-eradication feasibility survey
- Gather baseline ecological data prior to an eradication
- Calibrate the amount of rodenticide needed for an eradication
- Assess and mitigate risk to non-target species
- Conduct an effective rat eradication with bait-stations
- Conduct an effective rat eradication by hand-broadcasting bait
- Determine when one of the above methods is more appropriate than the other
- Determine eradication success

CSP and IC selected 5 small islands (Table 1) as study sites in the Pohnpei Rat Eradication Research Project (Fig. 1). Island selection was based on the following criteria:

1. Rats present
2. No permanent human habitations
3. Island Area between 1 and 10 hectares
4. No less than 0.5 Kilometers from the Pohnpei shoreline
5. For logistical ease, within 2 km of one or more other study islands
6. Accessible by small boat throughout the most of the tide cycle
7. Permission from land owner(s) and the municipal government

Three islands were selected for eradication: Dekehtik, Nahkapw, and Pein Mal. Hand broadcast eradications were performed on Dekehtik and Pein Mal, and a bait-station eradication was conducted on Nahkapw. 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. And eradication efficacy measures and non-target sampling plots were established on the treatment islands prior to bait application.

Non-target species (landbirds, land crabs, shorebirds, and bats) were sampled on all treatment islands prior to, during, and after bait application.

CSP and IC informed the public about the project and the small but implicit human health risk associated with use of rodenticides in rat eradications prior to, during, and after active bait application on the trial islands. The public outreach effort consisted of news paper articles, radio broadcasts, informing government and community leaders, and posting information signs on the treatment islands. Table 2 and Figure 2 provide a detailed account of project personnel and the project architecture.

Figure 1: Project site, Madolenihmw Municipality, Pohnpei, FSM

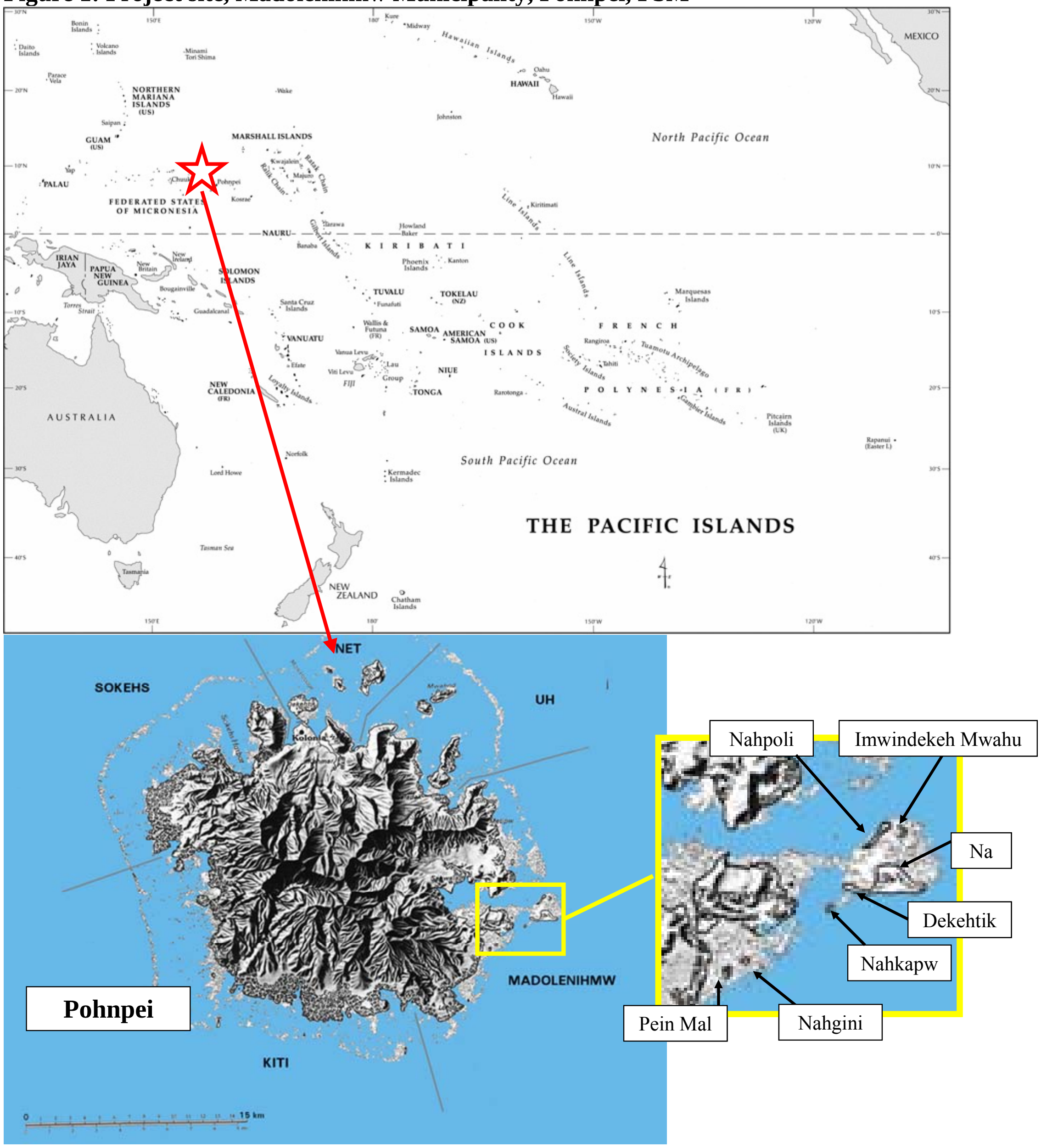


Table 1: Emergent land and mangrove areas of islands included in the Pohnpei Rat Eradication Research Project

Island	Land area (ha)	Mangrove area (ha)	Total area(ha)	Treatment
Dekehtik	2.63	0	2.63	Hand-broadcast
Imwindekeh Mwahu	1.18	1.19	2.37	Reference
Nahkapw	1.58	0	1.58	Bait-station
Nahpoli	4.12	3.7	7.82	Reference
Pein Mal	2.17	1.9	4.07	Hand-broadcast
Total	**13.15**	**7.19**	**20.34**	

Table 2: Pohnpei Rat Eradication Research Project personnel

Core Team	Country	Affiliation
Alexander Wegmann	USA	Island Conservation
Amy Carter	USA	Island Conservation
Andrew Roberts	New Zealand	Department of Conservation
Angus Parker	USA	Island Conservation
Bill Nagle	New Zealand	Pacific Invasives Initiative
Chandra Llewellyn	USA	Island Conservation
Dj Primo	Pohnpei	Conservation Society of Pohnpei
Epipanio Lengsi	Pohnpei	Conservation Society of Pohnpei
Gregg Howald	Canada	Island Conservation Canada
Jacob Sheppard	USA	Island Conservation
Jason Lepin	Pohnpei	Madolenihmw Municipal Government, Pohnpei
Jennifer Curl	USA	Island Conservation
Jennifer Lape	USA	Island Conservation
Joel Helm	USA	Island Conservation
Jonathan Steinburg	USA	Island Conservation
Karl Campbell	Ecuador	Island Conservation
Larko Mihkel	Pohnpei	Conservation Society of Pohnpei
Marceano Imar	Pohnpei	Conservation Society of Pohnpei
Nixon Daniel	Pohnpei	Conservation Society of Pohnpei
Patterson Shed	Pohnpei	Conservation Society of Pohnpei
Roseo Marquez	Pohnpei	Conservation Society of Pohnpei
Stacey Buckelew	USA	Island Conservation
Section 1 Participants: 14 - 25 February		
Anne Gouni	French Polynesia	Société d'Onithologie de Polynésie Manu
Billy Fuifatu	Samoa	Ministry of Agriculture & Fisheries
Dana Lujan	Guam	US Department of Agriculture
Natasha Doherty	Samoa	Ministry of Natural Resources and Environment
Remos Livae	Kosrae	Department of Agriculture
Vanessa Fread	Yap	Yap Community Action Program
Section 2 Participants: 14 - 25 February		
Elenoa Seniloli	Fiji	Birdlife International Pacific Partnership
Jason Jack	Kosrae	Kosrae Conservation and Safety Organization
Jeff Quitigua	Guam	Guam Agriculture
Joape Kuruyawa	Fiji	University of the South Pacific
Vilikesa Masibulavu	Fiji	Birdlife International Pacific Partnership
Project Advisors		
Alan Saunders	New Zealand	Pacific Invasives Initiative
Jill Key	Samoa	Pacific Islands Learning Network
Souad Boudjelas	New Zealand	Pacific Invasives Initiative

Figure 2: Pohnpei Rat Eradication Research Project Gannt Chart

PROJECT ACTIVITY	JANUARY													FEBRUARY																							
	F	S	Su	M	T	W	TH	F	S	Su	M	T	W	TH	F	S	Su	M	T	W	TH	F	S	Su	M	T	W	TH	F	S	Su	M	T	W	TH	F	S
	19	20	21	22	23	24	25	26	27	28	29	30	31	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Island Assessment	DK	DK	DK		NK NG PM																																
Wax Bait Making	X		X	X		X	X	X	X							X									X												
Day Off										X							X														X						
Trap Night			NG PM	NG PM	NG PM NK	NG PM NK	NG PM NK	NK PM			DK	DK	DK					DK	NP	NP	NP	PM	PM	PM								PM NK				DK	DK
Indicator Night			NG PM NK	NG PM NK	NG PM NK	NG PM NK	NG PM NK	NK PM	NK DK	NK DK	NK DK	NK DK	NK DK	NK DK	NK	NK	NK	NP NK	NP NK	NP NK	NP NK ID NA	NP NK ID NA PM	NP NK ID NA PM	PM NK NP	NK	NK	NK	NK	PM NK	PM	PM NK	PM NK NA	PM NK NA	PM NK NA	DK NK	DK NK	DK NK
Deploy Collars				PM	PM	PM	NK					DK	DK	DK																							
Telemetry					PM	PM	PM	PM NK	PM NK		PM NK	PM	PM DK NK	PM DK	PM NK	PM NK DK		PM NK	PM DK	PM NK	DK	DK NK	DK	DK NK	DK	DK	DK	DK NK	DK	DK NK		DK NK					
Reference Trap Night																						NA IM NP	NA IM NP	NP IM NP								NA					
Activate Bait-stations											NK																										
Check Active Bait-stations													NK		NK	NK		NK		NK		NK		NK				NK		NK		NK	NK		NK		
Activate Mangrove Bait-stations											PM																										
Check Mangrove Bait-station													PM	PM	PM	PM						PM	PM	PM					PM								
Bait Canopy											PM																	DK									
Practice Hand-broadcast		X			X							X															X										
Hand-broadcast (Placebo)					DM																																
Hand-broadcast (Active Bait)												PM															DK										
Uptake (Placebo)						DM	DM	DM	DM																												
Uptake (Active)													PM	PM	PM	PM		PM		PM								DK	DK	DK		DK					
Non-Target Sampling							PM NG NK		PM NK		PM NK DK		PM NK DK		PM	NK DK		PM DK NK		NK PM	DK	PM NK	DK	NK	DK				DK PM	NK		PM DK	NK				
Carcass Search (formal)														PM		PM		PM		PM		PM							DK PM			DK PM		DK		DK	
Carcass Search (informal)													PM DK NK	PM DK	PM NK	PM NK DK		PM NK	PM	PM NK		NK PM		NK				DK NK	DK PM	DK NK		NK	DK PM NK		PM DK		DK
Telemetry Study																					DK	DK	DK	DK													
Measure Telemetry Points																										Dk								PM NK			

PROJECT IMPLEMENTATION

Bait Application

The amount of bait applied to an island's emergent land area, or application rate - measured in kg/ha, needed for a broadcast application must ensure that every individual rat on the island can easily and normally access bait for a time-period that maximizes the likelihood that each rat will consume a lethal dose. Inadequate bait application increases the probability of eradication failure by violating the above assertion. High application rates decrease the probability of eradication failure, yet excessive bait remnant in the environment will leave non-target species at a higher than necessary risk of primary exposure to the applied rodenticide. We believe that a bait application rate that sufficiently delivers bait to all rats for a minimum of 4 days and a maximum of 7 days is acceptable to limit the temporal risk of primary exposure to non-target species, yet maximizing probability of eradication. During the Pohnpei Rat Eradication Research Project, we conducted a bait application rate calibration study to locate an application rate that satisfies the above criteria for the Pohnpei environment. As no two island environments are identical, there is not a reliable application rate that can be applied across the board; the appropriate application rate for each eradication project should be determined on site and should take into account seasonal variation in bait consumer populations.

