PALMYRA ATOLL RESTORATION PROJECT

The Nature Conservancy | U.S. Fish & Wildlife Service | ISLAND CONSERVATION Preventing Extinctions

Palmyra Atoll Restoration Project

Rat Eradication Efficacy Monitoring – One Year After Implementation

Prepared by

E. Oberg and A. Wegmann[1]

26 July 2012

[1]Contact: Alex Wegmann, Island Conservation, 100 Shaffer Rd. Santa Cruz CA 95060, +1.831.359.4787x114, alex.wegmann@islandconservation.org, www.islandconservation.org

Table of Contents

1 Introduction

In June of 2011, the Palmyra Atoll Restoration Project partnership (US Fish and Wildlife Service, The Nature Conservancy, and Island Conservation) treated all emergent land areas throughout Palmyra Atoll (Palmyra) with rodenticide to remove invasive alien rats (*Rattus rattus*). The eradication involved both aerial and ground application of bait containing the second generation anticoagulant brodifacoum at a concentration of 25 ppm (Brodifacoum 25 W Conservation Bait registered with the US EPA, sold by USDA - APHIS, and manufactured by Bell Labs, Madison WI).

Bait was applied to the atoll according to a strategic plan that minimized the risk of bait drift into the marine environment while ensuring that a sufficient amount of bait was delivered to every potential rat territory. Two applications of bait over the entire atoll were conducted during the eradication, and each application employed three methods of aerial broadcast baiting (full swath - 40m, directional swath - 20m, and narrow swath - 5 m), and hand baiting. Bait was also slung into the crowns of coconut palms (*Cocos nucifera*) that overhang near-shore waters as this habitat was not baited during the aerial application, and bait stations were placed and maintained around the camp area and on select small islands that are thought to be rat-free.

During the operation, a monitoring team led by the US Department of Agriculture assessed the near-term efficacy of the eradication by following 25 radio-collared rats. Eight weeks after the second bait application, a small team returned to Palmyra to establish rat detection stations throughout the atoll; with 2,560 detection station-nights, the team found no sign of rats. One year after the eradication, a monitoring team returned to Palmyra to re-establish and resample the rat detection stations.

There is a general perception that the required waiting period for confirming the success of rat eradication projects is two years. The “two-year” convention is based on rat reproductive biology in temperate or subarctic/subantarctic environments where the time for populations of rats to produce a new generation is approximately one year; the relevant metric is the number of new generations rather than the number of years (Broome 2011). In wet tropical environments where rat reproduction can be aseasonal, black rat generation time is approximately 0.3 years (Strecker et al. 1962), which allows for more than three generations within a one year period. By this measure, a failure to detect rats one year after the end of the baiting period (21 June 2011) should provide the confidence needed to confirm the

success of the Palmyra rat eradication while complying with best practices established by the conservation community.

This report describes the rat detection effort that occurred in July, 2012, one year after the implementation of the rat eradication. The objective of this monitoring effort was to survey the entirety of Palmyra's emergent land area for sign of rat presence. Personnel directly involved in this effort included Alex Wegmann (Island Conservation), Erik Oberg (Island Conservation), Jess Newton (US Fish and Wildlife Service), Coral Wolf (UC Santa Cruz), and Kelly Newton (UC Santa Cruz).

2 Methods

2.1 Focused rat detection effort - indicator blocks

One year after the rat eradication, a three-person team returned to Palmyra to establish rat detection stations (n = 284) throughout the atoll (Figure 1). Palmyra's land area is fragmented into numerous islands, each of which could harbor a residual population of rats. To maximize the probability of detecting rats, we designed the rat detection effort so that the detection station network included all of the islands. While it can be advantageous to utilize more than one type of detection device while determining whether or not rats are present on islands, we only used indicator blocks (Figure 2). Prior to the eradication, live traps and tracking-tunnels were paired with indicator blocks during rat detection efforts. While the traps and tracking-tunnels were able to detect rats, the probability of detecting rats with these two methods was significantly lower than the probability of detecting rats with indicator blocks (Table 1). By only using indicator blocks, we deployed more detection stations, achieved greater coverage with the detection station network, and refreshed the stations more frequently than we could have if we had incorporated live traps and tracking tunnels into the detection station network. Other detection devices, such as kill-traps (snap-traps), glue boards, and tracking-tiles are not suited for Palmyra's land crab-rich environment.

