

introductions are likely to occur. Sites requiring special attention may include, but are not limited to camping areas, trails, fence lines, helipads, and roads. Many harmful invasive ant species, such as *P. megacephala* and *A. gracilipes* primarily reproduce via budding (i.e., mated females walk rather than fly to nearby areas to found colonies) vs. mated flights. In these cases it is relatively easy to identify areas of encroachment by invasive ants into native forest.

7.5.3 Recommendations

1) Map the boundaries of the *A. gracilipes* infestation at the Nike Site. This can be accomplished by either setting a grid of bait cards or, if ant numbers are high enough, by having 3 people walk the boundary of the infestation; the inside person staying within the infestation, the outside person staying outside the infestation and the middle person recording waypoints along the boundary.

2) Attempt to eradicate *A. gracilipes* from Nike Greenhouse site.

Bait preference trials to begin in October 2010 with assistance from HDOA staff

3) Identify areas of encroachment by *P. megacephala* into native forest. Control using hydramethylnon suspended in a corn-grit matrix (e.g., AMDRO[®]) if warranted. Apply according to label specifications.

4) Use bait cards to conduct yearly monitoring of sensitive areas so that any new infestations can be identified and addressed. Ants are most likely to become established around disturbed areas frequented by humans such as bathrooms, campgrounds, fence lines, helipads, and roads. Areas undergoing construction of fences or other structures should be carefully monitored for new introductions. Activities including the transfer of soil, such as out-planting, should also be carefully monitored. Careful monitoring will increase chances of early detection, and early detection is the key to successful eradication or control.

5) Conduct additional surveys of high elevation sites in the Koolau Mountains.

6) Protect the Mount Kaala boardwalk area from invasion by ants.

Our data indicate that invasive ants have penetrated almost all areas with the exception of the highest elevation sites with intact native communities, such as the boardwalk area of Mount Kaala. Although ants were found at the gated entryway to the bog, none were found along the boardwalk. Every effort should be made to keep ants from penetrating this habitat.

7.6 RAT – KAHANAHAIKI: LARGE SCALE TRAPPING GRID

7.6.1 Introduction

In May 2009, OANRP initiated a large scale kill trapping grid for rat (*Rattus* sp.) control over an area of 65 acres (26 ha) at the Kahanahaiki MU (see map below). The control grid follows the New Zealand Department of Conservation's current best practices for kill trapping rats. Wooden rat trap boxes and tracking tunnel monitoring equipment were purchased from New Zealand in 2009 to facilitate this method of control (see photos below). The large scale trapping grid was established as a pilot study with a goal of reducing rat activity within the MU to a level that would benefit the endangered plants, tree snails and overall forest health. This approach moved away from our traditional rat control method of using small scale bait station grids centered around individual plants and/or small groupings of plant and/or around individual snail trees to a landscape level that would benefit the native ecosystem as a whole.

The grid encompasses 11 endangered plant species, including both wild and reintroduced populations, and a large population of endangered *Achatinella mustelina* (Oahu tree snail). The focal endangered taxa that have continued to be monitored closely are *Cyanea superba* subsp. *superba* and *Achatinella*

mustelina. The additional monitoring of seedlings, seed fall, arthropod composition and abundance, slug, and *Euglandina rosea* populations has continued through the reporting year. The Pahole Natural Area Reserve (NAR) has continued to serve as a comparison “control” site (outside the trapping grid) where rats remain at pre-trapping levels.

The overall purpose of this study is to assess the effects of rat removal on the following groups:

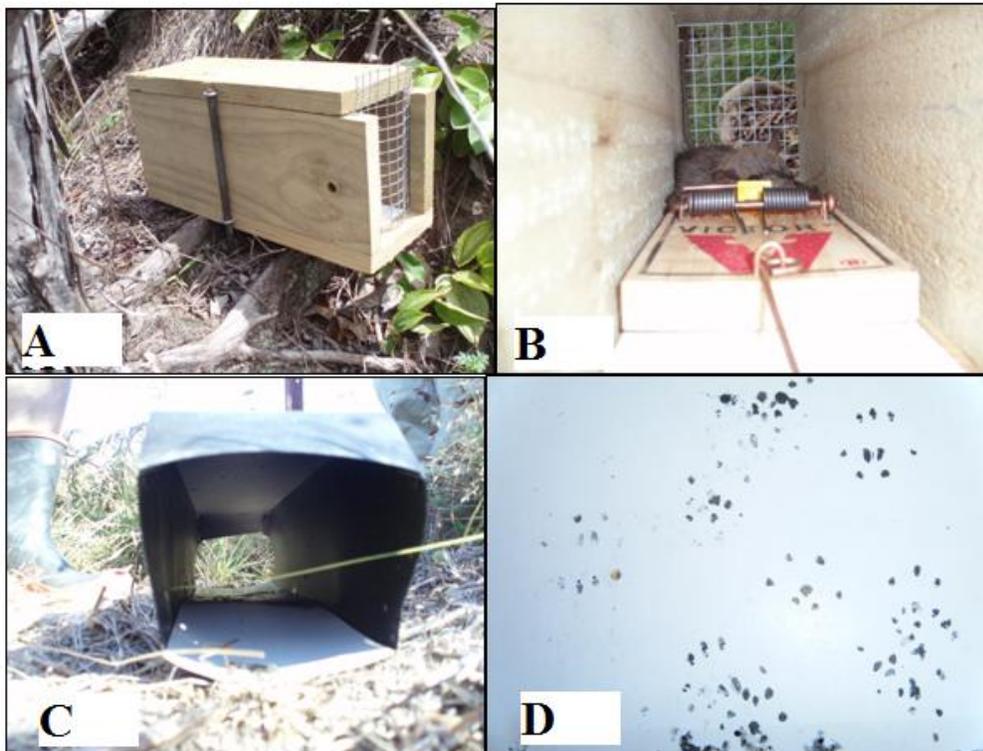
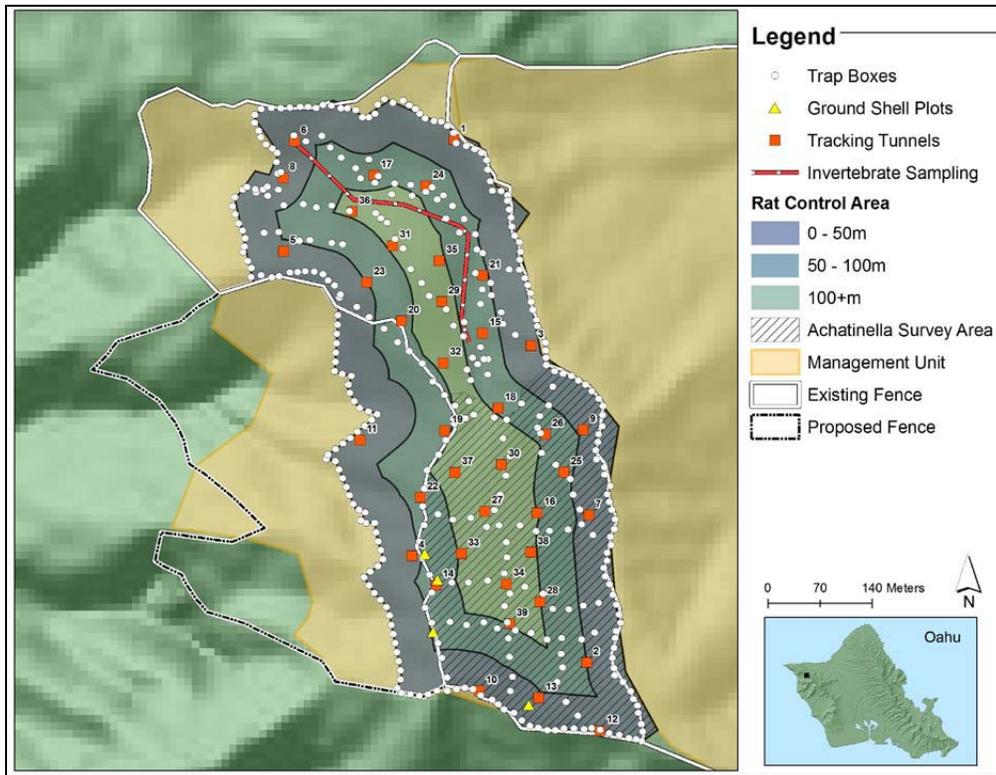
- a. Slugs (*Limax maximus*, *Veronicella cubensis*, *Deroceras leave*, *Meghimatium striatum*)
- b. Predatory snails (*Euglandina rosea*)
- c. Arthropods (multiple species)
- d. *Cyanea superba* subsp. *superba* (via fruit predation)
- e. Seedling plots (multiple species)
- f. Seed rain buckets (*Diospyros* sp. and *Psidium cattleianum*)
- g. *Achatinella mustelina*

Since rat diets may include all of the above groups, it is expected that their numbers will increase with rat removal. The experiment is on-going. Changes in plant and animal groups as rodent populations are suppressed over longer time periods are anticipated. Data collection for all groups which may be impacted by rats was collected over one year in both areas.

Management and monitoring actions by site

Management & Monitoring Actions	Kahanahaiki	Pahole
Rat Control	Yes	No
Rat Tracking Tunnel Monitoring	Yes	Yes
Slug Monitoring	Yes	Yes
<i>Euglandina rosea</i> Monitoring	Yes	Yes
Arthropod Monitoring	Yes	Yes
<i>Cyanea superba</i> subsp. <i>superba</i> Fruit Predation Monitoring	Yes	Yes
Seedling Plot Monitoring	Yes	Yes
Seed Rain Bucket Monitoring	Yes	No
Oahu Tree Snail (<i>Achatinella mustelina</i>) Monitoring	Yes	No

Kahanahaiki large scale trapping grid with trap, tracking tunnel locations, and sampling locations.