The ideal application rate ensures that bait is available to all rats in the treatment area for a given amount of time – in this case 4 days. Several factors influence bait availability:

- non-target bait consumers (land crabs, insects, birds, etc.) ◄
- bait density (# pellets per unit area) ◄
- bait palatability
- bait weathering (pellet composition)

Previous studies show that the specific bait used during the Pohnpei Rat Eradication Research Project - *Brodifacoum PI-25 Conservation* bait by Bell Laboratories, Inc., Madison Wisconsin - is highly palatable to *R. rattus*, and structurally resilient in a wet tropical environment. During this project, we focused on the remaining two factors, non-target bait consumers and bait density by conducting a bait application rate calibration study to target an ideal application rate for the target islands.

Methods

Placebo Bait Application

To target an effective broadcast application rate for the Pohnpei Rat Eradication Research Project, a non-toxic. 2.3g (mean weight) placebo bait (exact non-toxic replica of PI-25) was had-broadcast at 45kg/ha to Imwindekeh Mwahu (1.18 ha emergent land). To ensure uniform bait application across the entire island, a team of 4 hand-broadcasters spaced 5 meters apart walked parallel transects across the width of the island, stopping every 5 meters to apply bait to successive 5m x 5m ($25m^2$) areas. The person in the inside position of the baiting line placed flags along her line so the subsequent baiting swath would abut and slightly overlap the previous swath. Each hand-broadcaster carried up to 10 kg of pellets in a two-pocket tree-planting hip pack. A calibrated cup was used to accurately measure the 49 pellets necessary to reach the 45kg/ha application rate within the $25m^2$ baiting area (Appendix A). The number of pellets needed was calculated with the following equation:

$$\left[\frac{(\text{application rate (g)}/1\,\text{hectare})}{\text{pellet weight (g)}}\right]\times \text{plot size } (\text{m}^2) \longrightarrow \#\text{ of pellets needed}$$

or

$$\left[\frac{(4000g/10000m^2)}{2.3g}\right]\times 6.25m^2 = 17\,pellets$$

A baiting supervisor, or "line boss" controlled the movement and spread of the hand-broadcasters to ensure uniform bait application across the treatment area.

Application Rate Calibration

To estimate the mean bait consumption rate – hence forth referred to as "uptake rate" - we established randomly placed, fixed 5m x 5m plots ($25m^2$) throughout the island and monitored bait uptake for 4 days (n = 10 plots). Prior to bait broadcast, wire pin-flags were placed inside each plot and a single bait pellet was placed at the base of each flag (n = 49); the number of flags in each plot equaling the target application rate of 45kg/ha (Figure 3). Uptake plots were sampled every 24hrs; flags attending pellets were left alone while flags without pellets were pulled and counted. The total number of flags collected from each plot on each of the four sample days was recorded.

Figure 3: Bait uptake plot

The total number of bait pellets consumed from each given plot was used to extrapolate an application rate suitable for the two islands slated for rat eradication by hand-broadcast: Pein Mal, and Dekehtik. The number of pellets remaining in each plot was converted to kg/ha by multiplying the number of pellets remaining by the mean dry pellet weight, then dividing by the plot area (in ha). The consumption rate for each plot will be calculated by subtracting the remaining bait (kg/ha) from the target application rate (40 kg/ha). The mean and standard deviation of the consumption rate for all plots was calculated and the upper 99% confidence interval for the sample mean was used as the target application rate for the trial (Table 3).

Table 3: Application rate calibration study results (45 kg/ha placebo bait applied to Imwindekeh Mhawu)

	Day 1	Day 2	Day 3	Day 4
Imwindekeh Mwahu $25m^2$ Random/Fixed Uptake Plots				
Mean number of pellets removed from plot	33	40	45	46
99% Confidence Interval around mean (± pellets)	10	8	5	5
Mean bait mass per plot (g)	75	91	102	107
Mean bait mass per mass per m2 (g)	3	4	4	4
% of total application removed	67%	81%	91%	95%
% of total application removed at the of the 99.9% CI upper limit	88%	98%	102%*	105%*
Island estimate of bait removed (kg/ha)	30	36	41	43
Island estimate of bait removed at the 99.9% CI upper limit (kg/ha)	40	44	46	47

*** Unrealistic value due to high variance around the sample mean**

Because the 99.9% confidence interval upper limit bait uptake estimate exceeded the application rate by 5%, 3 kg/ha was added to the initial 45kg/ha application rate; 50kg/ha became our application rate for the two hand-broadcast active bait application events.

Active Bait Application: Canopy Baiting on Pein Mal and Dekehtik

During the course of this project, radio-collared *R. rattus* and *R. exulans* spent a significant amount of time in the forest canopy, and specifically in the crowns of mature *C. nucifera* trees (see *Rat Home Range Study: Results*, Appendix B for more information on rat habitat use). The 50kg/ha active bait application rate ensures that enough bait is distributed throughout the planar home range of every rat on the island; however ground baiting does not account for the 3rd dimension, the "tree" dimension, in every rat territory. To ensure that rats that may have been living in the canopy encountered bait, we fabricated "bolo baits" by joining two waxy, three-pellet bait clusters with 30-50 cm of biodegradable twine. The bait bolos were shot into approximately 1/3 of the palm trees on both Pein Mal and Dekehtik (Figure 4, Table 4).

Figure 4: Canopy baiting

Table 4: Canopy baiting activity log for Dekehtik and Pein Mal

Island	# of coconut palms on island	# of bolos deployed	Amount of bait applied to the canopy (g)
Dekehtik	640	220	3,036
Pein Mal	480	160	2,208

Active Bait Application: Mangrove Bait-stations on Pein Mal

Pein Mal's 2.17 ha of emergent land is flanked by a 1.9 ha ring of mangrove forest that reaches 50m in width along the southeast coast. The mangrove forest offers forage (mangrove propagules, intertidal fish, and invertebrates) and shelter (hollowed out trunks and logs) to rats. Several of the radio-collared *R. rattus* on Pein Mal made forays into the mangrove forest, and propagules still attached to mangrove trees bore rat chew marks, and one active rat nest was found in a hollow tree trunk 20 meters into the mangrove forest from dry land. Hand-broadcasting in the mangrove forest is impossible due to the twice-daily high-tide flooding events. It was unclear how important the mangrove forest was to rats. The day prior to hand-broadcasting bait on the island we installed bait stations (Figure 5) in a 15m x 15m grid throughout all of Pein Mal's mangrove forest (n = 144). The mangrove bait-station is a simple waxy "bait-muffin" (containing 8 x 2.3g bait pellets) nailed to a mangrove trunk 1.5m – 2 m above the high water mark. A subsample (n = 35) of the mangrove bait-stations were monitored on days 1-3, 8, and 17 post hand-broadcast bait application. During each mangrove bait-station sample day, all 35 stations where checked and the % of each bait-muffin remaining (100%, 75%, 50%, 25%, 0%) was recorded, and the probable bait consumer was identified by characteristic chew marks left in the waxy part of the bait-muffin (see *Wax Indicator* section below). The mangrove bait-stations were left on the island for 24 days post bait application.

Figure 5: Mangrove bait-station

Active Bait Application: Bait-stations on Nahkapw

Only one rat (*R. rattus*; adult female) was caught on Nahkapw, and wax indicator success was very low (see *Efficacy Measures* section below), suggesting that the island hosted a low density population of rats. Rather than hand-broadcast rodenticide across the entire island to kill a small number of rats - possibly just one rat - Rat-Go™ Elevated Bait-stations by Marine Endeavors (n = 22) were established along two transects that ran the length of the island (Figure 6). The bait-stations were spaced approximately 20m apart while the distance between the two transects varied with the shape of the island, but was never less than 10m or more than 30m. The bait-stations on Nahkapw were established on 29 January and removed on 22 February. Every two days, or when weather and scheduling permitted, bait-stations were assessed for station condition and bait condition – bait consumer (identified by characteristic marks left in the waxy portion of the bait muffin) was also noted if the bait was partially eaten. Because the ground based bait-stations did not experience any activity for the first 2 weeks, waxy bait-muffins (identical to those used in the mangrove forest on Pein Mal) were attached to tree trunks (1.5m – 2m above ground) adjacent to each ground-based bait-station.

Figure 6: Marine Endeavors bait-station

Active Bait Application: Hand-broadcast

Active rodenticide bait containing 25 ppm brodifacoum (PI-25) was applied to the following islands during the Pohnpei Rat Eradication Research Project: Pein Mal (2.17ha), and Dekehtik (2.63ha). The application rate for active bait, 50kg/ha, was determined by the *Application rate calibration study* described above. Bait was applied with a 6 person baiting line that followed the same method already described in the *Placebo Bait Application* section (Figure 7). During the active bait applications, hand-broadcasters used calibrated cups to efficiently apply 50kg/ha, or 54 pellets, to successive 25m^2 areas. Appropriate personal protective equipment was worn by all active bait handlers: full overall suit, nitrite gloves, and closed shoes to eliminate skin exposure to brodifacoum, and particle respirators were worn while transferring bait from storage buckets to baiting bags.

Figure 7: Hand broadcasting

Real-time Application Rate Sampling

During the active bait applications, a team of two people spot-sampled the real-time application rate by following the bating line and counting pellets within randomly selected 2m radius circle plots. The 2m radius plots were sampled with one person standing in the center of the plot holding onto the beginning of a 2m piece of string; the other person held onto the end string's end and walked a complete circle around the person in the center. All bait pellets passing under the string were counted while vegetation and leaf-litter were moved to decrease detection error. Major deviations from the target application rate (27 pellets per 2m radius plot = 50kg/ha) were reported to the line boss, who then encouraged the baiting line to either tighten or relax the spacing between hand-broadcasters depending on whether the line was over or under-baiting.

Active Bait Uptake Monitoring

Bait uptake was monitored for 8 days post bait application on Pein Mal and 6 days post bait application on Dekehtik. Bait uptake was measured with fixed plots similar to those used in the *Application rate calibration study*, and with random circle plots.

Pein Mal - 25m^2 Fixed Uptake Plots

Fixed 5m x 5m (25m^2) plots (n=10) were randomly placed throughout Pein Mal's emergent land area; these plots were established and sampled as discussed in the *Application Rate Calibration* section on days 1 – 4 and 8 post bait application. Pellets were placed within the plots at a density equal to a 100kg/ha application rate, while active bait was applied to the rest of the island at 50kg/ha. The rational behind this deviation from the placebo uptake plot design was that the increased bait density within the uptake plot would be able to detect a bait uptake rate higher than the bait application rate, i.e., an uptake rate > 50kg/ha.

Pein Mal – 25m^2 Random Circle Plots

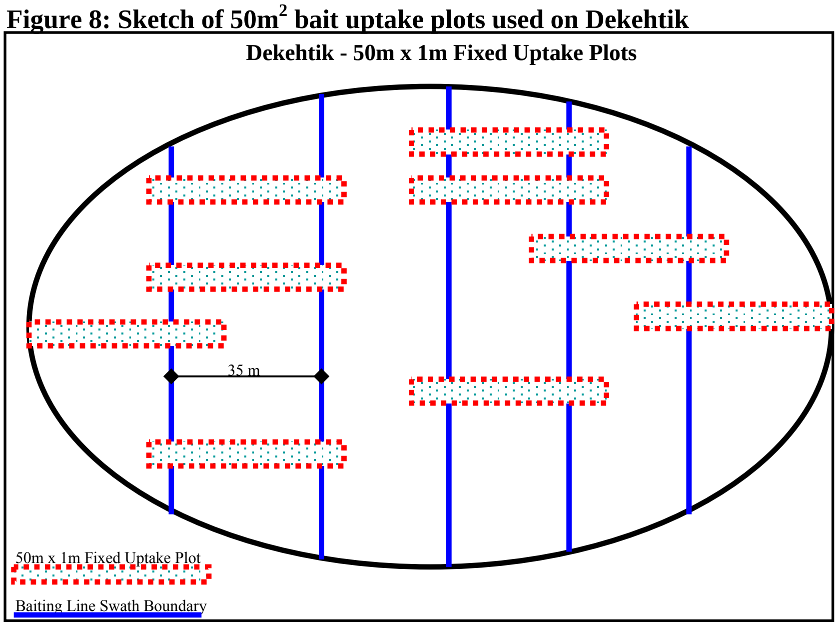
In addition to the fixed 25m^2 bait uptake plots, random 2.83m radius (25m^2) circle plots (n = 10 per sample day) were sampled to estimate the amount of bait remaining at days 1 – 4 and 6 post bait application. The method for sampling the 2m radius plots used for the real-time application rate sampling (see above) was used to sample the 25m^2 circle plots. Counter to the 25m^2 fixed uptake plots, the circle uptake plots provide a direct estimate of how much bait (kg/ha) remains unconsumed at a given time post bait application. The random circle plots also escaped any bias potentially caused by the proximity of a pin-flag to each bait pellet.