Table 1. A comparison of trap-based and indicator block-based detection of rats at Palmyra Atoll, from 2005 to 2010 (2-tailed, paired t-test, $\alpha = 0.05$).

Rat detection events at Palmyra Atoll	Stations (n)	Paired detection devices	Detection-nights	Rat detection (%)	df	t-value	p-value
2005 eradication trials (Buckelew et al. 2005)	82	Live trap	533.5	29.4 (SD 11.5)	2,988	13.82	< 0.001
		Indicator block	638	74.5 (SD 24.2)			
2010 pre-eradication rat detection (Alifano et al. 2010)	90	Live trap	539.5	30.9 (SD 46.2)	644	-4.55	< 0.001
		Indicator block	510.5	42.7 (SD 49.2)			
	20	Tracking tunnel	72	13.3 (SD 34.2)	74	4.21	< 0.001
		Indicator block	59.5	39.3 (SD 48.8)			

Each detection station consisted of a corrugated plastic indicator block filled with a peanut butter-flavored attractant (Figure 2). After inserting the attractant into the channels of the corrugated plastic detection blocks, the blocks were dried for several hours (typically overnight) before they were deployed. Excess blocks were sealed in plastic bags and stored in freezer for future use. The indicator blocks were nailed to the trunks of trees one to two meters above the ground (Figure 3). When possible, indicator blocks were nailed to coconut palms (*Cocos nucifera*); the crowns of coconut palms are preferred habitat

for rats (Wegmann et al. 2007). Once established, the detection stations were checked and serviced every three days over the twelve-day monitoring period. The incisor marks that rats leave in the plastic shell of the indicator block are readily distinguished from marks left by crabs or other invertebrates (Figure 2).

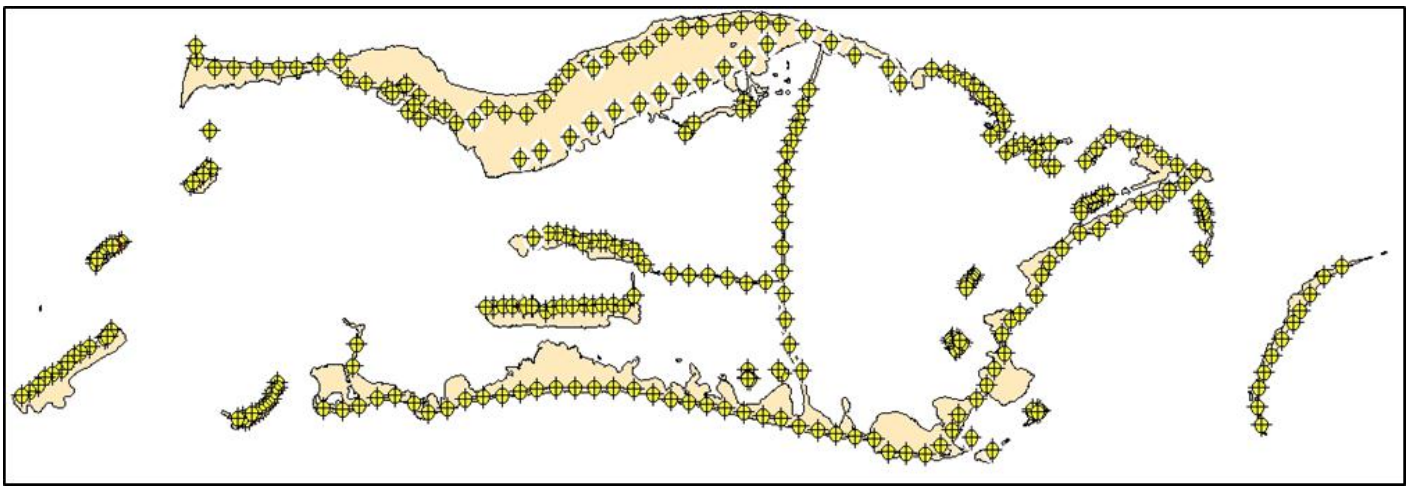

Fig. 1. Rat detection stations placed throughout Palmyra Atoll from 1 -15 July, 2012. Each station contained an indicator block. Each station was checked and serviced every three days over a twelve-day monitoring period.