Dekehtik – 50m^2 Fixed Uptake Plots

To avoid the high variance in the bait uptake estimates from the uptake plots on Pein Mal, 50m x 1m (50m^2) fixed uptake plots (n = 9) were randomly placed on Dekehtik 1 day prior to bait application. Pellets cast into the plots during the hand-broadcast effort were quickly marked with a pin-flag. The total number of pellets found in each plot directly after bait application was averaged across plots, multiplied by the pellet weight (2.3g), divided by plot area (50m^2), multiplied by 10,000m2 (1 hectare), and divided by 1000g (1 kg) to estimate the realized application rate. The 50m^2 plots were sampled 1-3, 4 and 5 days post bait application to estimate the bait uptake rate.

In principal, the island-wide bait uptake estimate from the 50m^2 plots should be a closer approximation of the true bait uptake rate for two reasons: 1) the longer plots were established in such a way that they cover the width of the swath left by the baiting line, thus absorbing variation in individual hand-broadcaster bait application, 2) the longer plots are more likely to account for patchiness in bait consumer populations (Figure 8).

Figure 8: Sketch of 50m^2 bait uptake plots used on Dekehtik



Results

Bait Uptake Study

Following bait application, the uptake, or removal rate, of applied rodenticide bait pellets was followed on Dekehtik and Pein Mal. We employed three methods to measure bait uptake (Table 5): 25m^2 random circle plots (Pein Mal), 25m^2 fixed plots (Pein Mal), and 50m^2 random/fixed plots (Dekehtik). Strong variation in the results makes it difficult to ascertain the true bait uptake rate through the monitoring period. Several factors likely contribute to the high variation in the uptake values within each methodology: variation in bait consumer distribution, variation in bait application (hand-baiter error); between methodologies: fixed flagged plots vs. random unflagged plots, 25m^2 plots vs. 50m^2 plots, and between islands: *R. rattus* on Pein mal vs. *R.* exulans on Dekehtik. We did not replicate the same methodology on both hand-broadcast islands and thus cannot compare estimated bait uptake between *R. rattus* and *R. exulans*. However, the results show that most bait was removed (consumed) within 24hrs of bait application, and there is a significant, negative correlation between bait uptake and the number of days post bait application: for Dekehtik r = -0.956, P-Value = 0.008, and for Pein Mal r = -0.958, P-Value = 0.01.

Individual pellets within the 50m^2 plots on Dekehtik were followed to determine the probability of survival (remaining within the plot) of a given pellet. Bait pellet survival probability dropped from 58% to 20% from day 1 to day 6 post bait application. Linear regression analysis (Figure 9) shows that the relationship between the probability of bait pellet survival and the number of days post bait application is significant (F = 51.91, P-Value = 0.000), yet the linear model only explains half of this relationship (R-sq = 54.7).

As major bait consumers, land crabs complicate broadcast eradications on tropical islands. Land crab populations are often patchy (A. Wegmann, personal observation), yet individual land crab home range size can exceed 8 ha (Wegmann 2007, unpublished data), making it nearly impossible to avoid land crab related bait loss during a broadcast-based eradication. The methods used during this project do not allow us to distinguish land crab related bait uptake from rat related bait uptake. Future broadcast based eradication projects should focus on this distinction, as land crab related bait consumption necessitates increased bait application rates, which increases non-target species exposure risk, human health risk, and project cost.

Figure 9: Linear regression model for bait pellet survival probability over time, Dekehtik

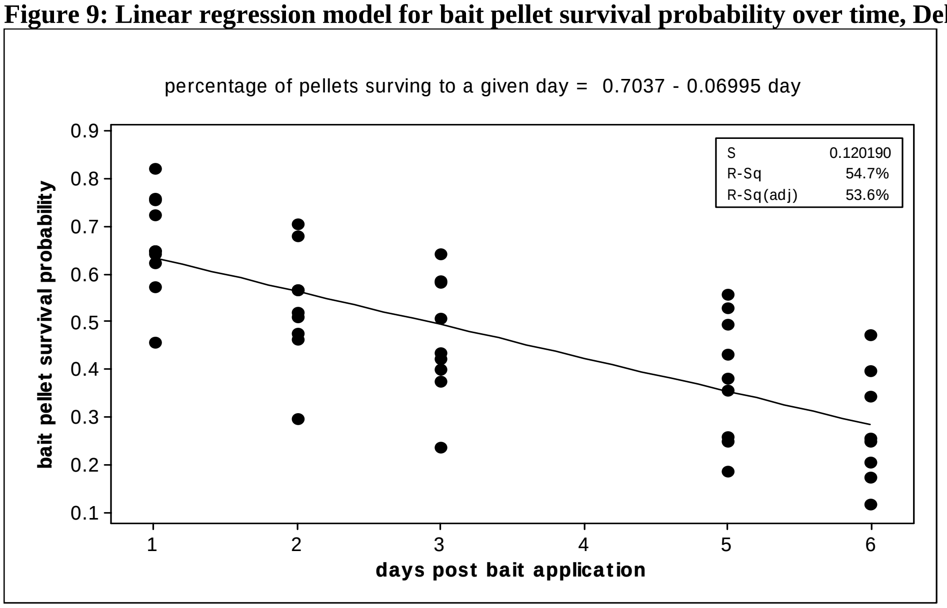


Table 5: Bait uptake study results (50 kg/ha active bait application on Pein Mal and Dekehtik)

Active Bait Uptake Sampling Events	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 8
Pein Mal 25m^2 Random Circle Uptake Plots							
Mean number of pellets remaining	26	21	11	14		6	
99% Confidence Interval around mean (±)	20	9	6	12		7	
Mean bait mass per plot (g)	60	48	25	32		13	
Mean bait mass per mass per m^2 (g)	2	2	1	1		0	
% of total application remaining	47%	38%	20%	25%		3%	
% of total application remaining at the of the 99.9% CI upper limit	7%	21%	7%	2%		-11%*	
Island estimate of bait remaining (kg/ha)	24	19	10	13		2	
Island estimate of bait remaining at the 99.9% CI upper limit (kg/ha)	3	10	3	1		-6*	
Pein Mal 25m^2 Random/Fixed Uptake Plots[Ψ]							
Mean number of pellets removed from plot	54	69	77	83			91
99% Confidence Interval around mean (±)	13	12	13	12			12
Mean bait mass per plot (g)	124	158	177	192			210
Mean bait mass per mass per m^2 (g)	5	6	7	8			8
% of total application removed	43%	55%	62%	67%			73%
% of total application removed at the of the 99.9% CI upper limit	55%	66%	73%	77%			83%
Island estimate of bait removed (kg/ha)	50	63	71	77			84
Island estimate of bait removed at the 99.9% CI upper limit (kg/ha)	63	76	83	89			96
Dekehtik 50m^2 Random/Fixed Uptake Plots							
Mean number of pellets removed from plot	34	48	57		64	73	
99% Confidence Interval around mean (±)	12	14	15		16	16	
Mean bait mass per plot (g)	78	111	131		147	169	
Mean bait mass per mass per m^2 (g)	2	2	3		3	3	
% of total application removed	33%	47%	56%		63%	72%	
% of total application removed at the of the 99.9% CI upper limit	59%	77%	88%		96%	107%*	
Island estimate of bait removed (kg/ha)	16	22	26		29	34	
Island estimate of bait removed at the 99.9% CI upper limit (kg/ha)	28	36	41		45	50	
Probability of any bait pellet surviving to the indicated sample day	67%	53%	47%		38%	29%	
Probability of any bait pellet surviving to the indicated sample day at the 99.9% CI lower limit	58%	43%	36%		28%	20%	

*** Unrealistic value due to high variance around the sample mean**
Ψ The 25m^2 fixed plots on Pein Mal were baited at 100 kg/ha while the island was baited at 50 kg/ha

Bait-stations

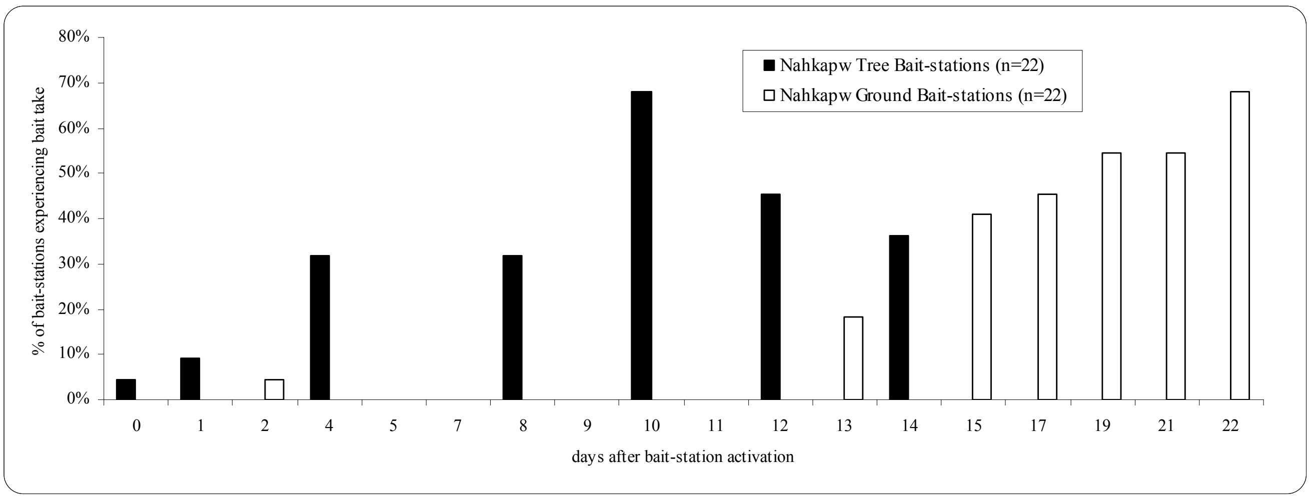
Both ground and tree based bait-stations were deployed during the project. Bait-stations minimize non-target competition for bait, yet amplify the potential for missing rats by increasing the spatial gap between delivered bait units. Ground- and tree-based bait-stations were deployed on

Nahkapw Island to eradicate a low-density rat population[1], and tree based bait-stations were established on Pein mal to extend the effective bait application area throughout the island's mangrove forest habitat.

Less than 1 kg of PI-25 brodifacoum bait was available via bait-stations at any given time on either island (Table 6). Less than 1 kg of bait was removed from the mangrove bait-stations on Pein Mal, and approximately 1.5 kg of bait was removed from both tree and ground bait-stations on Nahkapw. On Nahkapw, ground bait-stations experienced minimal bait take until two weeks after bait-station activation while tree bait-stations on Nahkapw experienced bait take soon after station activation; bait take occurrences increased with time for both station designs. The initial, prolonged period of no bait take for ground bait-stations suggests that both rats and land crabs acclimate to the presence of ground bait-stations. The tree bait-stations on Nahkapw did not experience the same delay in bait take (Figure 10).

Indicative chew marks left on the waxy bait blocks show that crabs were the primary known bait consumer at ground and tree bait-stations on Nahkapw, while rats were the primary bait consumers at mangrove bait-stations on Pein Mal (Figure 11).

Figure 10: Ground and tree bait-station activity on Nahkapw, 31 January – 22 February 2007



On Nahkapw, the sole radio collared rat was found dead on 22 February, 25 days after activation of the ground bait-stations and 16 days after activation of the tree bait-stations. The first recorded rat bait take occurred at a tree bait-station on 15 February, 8 days after the tree bait-stations were installed and 7 days before the radio collared rat died - probably from consuming a lethal dose of brodifacoum[2]. The first recorded rat bait take from a ground based bait-station occurred on 19 February, 22 days after the ground bait-stations were activated and 3 days before the radio collared rat died. Because we do not know if the bait take by "unknown bait consumers" is rat or crab related, we cannot be certain when or from which type of station the radio collared rat consumed enough bait to incur a lethal dose.

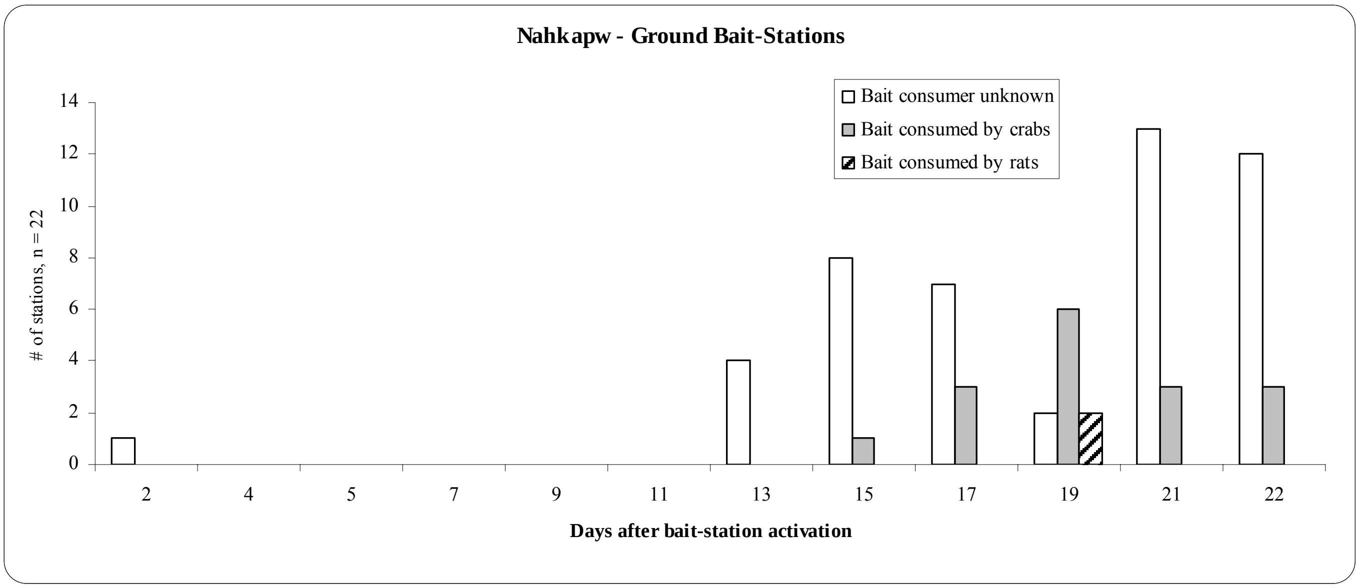
[1] We only detected one rat, an adult female *Rattus rattus*, on Nahkapw; because of this we decided to conduct a bait-station eradication rather than incur the non-target risk associated with a hand-broadcast treatment.

[2] A field necropsy found cranial hemorrhaging, bleeding from the nose and anus, and a stomach full of PI-25 bait.

Table 6: Amount of bait applied to and consumed from bait-stations on Pein Mal and Nahkapw

Treatment Island	Total daily amount of bait available while bait-stations were active (g)	Total amount of bait removed from bait-stations (g)
Pein Mal - mangrove bait-stations	644	704
Nahkapw – tree bait-stations	405	554
Nahkapw - ground bait-stations	405	833

Figure 11: Bait consumer record for bait-stations on Nahkapw, 31 January - 22 February, 2007



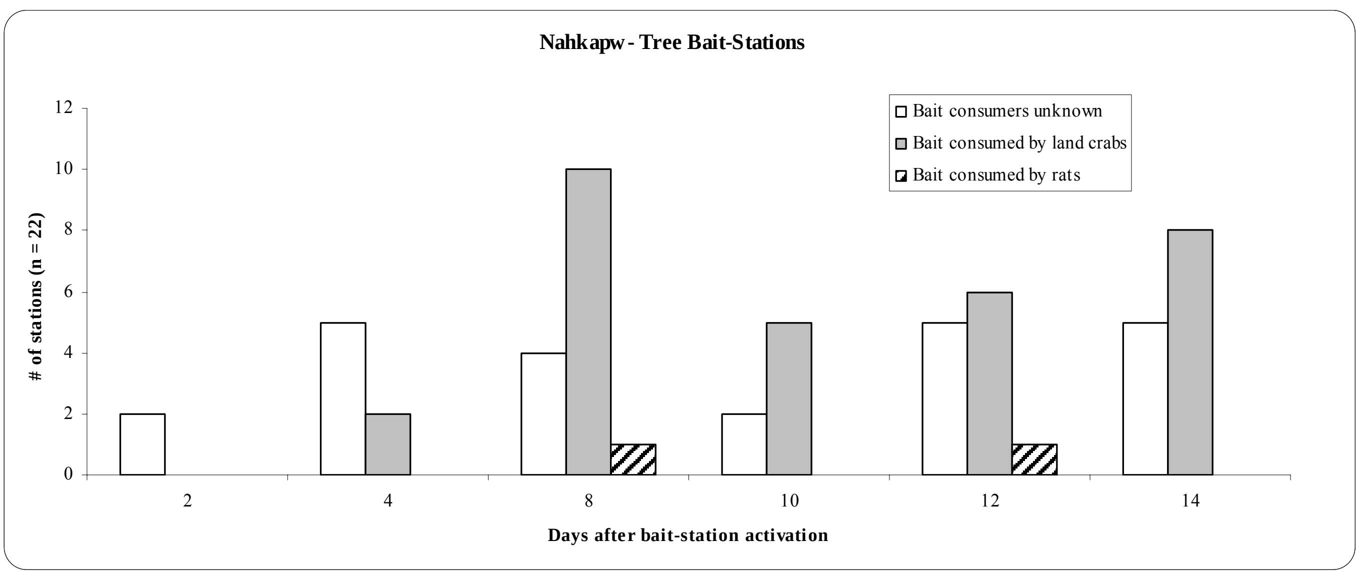
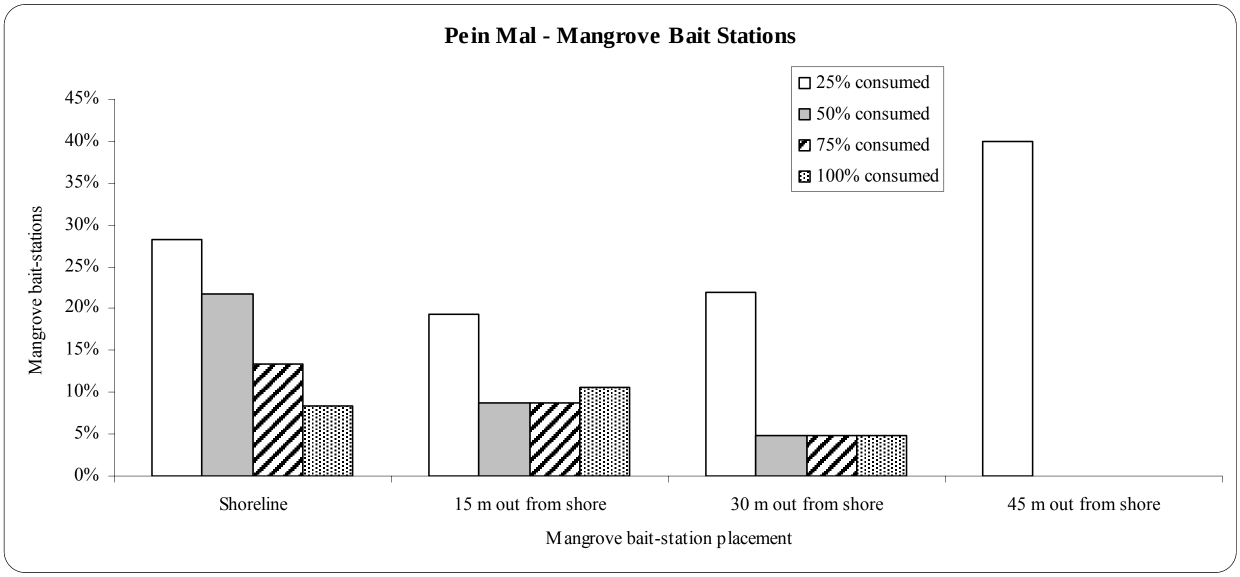


Figure 12: Mangrove bait-station activity on Pein Mal, 31 January – 3 February, 2007



On Pein Mal, mangrove bait-stations were supplementary to the hand-broadcast application of PI-25 bait pellets. The mangrove bait-stations were activated one day prior to the hand-broadcast application. They experienced significant rat bait take directly after the hand-broadcast application. The high level of rat bait take from the mangrove bait-stations and the extensive use of the mangrove habitat, as indicated by the consumption of bait from bait-stations placed at increasing distances from the shoreline (Figure 12), strongly emphasize that rat eradications on islands with extensive mangrove habitat should include mangrove baiting in the eradication[3].

EFFICACY TESTING

The Pohnpei rat eradication research project has several technical objectives: 1) to test the efficacy of both the bait and the employed baiting methods in successfully eradicating rats from the target islands, 2) to understand and mitigate habitat disturbance and rodenticide exposure risk to non-target species, and 3) to understand the operational and regulatory environment. The first objective, efficacy testing, ensures that either eradication success or eradication failure is quantitatively documented and thus defensible. We monitored eradication efficacy using the following three techniques: 1) live trapping, 2) wax chew blocks, and 3) radio telemetry. The test will follow a Before-After/Control-Impact (BACI) design (Smith 2002) where all efficacy measures are run before and after bait application. During post bait application efficacy testing, live trap and wax indicator transects were established and monitored in an untreated reference area. Trap and wax indicator activity in the reference area supplied a rat detection measure used to validate trap and wax indicator activity on the treated islands.

<u>Methods</u>

Radio Telemetry

[3] Mangrove propagules still attached to the tree were found with fresh rat chew marks

Captured adult rats (n= 18), chosen randomly, were fitted with radio collars prior to bait application on Pein Mal, Nahkapw, and Dekehtik islands (Table 7). Trapped rats were anaesthetized with isoflourane and fitted with a radio collar (Advanced Telemetry Systems, Minnesota) programmed to a unique frequency, and a uniquely numbered stainless steel ear tag. All radio collared rats were released at the point of capture. Prior to release, the following data was collected from each radio collared rat:

- Species, sex, reproductive condition and weight
- Ear tag #
- Radio collar frequency
- Personnel involved with collaring
- Capture and collaring date, time and location
- Condition of rat at time of collaring

We used directional Yagi antennas and digital receivers to track collared rats prior to and after bait application. Collared rats observed as inactive (i.e. a dead rat or a slipped collar) prior to bait application were excluded from post bait application analysis. Post bait application radio tracking continued until the mortality of each radio collared rat was visually confirmed or assumed based on the rats' activity/inactivity pattern. The following information was recorded for each observation made of a collared rat:

- Date, time and general location (coastal, interior) of radio collared rat
- Specific spatial location (actual location or bearing and distance from a fixed marker location) of each rat located.
- Condition of rat at time of location (moving, not moving).
- Habitat usage (tree or ground)

Radio collared rats were tracked and observed before, during, and after bait application. A minimum of 3 independent (different day) observations were made of each rat prior to bait application. Each collared rat was tracked and observed daily from the time that bait was applied to the treatment island to the day that mortality was observed. To conclude mortality for a radio collared rat, one of the following must occur: the dead rat is observed, the radio collar signal is located repeatedly in the same location over a period of three days and the signal is invariable indicating no movement. The following data was gathered for each recovered radio collared rat:

- Date, time and location of each rat
- Condition of radio signal (moving, not moving)
- Condition of rat at time of recovery - dead, moribund, and carcass condition
- Location of death (above/below ground)
- Date carcass was recovered or signal last heard.

Table 7: Specifics of radio collared rats for each treatment island

Island	# Collared Rats	Rat Species	Female / Male Ratio	Mean rat weight (g)
Pein Mal	7	*R. rattus*	4 / 3	166
Nahkapw	1	*R. ratus*	1 / 0	195
Dekehtik	10	*R. exulans*	4 / 6	64

Live Trapping

Live trapping occurred on all six project islands. On the three treatment islands, live trap transects were established and opened prior to bait application, and then re-opened 9 to 21 days post bait application for eradication efficacy testing (Table 8). On all project islands, live trap transects were spaced 20 - 40 m apart in response to island topography; live traps were spaced 10 or 20 meters apart on the transects (Table 9). Live trap transects were randomly located on each island. Each live trap station was accompanied by a wax indicator station established on a tree > 5m distant from the live trap. All live traps were mounted on tree trunks 1.5 – 2 m above the ground to discourage land crab interference. Trap location was maintained during baiting operations so that post bait application trapping would spatially replicate the pre baiting trapping session. While active, live traps on all project islands were checked once every 24 hours; the following data was collected during each sampling event:

- Number of traps armed nightly.
- Number of trap success and contents: no activity, trip no catch, rat, crab, lizard, trap gone
- Weight, sex, age class, and reproductive condition of each rat captured.
- Tag number associated with each rat.
- Radio collar frequency (if applicable)

Table 8: Live trapping activity schedule on treatment islands

	Dekehtik	Nahkapw	Pein Mal
Pre bait application live trap and wax indicator establishment (days before bait application)	24	7	10
Initiated post bait application live trap monitoring (days after bait application)	9	21	10
Number of pre bait application live trap sample days	5	3	6
Number of post bait application live trap sample days	3	5	5

Table 9: Live trap and wax indicator placement on all project islands

	Dekehtik	Imwin Dekehmwahu	Na	Nahgini	Nahkapw	Nahpoli	Pein Mal
Number of transects	2	1	1	2	1	3	2
Spacing between transects (m)	40	n/a	n/a	20	n/a	10	10
Number of traps	20	10	10	20	15	40	20
Spacing between traps (m)	20	10	20	10	10	20	20
Number of wax indicators	20	10	10	20	15	30	20

Following the BACI design, live trapping was conducted on each treatment island prior to bait application with a repeat trapping session post bait application. In concert with the post bait application trapping session, live trap transects were established and activated on 3 reference islands (Table 10) to measure the probability of detecting rat presence with live traps. Post bait application live trapping did not commence until 10 days after bait application or after all of the radio collared rats were confirmed dead.