A three-day monitoring period was allowed for each indicator block. After the three-day period, the condition of each block was noted (Figure 2), and the blocks were replaced. To estimate the scale of the detection effort, blocks that had been relieved of the attractant by invertebrates (ants, crabs, cockroaches) were allotted half of the possible detection-nights (1.5 nights); blocks that retained at least half of the original amount of attractant were allotted all three detection-nights.

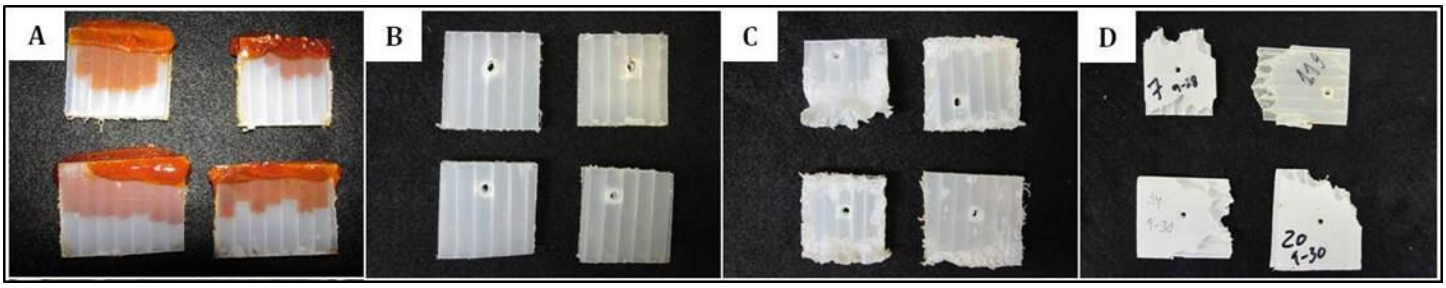

Fig. 2. Rat indicator blocks used to detect rat presence on Palmyra: A) rat indicator block filled with peanut butter candy attractant, B) deployed indicator blocks with the attractant removed by ants, C) deployed indicator blocks with the attractant removed by land crabs, D) deployed indicator blocks with the attracting removed by rats from a pre-eradication rat detection effort (Alifano et al. 2010).

2.2 Opportunistic rat detection effort

While traversing the islands, the rat detection team scoured the forest and beaches for sign of rats: rats scurrying out of our way, coconuts and other fruit chewed by rats, fresh husking stations, scat, and rat tracks on sand and in mud. In addition to the indicator block network, all personnel at Palmyra (5-35 people were on the atoll at any given time since the eradication commenced) were aware of the rat eradication project and were vigilant for sign of rats.

Fig. 3. Rat indicator block nailed to a coconut palm (*Cocos nucifera*) during the July, 2012 rat detection effort at Palmyra Atoll

3 Results and Discussion

3.1 Focused rat detection effort - indicator blocks

With 284 indicator blocks deployed throughout the atoll, and 2,496 station-nights, rats were not detected (Table 2).

Table 2. Results from pre-eradication (Alifano et al. 2010) and post-eradication rat detection efforts where corrugated-plastic indicator blocks were deployed throughout Palmyra Atoll.

Island	Pre Eradication - September 2010			Post Eradication – July 2012		
	Stations (n)	Block Nights	Blocks chewed by rats (%)	Stations (n)	Block Nights	Block chewed by rats (%)
Ainsley	2	8	38	1	12	0
Barren	10	37.5	29	11	102	0
Bird Island				5	42	0
Bunker	3	8.5	31	2	15	0
Castor				2	12	0
Cooper				59	516	0
Dudley	5	8.5	0	7	72	0
Eastern	12	53.5	66	19	169.5	0
East-West Causeway				5	36	0
Fern				8	69	0
Home	5	39.5	85	10	91.5	0
Leslie	4	22.5	84	9	64.5	0
Little Eastern				6	52.5	0
Lost				17	135	0
North Fighter Strip	9	34	46	17	163.5	0
North-South Causeway	11	68.5	56	2	16.5	0
Paradise Peninsula				7	72	0
Pollux				14	118.5	0
Portsmouth	3	14.5	34	13	118.5	0
Quail	5	39	38	46	396	0
Sand	9	37	62	16	154.5	0
South Island Complex	15	82	62	8	67.5	0
South Fighter Strip	4	9.5	42	1	12	0
Whippoorwill	8	38.5	44	11	102	0
TOTAL	105	501		284	2,496	
MEAN			51			0

3.2 Opportunistic rat detection effort

Opportunistic searches for sign of rats also found none. The rat detection team logged 99.5 person-hours of searching for sign of rats (this excludes transit time to and from the detection station transects) and traversed a total of 152 km while checking the indicator blocks. The search effort covered an area equivalent to 152 ha, or 65% of Palmyra's emergent land area, assuming that a 10 m wide swath was visible to the observer. Natural indicators of rat presence that were assessed during this search effort were green coconuts chewed by rats, coconut palm inflorescences chewed by rats, and *Pandanus* diaspores chewed by rats. No sign of rats was found with the natural indicators (Table 3).