Table 10: Record of trap-nights and indicator-nights on all project islands

	Indicator-nights		Trap-nights	
	pre bait application	**post bait application**	**pre bait application**	**post bait application**
TREATMENT ISLANDS				
Dekehtik	91.5	98.5	78.5	75
Nahkapw	38	329	25	89
Nahnigi	84.5	0	70.5	**
Pein Mal	87	101	90	91.5
REFERENCE ISLANDS				
Na	*	84.5	*	70.5
Imwin Dekehmwahu	*	43	*	38
Nahpali	*	227	*	204

* Live trapping was not conducted on reference islands prior to bait application on treatment islands, ** Nahnigi was dropped from the list of treatment islands after our initial assessment failed to detect rats on the island

Wax Indicator Blocks

Peanut butter flavored wax chew blocks were employed as a third measure of eradication efficacy. Rats chewing on the blocks leave tell-tale incisor marks on the wax (Figure 13). Wax indicator blocks were paired with live traps along trapping transects; wax indicators were placed > 5m from the associated live trap. Wax indicator stations were sampled when the live traps were checked. Because wax indicator blocks pose no risk to non-target species, they were left, on occasion, unattended for 48 hours, in which case the 48 hour sample period was counted as 2 wax indicator nights (Table 10). While sampling the wax indicators, each block with chew marks from the previous sample period was either replaced or shaved clear of all marks with a knife, and a fresh smudge of peanut butter was applied to each block during each sampling event. The following data was recorded for each wax indicator block:

Figure 13: Wax indicator block

1. Date, time, island, station number
2. Rat, crab, bird or insect marks detected, or block missing.

Efficacy Testing Results

Live Trapping and Wax Indicators

Rats were detected with Hagaruma live traps on all treatment islands prior to bait application. Crab interference with traps was low on Dekehtik (0.65%), and moderate to high on Pein Mal (11%) and Nahkapw (45%). Pre-bait application trap success ranged from 52% to 39%; all treatment islands experienced 0% post bait application trap success (Table 11).

Table 11: Pre and post bait application trap success on all treatment islands

	Pre bait application trap nights (trip-no-catch = 0.5 trap nights)	Pre bait application trap success (rat captures / trap nights)	Post bait application trap nights	Post bait application trap success	Overall crab trap success
Dekehtik	78.5	52%	75	0%	0.65%
Nahkapw	25	4%	89	0%	45%
Pein Mal	90	39%	91.5	0%	11%

Concurrent with post bait application efficacy sampling on the treatment islands, a trapping and wax indicator session was run on three reference islands. Reference island trap success ranged from 7% to 40%, and reference island wax indicator success ranged from 5% to 62% (Table 12). Rat detection on the reference islands indicates that the concurrent lack of rat detection on treatment islands is in response to the eradication efforts and not an undefined natural phenomenon.

Table 12: Post bait application indicator and trap success on all reference islands

Reference Islands	Indicator nights	Indicator success	Trap nights	Trap success
Imwin Dekehmwahu	43	37%	38	21%
Na	84.5	62%	70.5	40%
Nahpali	227	5%	204	7%

Pre bait application wax indicator success for rats ranged from 53% to 13% across all three treatment islands, and crab interference (crab indicator success) with wax indicators ranged from 5% to 24% (Table 13). As discussed above, wax indicators were sampled prior to bait application, and 10 days after bait application on Dekehtik and Pein Mal – the two hand-broadcast islands, while wax indicators were sampled prior to and throughout the active bait-station period on Nahkapw.

Table 13: Pre and post bait application indicator success on all treatment islands

Treatment Island	Pre bait application indicator nights	Pre bait application indicator success	Post bait application indicator nights	Post bait application indicator success	Overall crab indicator success
Dekehtik	91.5	47%	98.5	1%	23%
Nahkapw	38	13%	329	4%*	5.1%
Pein Mal	87	53%	101	0%	24%

*** This includes rat chew marks found during the active bait-station period**

Rat chew marks were found on one wax indicator block 12 days after the bait application on Dekehtik. The wax indicator was positioned approximately 250 meters from the narrow channel that separates Dekehtik from untreated Na Island. It is possible that the detected rat invaded Dekehtik from Na; however, we did not detect rat presence with live traps or wax indicators positioned closer to the channel. It is likely that the sampling was initiated prematurely as 12 days lies within the physiological window, or latent period, if rats were to have consumed bait between day 1 and 4. A low wax indicator success rate was recorded on Nahkapw after the bait-stations became active, however no rat marks were found on wax indicators after the sole radio collared rat died.

Radio Telemetry

All radio collared rats on each treatment island were active prior to bait application, and 100% of the radio collared rats were found dead within 6 days of hand-broadcast bait application on Dekehtik and Pein Mal, and within 18 days of bait-station activation on Nahkapw.

NON-TARGET SPECIES MONITORING AND MITIGATION

During the Pohnpei Rat Eradication Research Project we monitored the associated effect of brodifacoum on the treated terrestrial ecosystems by:

1. Performing pre and post-application non-target species Index of Abundance (IOA) surveys to assess potential impact to non-target species

2. Opportunistically observe non-target species interaction with bait hand-broadcast on islands and bait placed in bait-stations.

3. Performing organized and informal non-target species carcass searches to assess the direct effect of brodifacoum.

While species present in the study area and considered at risk of exposure to the rodenticide are abundant throughout Pohnpei, none are known to be endemic to the project islands.

Table 14: Non-target species present on treatment islands

Non-target species guilds present on treatment islands	
Birds	**Mammals**
Micronesian Pigeon *Ducula oceanica*	Caroline Flying Fox *Pteropus molossinus*
Starling *Aplonis opaca*	Sheath Tailed Bat *Emballonura sulcata*
Pohnpei Lory *Trichoglossus rubiginosus*	
Caroline Is. Reed Warbler *Acrocephalus syrinx*	**Terrestrial Invertebrates**
Micronesian Kingfisher *Halcyon cinnamomina*	Coconut Crab *Birgus latro*
Micronesian Honeyeater *Myzomela rubratra*	Hermit Crab *Coenopita* sp.
Pohnpei Flycatcher *Myiagra pluto*	Land Crab *Geocarcoidea* sp.
White tern *Gygis alba*	
Black Noddy *Anuos minutus*	**Reptiles**
Brown Noddy *Anuos stolides*	Oceanic gecko *gehyra oceanica*
White-tailed Tropicbird *Phaethon lepturus*	Mourning gecko *Lepidodactylus lugubris*
Ruddy Turnstone *Arenaria interpres*	Rock gecko *Nactus pelagicus*
Wandering Tattler *Heterscelus incanus*	Micronesian gecko *Perochirus ateles*
Golden Plover *Pluvialis fulva*	Blue-tailed copper-striped skink *Emoia impar*
Bristle-thighed curlew *Numenius tahitiensus*	Green skink *lamprolepis smaragdina*
Pacific Reef Heron *Egretta sacra*	

Land crabs are attracted to and consume bait pellets. However, land crabs are not affected by brodifacoum. Land crabs consume the bait, digest it and pass the inert ingredients and the majority of the rodenticide as feces. Seabirds are also at no, or low risk of exposure to the applied rodenticide due to their marine based foraging habit. Land birds, shorebirds, and bats forage in the terrestrial environment and are potentially at risk of exposure to applied bait.

Because few if any of the landbird and bat species, and none of the shorebird species are resident on the treatment islands, it is very difficult to assess the direct impact of rodenticide bait application on these groups of non-target species. Thus the following sampling programs are not robust measures of non-target species response to brodifacoum bait application; rather, they are quantitative indices used to detect a possible impact of rodenticide on these non-target species.

Methods

Landbird Index of Abundance (IOA) Sampling

Landbird IOA values from the pre bait application sessions were compared to landbird IOA values from post bait application session as an indirect measurement of rodenticide impact on landbirds frequenting the treatment islands. Five landbird IOA sampling stations were placed on each treatment island. Landbird IOA station sampling included a 5 minute wait period followed by a 5 minute sample period where all birds observed by sight or sound within a 20m radius from the plot center were identified and tallied. Audio observations were distinguished from visual observations, and weather conditions were noted at the beginning of each sample. All five landbird IOA stations on a treatment island were sampled within the same 1.5 hour period, and effort was made to conduct the landbird samples before other project activities caused disturbance.

For each landbird species the IOA value is calculated by totaling the number of bird observations, by species and island, during each 5 minute sample period, and then dividing this value by the number of sample periods for each island. Pre and post bait application landbird IOA sessions were conducted on each treatment island, and the respective values were compared to indirectly measure the effect of rodenticide application on landbirds visiting the treatment islands.

Shorebird Census

Prior to and after bait application, shorebirds present on and in the intertidal area surrounding each treatment island were repeatedly censused. To conduct the shorebird census, one or two people would walk the perimeter of the treatment island, identifying and counting all shorebirds observed on or directly flying from the treatment island. Time, tide cycle, and weather conditions were noted during all shorebird censuses. Pre and post baiting census values were compared as an indirect measure of rodenticide on the shorebirds visiting the trial islands.

Bat Monitoring

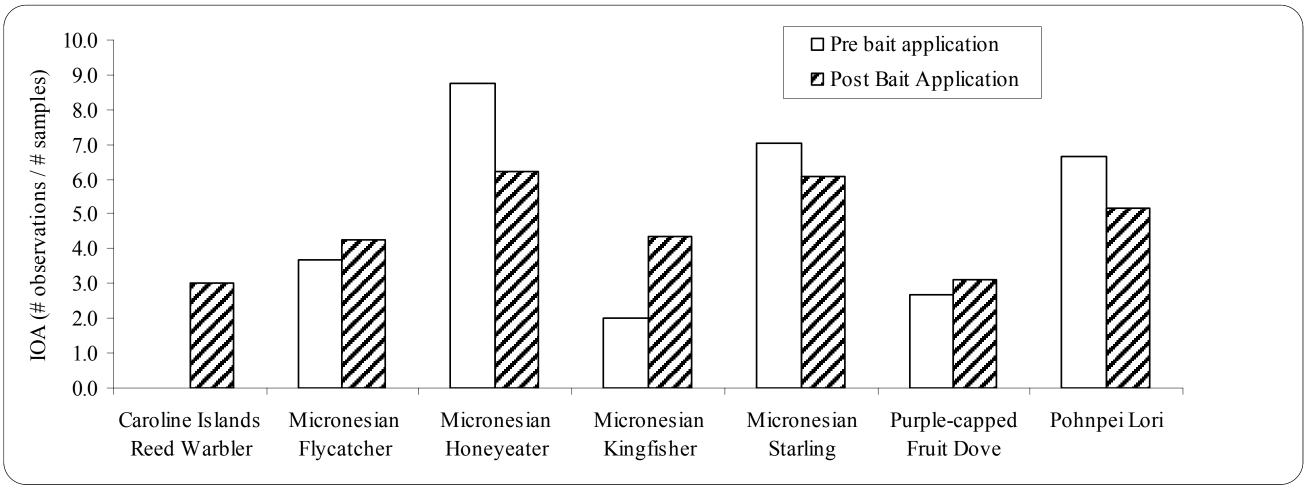
Both the Caroline Islands Fruit Bat and the Sheath-tailed Bat are crepuscular or nocturnal foragers, and tend to remain in cryptic roosts during daylight hours. Because we only visited the treatment islands during daylight hours, we did not systematically sample bat presence pre and post bait application; however, we did keep record of bat observations throughout the project. We compared presence / absence values for both bat species before and after bait application on each treatment island as an indirect measure of rodenticide impact on bats that visit or roost on the treatment islands.

Non-target Species Monitoring Results

Landbirds

Despite a slight decrease in the number of Micronesian Starlings and Pohnpei Loris observed after bait was applied to the three treatment islands (Figure 14), pre and post bait application landbird Index of Abundance (IOA) values are not significantly different (T-Value = -0.15 P-Value = 0.881 DF = 7). This result combined with the failure to observe any landbird-bait interaction during the entire project suggests that this suite of landbirds are not at high risk of exposure to and consumption of rodenticide bait pellets with either a hand-broadcast or bait-station eradication. This assertion does not take into account seasonal variation in bird foraging behavior. Several times during the project we observed landbirds flying form the main island (Pohnpei) to the offshore islands, and flying between the offshore islands. The probable migration of landbirds from Pohnpei to the offshore islands makes it difficult to ensure that these results truly reflect a no-interaction response between the application of PI-25 brodifacoum bait to the treatment islands and the landbirds observed on these islands. However, at a base level, our results demonstrate that there were landbirds present before and after bait application, and that there is no significant difference between the landbird IOA values generated during the two sampling periods.

Figure 14: Land bird IOA results from pre and post bait application sampling for all treatment island



Shorebirds

Combined shorebird sampling values from all treatment islands show no significant difference between the results from the pre and post bait application sampling sessions (T-Value = -0.81, P-Value = 0.455, DF = 12) (Table 15). We did not observe a single instance of shorebird-bait interaction. Shorebird sampling occurred only during daytime hours, and only on days that we visited the treatment islands; therefore, the assertion that there is a no-interaction response by the suit of shorebirds sampled in this study to the application of PI-25 brodifacoum bait to the treatment islands does not take temporal or seasonal variation into account. And, as with the landbirds, we cannot assume that the shorebirds sampled prior to bait application on any of the treatment islands are the same birds sampled after bait application on those islands.

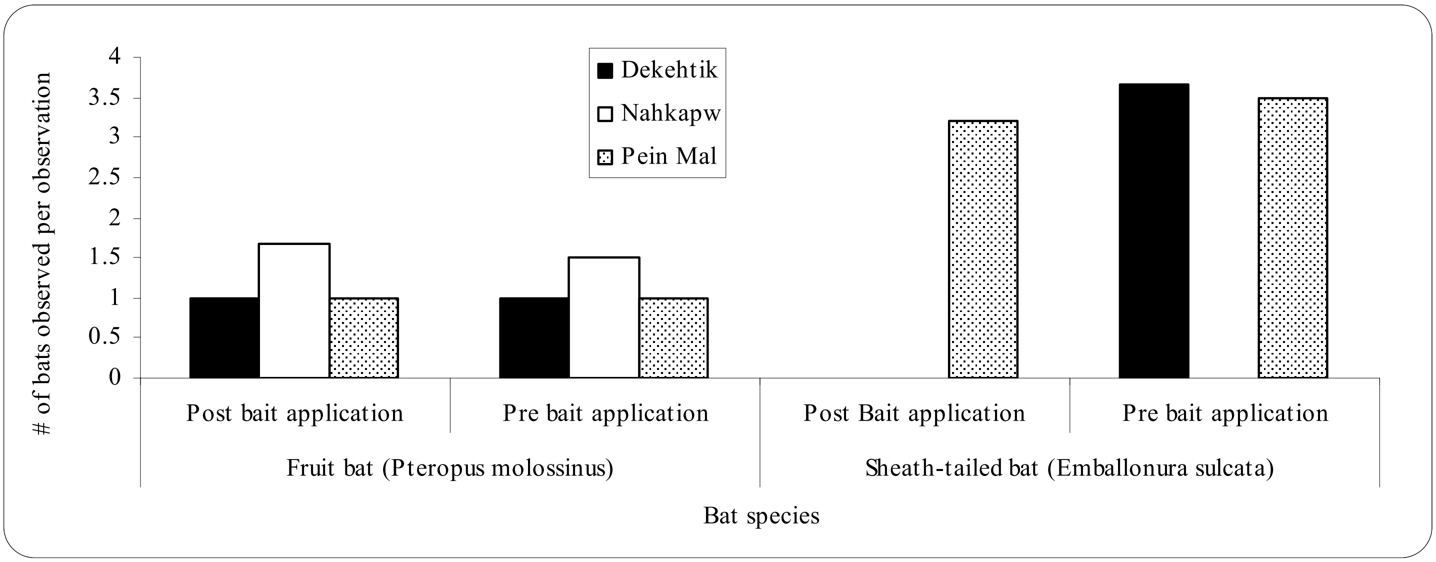
Table 15: Shorebird census results – values represent the relative frequency of observation for each species (number of individuals observed / number of censuses completed on the given treatment island)

	Dekehtik		Nahkapw		Pein Mal	
Shorebird species	Pre bait application	Post bait application	Pre bait application	Post bait application	Pre bait application	Post bait application
Bristle-thighed Curlew	0.0	0.0	0.7	0.3	0.0	0.0
Siberian Tattler	0.7	2.2	3.7	3.6	0.0	2.8
Golden Plover	0.0	0.0	0.0	0.4	0.5	1.0
Ruddy Turnstone	1.4	1.2	5.7	4.8	0.0	0.8
Pacific Reef Heron	1.8	2.6	2.0	1.7	5.0	4.0

Bats

Fruit bats were observed on all three treatment islands prior to and after bait application, and Sheath-tailed bats were observed on Pein Mal prior to and after bait application. On Dekehtik, Sheath tailed bats were observed prior to but not after bait application (Figure 15). The strong similarity between values from the pre and post bait application Fruit bat sampling sessions suggest that Fruit bats are not negatively impacted by ground or canopy baiting. The post bait application lack of Sheath-tailed bat observations on Dekehtik is based on one observation period. Thus it is a noteworthy observation, but not conclusive of bait application impact on Sheath-tailed bats due to similarity between pre and post bait application Sheath-tailed bat observations on Pein Mal. As with the landbirds and shorebirds, we do not know if the bats observed prior to bait application are the same individuals observed after bait application on the treatment islands.

Figure 15: Bat sampling pre and post bait application on treatment islands



Carcass Searching

A total of 293 person-hours spent searching for carcasses on all three treatment islands failed to detect any dead or moribund non-target species (Table 16). Excluding the radio collared rats, only 5 dead rats (all on Pein Mal) were found during carcass searches. It is possible that most rats die in their nests, which could reduce the risk of secondary exposure to rodenticide for non-target species that are likely to feed on sick or dead rats.

Table 16: Carcass search record for all treatment islands

Island	Formal (hrs)	Informal (hrs)	Island Total (hrs)
Dekehtik	4	59	63
Nahkapw	3	25	28
Pein Mal	16	190	206
Grand Total			297

RESEARCH ERADICATION DISCUSSION

Of the six islands utilized in this project (Table 1), three were selected for eradication: Dekehtik, Nahkapw, and Pein Mal. Hand broadcast eradications were performed on Dekehtik and Pein Mal, and a bait-station eradication was conducted on Nahkapw. 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. And eradication efficacy measures and non-target sampling plots were established on the treatment islands prior to bait application. Non-target species (landbirds, land crabs, shorebirds, and bats) were present on all treatment islands prior to, during, and after bait application; non-target species monitoring was conducted prior to, during, and after bait application on all three treatment islands.

Strong variation in the results makes it difficult to ascertain the true bait uptake rate through the monitoring period; however, linear regression analysis shows that the relationship between the probability of bait pellet survival and the number of days post bait application is significant. The methods used during this project do not allow us to distinguish land crab related bait uptake from rat related bait uptake. Future broadcast based eradication projects should focus on this distinction, as land crab related bait consumption necessitates increased bait application rates, which increases non-target species exposure risk, human health risk, and project cost.

On Nahkapw, ground bait-stations experienced minimal bait take until two weeks after bait-station activation while tree bait-stations on experienced bait take soon after station activation. On Pein Mal, the high level of rat bait take from the mangrove bait-stations and the extensive use of the mangrove habitat reinforce the understanding that rat eradications on islands with extensive mangrove habitat should need to include mangrove forest baiting in the eradication plan.

Rats were detected with Hagaruma live traps on all treatment islands prior to bait application, and all treatment islands experienced 0% post bait application trap success. Reference island trap success did remain high during the post bait application trapping periods. Rat detection on the reference islands indicates that the concurrent lack of rat detection on treatment islands is in response to the eradication efforts and not an undefined natural phenomenon. The detection of rat chew marks on a wax indicator on Dekehtik 12 days after bait application is not conclusive evidence that one or more rats survived the eradication effort because this event was still within brodifacoum's latent, which can last up to 21 days (Howald et al. 2004). Both the live trap and radio telemetry measures of eradication efficacy failed to detect rat presence after bait application on both islands where bait was hand-broadcast at 50kg/ha. The fact that one wax indicator block detected rat presence on Dekehtik 12 days post bait application suggests that radio telemetry and live trapping alone are not sufficient measures of eradication efficacy, and reinforces the need for multiple means of detecting rat presence in a post bait application environment.

We observed zero non-target take events during the entire project despite significant effort put into carcass searching, structured non-target species monitoring, and non-target observations.

RISKS AND RISK MANAGEMENT

Varied forms of risk are inherent to large scale ecological restoration projects; toxin based rat eradications are not an exception to this rule.

Mitigation Needs

Human Health

The risk of human exposure to rodenticide is of concern and needs to be mitigated through a combination of eliminating exposure potential through education and awareness, and prohibiting harvesting of key species immediately after the eradication and for a short period of time afterwards.

The Conservation Society of Pohnpei and Island Conservation worked with local government officials and land owners to publicly announce, post, and enforce a no-tolerance policy on harvesting land-crabs until consistent monitoring shows that land crab brodifacoum residues are below detectable limits or as determined from toxicological monitoring on similar projects elsewhere. CSP and IC informed the public about the project and the small but implicit human health risk associated with use of rodenticides in rat eradications prior to, during, and after active bait application on the trial islands. The public outreach effort consisted of news paper articles, radio broadcasts, informing government and community leaders, and posting information signs on the treatment islands. Despite this effort, community members accessed the treatment islands shortly after bait application.

Water collection

The risk of rodenticide entering into and contaminating the water supply during and after baiting activities was extremely low to non-existent. The islands selected for active bait application did not host temporary or permanent settlements, and did not have water catchment facilities.

Non-target species

Land crabs

Land crabs are an important part of the diet of local fisherman and island visitors. The coconut crab population is skewed toward smaller, younger crabs indicating that there is significant harvesting pressure on larger, adult crabs. Land crabs will be attracted to and consume bait broadcast for rats. However, crabs will not be affected by the rodenticide. Land crabs consume the bait, digest it and pass the inert ingredients and the majority of the rodenticide as feces. On Palmyra Atoll, 21 days after the hand-broadcast application of a 25 ppm brodifacoum bait, land crab tissue residues hovered around the 8 to 12 ppb range, and fell to1 ppb after 56 days indicating that crabs do not accumulate rodenticide in their tissues.

Mammals

Fruit bats and Sheath-tailed bats are the only native mammals on Pohnpei. Fruit bats are considered frugivores, but in addition to fruit, consume flowers and leaf material from various trees. Consumption of fruits by Fruit bats involves the squeezing of juices out of the fruit against the palate and ejecting the pulp of the fruit in the form of a pellet. The bait used in the eradication will be a hard, compressed grain pellet that will not likely be attractive to the bats. If fruit bats did inadvertently take pellets into their mouth, the dry, hard pellet could not be compressed against the palate and would likely be immediately rejected. Further, Fruit bats forage in the forest canopy where bait was available at low densities. Sheath-tailed bats forage on flying insects and were at very low risk of coming into contact with the applied bait, but theoretically at risk through insects.

Birds

There are six native species of birds that frequent the project area, none of which were endemic to the islands. Only two species, the abundant and ubiquitous Micronesian Starling and the less common Micronesian Kingfisher, were at a high risk of exposure to the rodenticide applied to the trial islands (Table 17).

Despite the perceived risk of exposure to rodenticide bait for the Micronesian Starling and the Micronesian Kingfisher, we were not able to detect any rodenticide bait related impact on either of these landbirds, and did not observe any instances of interaction between these birds, or any landbird, and bait applied to the ground or forest canopy. That said, our detection methods were not robust; the no-interaction results from this study should be considered informative rather than conclusive and subsequent rodenticide based eradications should consider incorporating landbird monitoring and mitigation into the eradication plan.