Table 3. Natural indicators observed during opportunistic search for sign of rats at Palmyra in July, 2012. The pre-eradication measures are from an assessment of rat impacts on the recruitment of species of trees at Palmyra (Wegmann 2009).

Natural indicator	Pre-eradication measure	Post-eradication observations (n)
Green coconuts chewed by rats	1.04/m^2 (n = 275, SD 1.35m^2)	0
Pandanus diaspores chewed by rats	0.4/m^2 (n = 30, SD 0.93m^2)	0
Coconut palms with inflorescences chewed by rats	81% (n = 21, SD 40%)	0

The two UC Santa Cruz personnel engaged in monitoring the response of plant, bird, and invertebrate communities to the removal or rats spent 75 person-hours crisscrossing most of Palmyra's islands; rats were not observed. Ana Miller-ter Kuile, a researcher with Stanford University, accompanied by TNC and USFWS personnel, logged 38 person-hours of opportunistic night-time observation for rats on 12 of Palmyra's 25 islands; rats were not observed.

3.3 Eradication success

Although no amount of effort will yield absolute certainty that rodents are absent from Palmyra, the results from this detection effort provide sufficient confidence to say that this is the case for the atoll. A future incursion; however, remains a serious risk that requires persistent attentiveness and mitigation

4 Ecosystem Response – Preliminary Observations

Palmyra's terrestrial and marine ecosystems appear to be changing to the removal of rats. Of note, the density of fiddler crabs (*Uca* sp.) seems to be higher than it was prior to the eradication (K. Lafferty – pers. com. 2012). Fiddler crab chela (claws) and carapace and leg segments were one of the most frequently observed items in rat husking stations (where rats go to process and consume prey) that were assessed prior to the eradication (A. Wegmann – unpublished data); it is possible that the fiddler crab community is recovering from a 70 year predator-driven population decline. As an important prey item for other crabs, several species of fish including eels, and shorebirds, fiddler crabs are a strong nexus between marine and terrestrial communities.

The CCAL ecosystem monitoring team repeated several ecosystem-response measures that were taken prior to the eradication and during last summer's monitoring trip. The team counted seedlings along established transects and around locally rare native trees, collected terrestrial arthropods, and collected

three months' worth of bird vocalizations from eight acoustic recording units placed throughout the atoll. Of note, several patches of *Pisonia* seedlings (*Pisonia* is the dominant native tree species at Palmyra) that were discovered during the August 2011 post-eradication monitoring had grown from 5 cm to 70 cm. Also, nesting pairs of White Terns and Black Noddies appeared to be more common during this year's surveys. Final results from the ecosystem monitoring effort will be presented in an annual report issued by the UC Santa Cruz - Coastal Conservation Action Lab.

5 Literature Cited

Alifano, A., A. Wegmann, M. Pott, and E. Oberg. 2010. Assessment of rat detection and rodenticide application methods at palmyra atoll. Island Conservation, Santa Cruz, California.

Broome, K. 2011. Current agreed best practice for rat eradication - aerial broadcasting poison bait.

Strecker, R. L., J. Joe T. Marshall, W. B. Jackson, K. R. Barbehenn, and D. H. Johnson. 1962. Pacific island rat ecology: report of a study made on Ponape and adjacent islands, 1955-1958. Honolulu.

Wegmann, A., R. Marquez, G. Howald, J. Curl, J. Helm, C. Llewellyn, and P. Shed. 2007. Pohnpei rat eradication research and demonstration project: Pohnpei, Federated States of Micronesia - 16 January to 7 March 2007. Island Conservation, Santa Cruz, USA.

Wegmann, A. S. 2009. Limitations to tree seedling recruitment at Palmyra Atoll. University of Hawaii, Honolulu.