Table 17: Landbird species of Pohnpei and their risk of exposure to the rodenticide

Species	Foraging Strategy/Diet	Risk of Exposure to the Rodenticide	Rationale	Mitigation Needed
Micronesian Pigeon *Ducula oceanica*	Frugivore/Granivore	Low to Medium	Diet/Forages primarily in the canopy	None
Micronesian Starling *Aplonis opaca*	Omnivorous diet	High	Diet/ behavior	Recolonization
Pohnpei Lory *Trichoglossus rubiginosus*	Nectarivore	Low	Forages primarily in forest canopy	None
Caroline Is. Reed Warbler *Acrocephalus syrinx*	Insectivore	Low	Diet and forages in shrub and canopy layer	None
Micronesian Kingfisher *Halcyon cinnamomina*	Carnivore/Insectivore	Medium	Diet	Recolonization
Micronesian Honeyeater *Myzomela rubratra*	Nectarivore	Low	Diet, Forages in shrub and canopy layer	None
Pohnpei Flycatcher *Myiagra pluto*	Insectivore	Low	Diet and forages on flying insects	None

Reinvasion

A key component of rat eradications is the development of a plan to prevent the re-introduction of rats, or other non native species. Frequent recreational and resource gathering use of the treatment islands combined with the relatively short distance from the treatment islands to other untreated islands or the Pohnpei shoreline greatly inflate the risk of rat reinvasion on the islands used during this project. Because the project's primary goals were: 1) to test eradication methods to guide the future Ahnd Atoll eradication, 2) to understand non target issues on islands with out endemic species, 3) and to understand community issues relating to eradication projects. The project benefits are less tangible than those from a straight forward eradication as this project was a trial, or research eradication, not an eradication effort. However, the effort and conservation gains made from this project will not be negated with the likely re-introduction of rodents to the treatment islands. The Conservation Society of Pohnpei will periodically monitor the treatment islands for rat presence with live traps and wax indicator blocks.

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Appendix A: Bait Application Rate Quick Reference Table – used to determine appropriate number of bait pellets per uptake plot. (*application rates and plot sizes used during the Pohnpei Rat Eradication Research Project)

	Application Rate (kg/ha) with a 2.3 gram bait pellet																			
Plot Size (sq. meters)	**5**	**10**	**15**	**20**	**25**	**30**	**35**	**40**	**45**	**50**	**55**	**60**	**65**	**70**	**75**	**80**	**85**	**90**	**95**	**100**
5	1	2	3	4	5	7	8	9	10	11	12	13	14	15	16	17	18	20	21	22
10	2	4	7	9	11	13	15	17	20	22	24	26	28	30	33	35	37	39	41	43
15	3	7	10	13	16	20	23	26	29	33	36	39	42	46	49	52	55	59	62	65
20	4	9	13	17	22	26	30	35	39	43	48	52	57	61	65	70	74	78	83	87
25	5	11	16	22	27	33	38	43	49*	54	60	65	71	76	82	87	92	98	103	109*
30	7	13	20	26	33	39	46	52	59	65	72	78	85	91	98	104	111	117	124	130
35	8	15	23	30	38	46	53	61	68	76	84	91	99	107	114	122	129	137	145	152
40	9	17	26	35	43	52	61	70	78	87	96	104	113	122	130	139	148	157	165	174
45	10	20	29	39	49	59	68	78	88	98	108	117	127	137	147	157	166	176	186	196
50	11	22	33	43	54	65	76	87	98	109*	120	130	141	152	163	174	185	196	207	217
55	12	24	36	48	60	72	84	96	108	120	132	143	155	167	179	191	203	215	227	239
60	13	26	39	52	65	78	91	104	117	130	143	157	170	183	196	209	222	235	248	261
65	14	28	42	57	71	85	99	113	127	141	155	170	184	198	212	226	240	254	268	283
70	15	30	46	61	76	91	107	122	137	152	167	183	198	213	228	243	259	274	289	304
75	16	33	49	65	82	98	114	130	147	163	179	196	212	228	245	261	277	293	310	326
80	17	35	52	70	87	104	122	139	157	174	191	209	226	243	261	278	296	313	330	348
85	18	37	55	74	92	111	129	148	166	185	203	222	240	259	277	296	314	333	351	370
90	20	39	59	78	98	117	137	157	176	196	215	235	254	274	293	313	333	352	372	391
95	21	41	62	83	103	124	145	165	186	207	227	248	268	289	310	330	351	372	392	413
100	22	43	65	87	109	130	152	174	196	217	239	261	283	304	326	348	370	391	413	435

Appendix B: Rat Habitat Use Study

An adequate bait application rate depends on the assumption that bait is made available to every rat in every rat territory for a given amount of time. It is important to know the home range (territory size), and habitat use patterns (tree use vs. ground use) of the rat species targeted for eradication. Intra-genera variation in rat home range size has been documented (Lindsey et al. 1999, Russell and Clout 2004). Rat home range size will likely differ from one environment to another and one eradication project to the next. Determining whether the targeted rat species spends a significant amount of time in the forest canopy, as discussed previously in the *Active Bait Application: Canopy Baiting on Pein Mal and Dekehtik* section, is an important factor in deciding whether a ground application sufficiently exposes all rats to the applied rodenticide, or whether additional bait should be applied to the canopy; this is a central issue in the tropics where bait competition by land crabs is high and canopy habitat is rat friendly. The Pacific rat home range and habitat use study was conducted on Dekehtik Island (2.6ha) from 10 to 14 February. .

<u>Methods</u>

Rat Habitat Use Monitoring

On Dekehtik Island, ten Pacific rats were captured using Hagaruma live traps and fitted with ATS 4.2g radio-collars (made by Advanced Telemetry Systems, Minnesota). Each rat was anaesthetized with isoflourane and fitted with a collar programmed to a unique frequency. Digital receivers fitted with directional Yagi antennas were used to track the collared rats over four consecutive 24hr sample days prior to rodenticide bait application (9-12 June), and then again 4 days post bait application (15-19 June). Each radio collared rat was located every four hours throughout each sample day prior to bait application, and each rat still alive was located once per 24hr period after bait application. For the pre bait application sampling, we assumed that the four hour spacing between samples was more than sufficient time for the rats to recover from any study related disturbance. The following variables were sampled for 7 radio-collared Pacific rats:

- time of observation
- location of observation
- whether the rat was observed on the ground or in the forest canopy - if in the canopy the tree species that hosted the rat was recorded
- whether the rat was active or inactive at time of observation.

Each observed rat location was marked with flagging tape that bore the following information: rat ID, time, date, ground or tree, active or inactive. If the rat was in the forest canopy, the flagging tape was tied to the tree that hosted the rat.

Georeferencing Rat Locations

Upon completion of the four-day observation period, every observed rat location was tied into a georeferenced grid with the following procedure. Eight GPS benchmark waypoints were fixed (with a Garmin-12 XL hand-held GPS unit) at convenient points around the perimeter of the island and outside of the forest canopy. Rat locations, marked with flagging tape, were spatially tied to the nearest benchmark by recording the distance and bearing from the bench mark to the rat location with a 100 meter tape and a hand held magnetic compass. If a rat location was out of line-of-sight from any benchmark, that location was tied into a previously surveyed rat location, and thus tied into the georeferenced grid. At each rat location, all information on the flagging tape was transferred to a data sheet, as was the bearing and distance from associated benchmark. The benchmark locations were entered into the computer mapping program, MapSource™, and the associated bearing and distance measurements were used to generate decimal degree latitude and longitude values for each rat location.

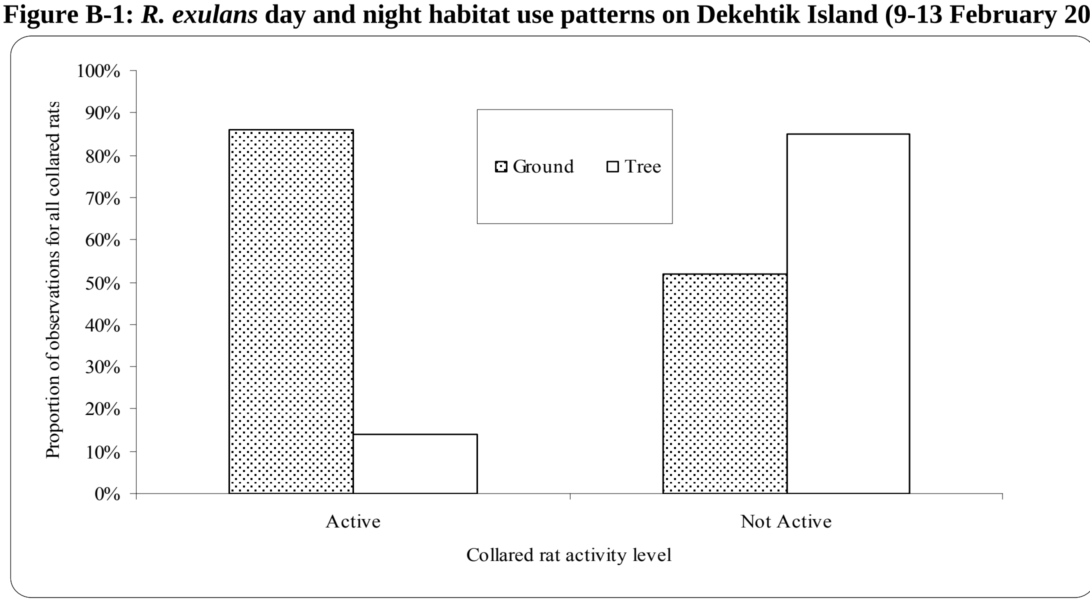
Estimating Rat Home Range size

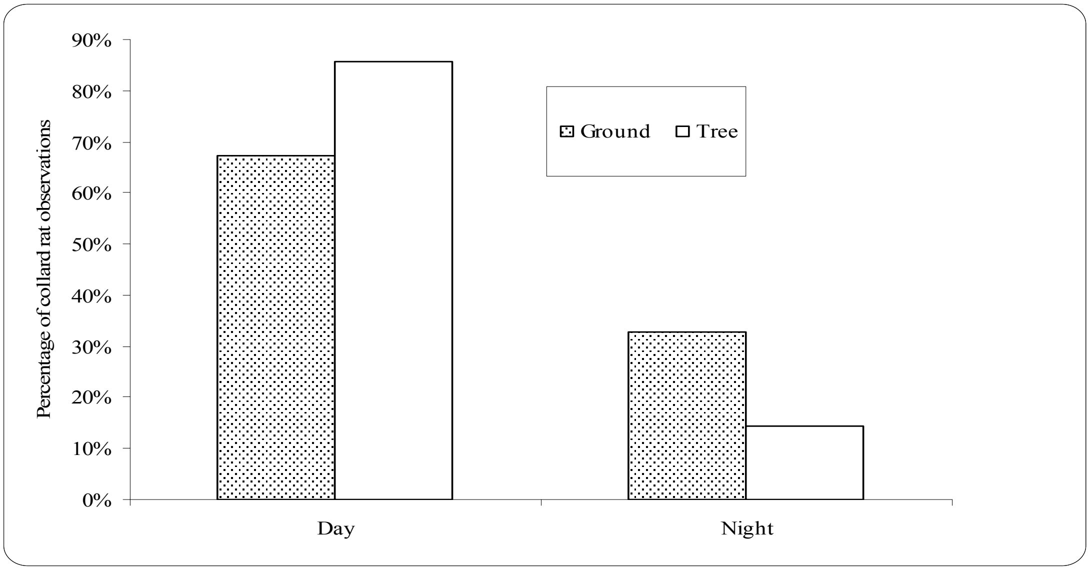
Decimal degree latitude and longitude values for each rat location were sorted by individual rat, imported into ArcView 3.3™ and converted to point based shape-files. The ArcView extension, Animal Movement™, was used to calculate 95% Kernel home range estimates for each rat with comparisons of before bait application home range size vs. after bait application home range size, and ground home range size vs. tree home range.

Results

All study rats on Dekehtik were predominantly active at night, and while active, were most frequently observed on the ground rather than in the forest canopy. Daytime observations found most rats in the forest canopy and inactive (Figure B-1). The predominance of observations that found rats inactive in the forest canopy during daytime hours implies that most rats on Dekehtik use the forest canopy for nesting habitat. And, the prevalence of observations that found rats active on the ground at night indicates that rats on Dekehtik preferentially forage on the ground. All seven radio collared rats were observed both on the ground and in the forest canopy during the 4 day study period. This habitat use pattern is similar to that of *R. rattus* on Palmyra Atoll (Howald et al. 2004) and enforces the understanding that rats on tropical islands function in a three-dimensional habitat that includes the forest canopy. During a bait broadcast scenario, either hand-broadcast or aerial broadcast, it is essential to use a bait application rate that is high enough to ensure that every rat has access to a lethal dose of bait. However, given the documented use of the forest canopy by both *R. rattus* and *R. exulans*, it is equally important to include the forest canopy in the bating plan; this happens naturally with an aerial broadcast, and can easily be incorporated into a hand-broadcast approach through sling-shot canopy baiting (see above).

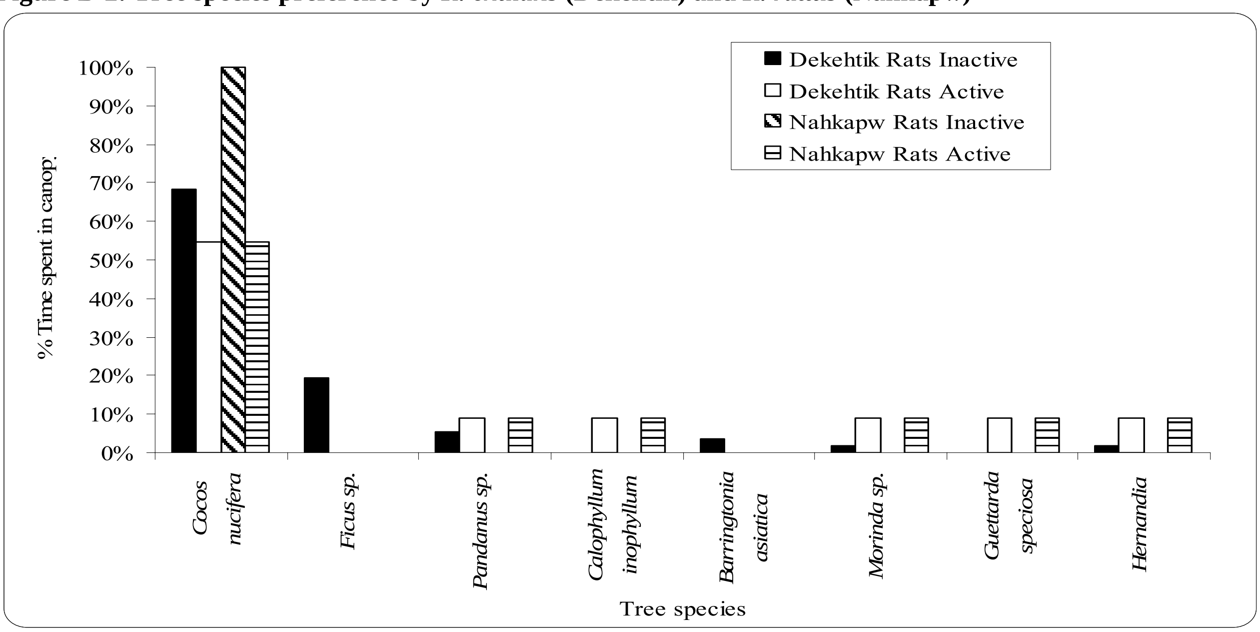
Figure B-1: *R. exulans* day and night habitat use patterns on Dekehtik Island (9-13 February 2007), Pohnpei, FSM





A large majority of the radio collared rats on Dekehtik were found in the canopies of coconut palms even though coconut palms only account for 30% of Dekehtik's forest canopy area[4]. The same holds true for the one radio collared rat (*R. rattus)* on Nahkapw, which was found exclusively in coconut palm canopies when observed in the forest canopy (Figure B-2). The demonstrated preference for coconut palm canopy habitat use by rats, also documented on Palmyra atoll (Howald et al. 2004), supports targeting coconut palms while canopy baiting.

Figure B-2: Tree species preference by *R. exulans* (Dekehtik) and *R. rattus* (Nahkapw)



Estimated home range sizes for *R. exulans* on Dekehtik vary from 344m² to 12,129m² (Table B-1). One of the radio collared rats, # ID2 (female), may have been influenced by the presence of food (fish cooked over an open fire) during the study period as this rat moved several hundred meters

[4] Coconut palm canopy area on Dekehtik was calculated by multiplying the effective crown area (12.5 m²) by the number of coconut palms on the island (640), and dividing the resulting area by the total area of the island (2.6ha).

from its previously recorded area of activity to our campsite, and then returned to its pre-study area after we completed the four-day study. ID2's recorded home range size is conspicuously larger than that of the other rats in the study; therefore we analyzed the home range data with and without the data for ID2.

Table B-1: Estimated home range sizes for *R. exulans* in the Pacific rat home range and habitat use study on Dekehtik (m^2)

Study Rat ID	Pre bait application	Post bait application
ID1	1459	1370
ID2	10511	12129
ID4	344	358
ID5	1605	1605
ID7	3967	4257
NG1	1425	1562
NG2	1325	3447

Mean estimated rat home range size increased after rodenticide bait was hand-broadcast on Dekehtik (Tables B-1 and B-2); however, a one-sided 2-sample T-test shows that this difference between pre- and post-bait application home range size is not significant (values log transformed to meet the assumption of normal distribution, T-Value = -0.31, P-Value = 0.382, DF = 11) given the high variation in recorded home range values.

Table B-2: Post bait application increase in *R. exulans* estimated home range size on Dekehtik Island (2.6 ha)

Dekehtik Island - *Rattus exulans* (n = 7)	Including rat # ID2	Not including rat # ID2
Mean home range pre bait application - m^2 (Std dev)	2948 (3512)	1688 (1205)
Mean home range post bait application - m^2 (Std dev)	3533 (4016)	2100 (1454)
Mean tree use area within home range - m^2 (Std dev)	854 (952)	854 (952)
Mean % increase in home rage post bait application	17%	20%

Home range estimates for *R. rattus* were generated with the same rat location georeferencing method used in the *R. exulans* study on Dekehtik, except for that the rat location observations were from the radio telemetry section of the eradication efficacy testing (see below). The estimated pre- and post bait application mean home range sizes for *R. rattus* on Nahkapw (n = 1) and Pein Mal (n = 7) are slightly smaller, yet similar to those measured for *R. exulans* on Dekehtik (Table B-3).

Table B-3: Post bait application increase in *R. exulans* estimated home range size on Pein Mal (2.2 ha) and Nahkapw (1.6 ha) Islands

Pein Mal and Nahkapw Islands - *Rattus rattus* (n = 8)	
Mean home range pre bait application (m^2)	1362 (1963)
Mean home range post bait application (m^2)	1811 (2230)
Mean % increase in home rage post bait application	25%

In contrast with the results from the *R. rattus* home range study at Palmyra Atoll (Howald et al. 2004), the difference between male and female *R. exulans* home range size is not significantly different (values log transformed to meet the assumption of normal distribution, T-Value = -0.53 P-Value = 0.299 DF = 23).

Appendix C: Invasive Rodent Eradication Training Evaluation

In order to improve future training experiences such as this one, the following training evaluation form was given to all participants at the end of their demonstration section. Participants were informed that their responses will be kept confidential, and that the scores and comments provide will be compiled and shared project partners. The results from the participant self evaluations (Table C-1, n = 9) suggest that the demonstration successfully transferred rat eradication knowledge and techniques in such a way that these skills can, and likely will be applied conservation actions throughout the Pacific.

Table C-1: Participant training evaluation form responses

EVALUATION QUESTIONS	Competent	Maybe	Neutral	Novice	Satisfied	Semi-skilled	Skilled	Very satisfied	Yes	Yes, with assistance	Expert
How would you rank your expertise in invasive species eradication after attending the training?							33%				67%
How would you rank your expertise in invasive species eradication before attending the training?	17%			33%		33%	17%				
Do you feel as a result of this training that you could assess risk to non-target species?									83%	17%	
Do you feel as a result of this training that you could calibrate the amount of rodenticide needed for an eradication?									50%	50%	
Do you feel as a result of this training that you could conduct a pre-eradication feasibility survey?									67%	33%	
Do you feel as a result of this training that you could conduct post-eradication ecosystem response monitoring?									50%	50%	
Do you feel as a result of this training that you could gather baseline ecological data prior to the eradication?									67%	33%	
Do you feel as a result of this training that you could hand broadcast rodenticide bait at the determined application rate?									83%	17%	
How satisfied do you feel about the training overall?			33%		33%			33%			

Training Evaluation Written Responses:

In relation to invasive species eradication what other types of training, mentoring, support etc do you think you could benefit from that would help you execute projects in your country?

"Population density estimation techniques"

"For my program I need training about the control of the rodent species and the cats eradication."

"More training on rat eradications would be good but also something on myna birds, red vented bulbul and yellow crazy ant, as they are a major problem in my country. Also, something on eradication/control of invasive plants."

"A similar rodent training would be very beneficial for me to execute projects. It would be better to have classroom/theory sessions before going into the field to apply what was discussed. This form of workshop would be helpful for me, but that is only because I didn't have prior training in any type of invasive species eradication prior to this rodent demonstration."

"Preparing funding proposals –writing up feasibility studies, action plans –MOU's for partnerships"

"The sharing of information with eradication projects amongst the pacific islands and support from NGO's (IC, PILN…) and other stakeholders"

"With people in the pacific, community is very important therefore it is important to possess community outreach skills that will enable you to educate communities to support your project to run successfully. Pohnpei was a perfect example of not engaging the community; as a result there were still a lot of people visiting the Dekehtik, despite being informed not to."

Did anything exceed your expectations in this training? If the answer is yes, please tell us what.

"No"

"Yes everything exceeded my expectations. It was a great training. I though that most of the work would just be in an office but it wasn't at all, it was all hands on field work which was great. An Alex and his team were so helpful, explaining everything so well and answering all the questions we had."

"I was impressed with the patience and understanding of the IC project managers. They were patient in answering questions and they welcomed any suggestions and discussions from the participants. I found that very helpful and encouraging especially since I have no background in invasive species eradication."

"The amount of time put into investigating, researching bait application and uptake, very thorough."

"No, I learned a lot these past few days while participating in the training. After the third day in the field and from prior experiences, I feel confident that I could conduct an eradication project in my country."

"Yes it did, but i didn't expect that it would a hands-on training for the team.This was very helpful because i was not only able to grasp the tehniques in the classroom but also all finer details when out in the field."

What specific benefits, if any, did you get from this training?

"Actually conducting hand broadcast of rodenticide."

"I learned a lot of things and I can change my methodology for some of my programs. I met some people who are able to help me in the future."

" The whole training was a benefit, before I arrived I didn't know anything about rat eradications and now I know what is involved to carry out an eradication. And its really made me question some of the decisions which are being made for our eradication project. For example, the amount of bait we are applying per hectare seems to be extremely low and I don't know how they came up with that amount. So a specific benefit would be that the training has made me think and question what we are doing in our eradication project."

"Specifically, I was able to meet people who have been working in the field of invasive species eradication, specifically rodent eradication. I was able to meet new people in similar fields forming a learning network across various Pacific Islands. Lastly, I was able to discuss potential rodent eradication projects for Yap with IC staff and experts and at the same time gain their support."

"Learning to cover "gap" areas, to think about possible variables that affect data."

"Sharing of information from those who presented; and building a camaraderie with people from other islands who have eradication experience."

"Even though I had some experience prior to attending this training it has boosted my confidence since I now have the understanding and the techniques of eradication and monitoring. This training has been an eye opener since I have learnt new techniques that I am now applying back here in Fiji."

Did anything fail to meet your expectations? If the answer is yes, please tell us what and why it failed.

"Should have conducted more "classroom" type training before the field work to better inform participants about what, where and why things are being done. Field activities could have been better coordinated, as the participants did not know what they were doing the following day."

"Maybe some tool to calculate the density of rat populations and how to use some software (density or distance)"

"No."

"Well, I went to Pohnpei for the Rodent Eradication Demonstration without any expectations since I had not idea what a rodent eradication is all about. At the end of my participation in the trial, I had a clearer idea of what an eradication project would require and a lot of my questions were answered. In my opinion, my trip to Pohnpei for the rodent eradication demo was worthwhile and not a failure at all. We were all learning together - as a team."

"N/A Ok, maybe food shortage."

"Yes, accessibility to internet access. The packet I received indicated that participants will have access. However, there was no mentioning of it and apparently it was used only be those conduction the demonstration. Please clearly indicate what is accessible and make mentioning of it at arrival. Other than that the project was fine."

"Yes there were certain minor problems that I faced such as never had any idea what I was supposed to be doing each day until I reached the field (no programmes). Towards the end of the training while coming back from training after a hard day there were no lunch provided as the food had run out. These are just minor problems that we encountered during our stay."

What would you change to improve future training?

"More classroom training and better organization of field activities."

"I am very happy to participate in this training and I know how it's difficult to organize that. All is perfect and the team of Island Conservation is really perfect and professional. Continue and thank you very much."

"Maybe just better access to the internet and phone services"

"The only suggestion I have is to include an orientation at the beginning of the trial for participants to be clearly explained what the project is all about, and how the training is going to be conducted. It took me a couple of days with many questions asked to fully understand why we were there and what we would be doing. Only after this, was I able to think about how could apply this new information and skill to my projects back home. Thanks you for giving me this opportunity to comment on and to evaluate the Pohnpei Rodent Eradication Demonstration/Training. I would also like to thank you for granting me the opportunity to participate in this training."

"Set a timetable and keep to it –Do not carry out eradication and training together -More conference/classroom time."

"Explanation of the project and parts of the project prior to conducting field activities. Hold a lesson lecture before the hands-on activities. After field work each day hold a discussion regarding the daily activities, while things are still fresh in our minds."

"Just have a work programme set out for the participants so that they have a fair idea what is expected of them each day. Thats the only thing i would change because the training was great and very helpful."