(A) Wooden rat trap box deployed. (B) Wooden rat trap box with Victor rat trap. (C) Plastic tracking tunnel with inked tracking card. (D) Tracking card with rat tracks.

7.6.2 Methods and Results

Please refer to chapter 6.6 of the 2009 Status Report For the Makua and Oahu Implementation Plans for a full description of methods used. (http://manoa.hawaii.edu/hpicesu/DPW/2009_OIP/007.pdf). Methods are paraphrased here to better understand results.

7.6.2.1 Rat Control (Kahanahaiki MU)

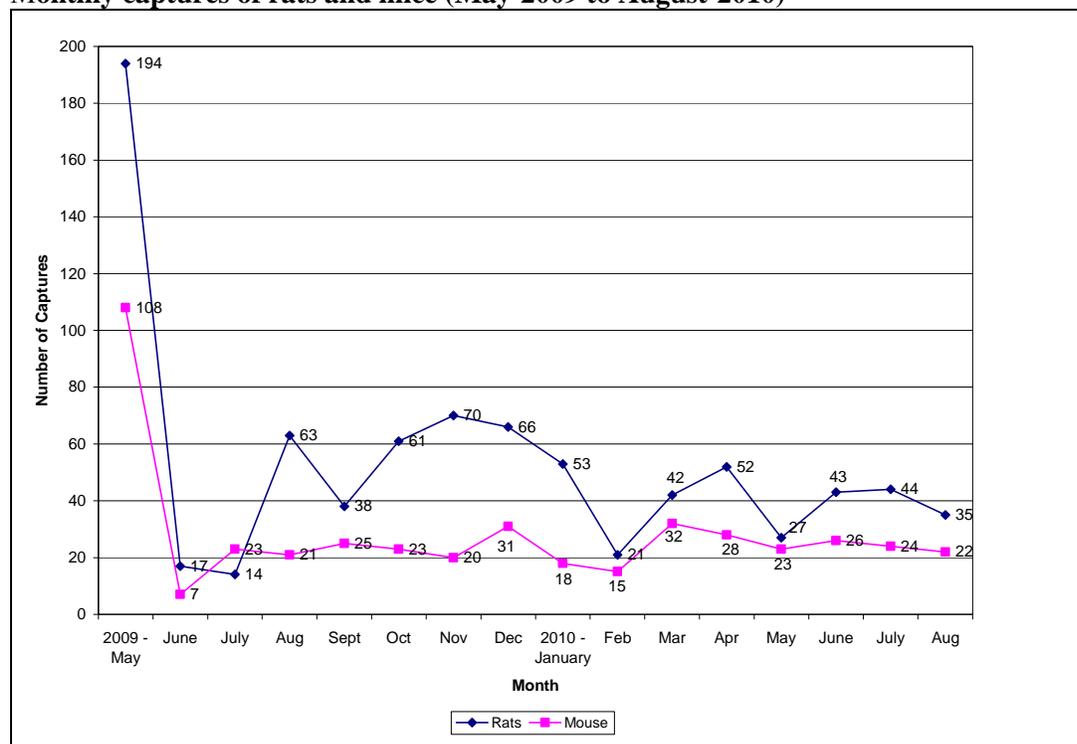
Study design

The grid was initially established in May 2009 with 402 traps and later expanded to 480 traps. The perimeter consists of 234 traps spaced at 12.5 meters apart. The interior contains 246 traps established on transects and existing trails (14 trap lines) at a spacing of 25 meters between traps. Traps were checked daily for approximately the first two weeks, then on a weekly basis for eight weeks, then two three week intervals, with the current checking interval bi-weekly.

Results

The trapping grid has been checked 49 times over a 16 month period (May 2009-August 2010) with a total of 840 rats and 444 mice trapped (See figure below). Approximately, a quarter of the total rats captured occurred in the first month (May 2009) of trapping. On average, 43 rats were captured per month after the initial knockdown occurred, with approximately 17 rats captured per grid check.

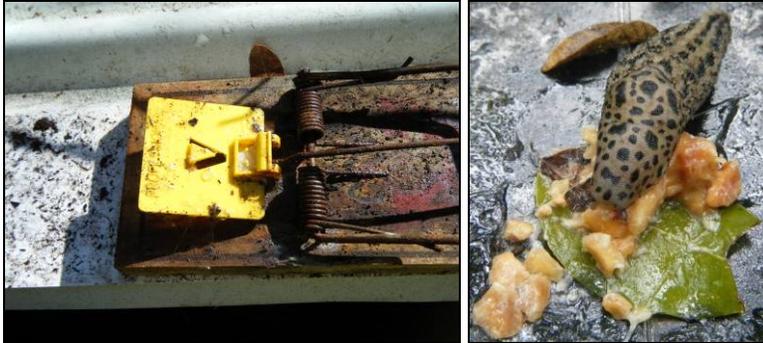
Monthly captures of rats and mice (May-2009 to August-2010)



Slug Interference

Over the past 16 months that the trapping grid has been in operation, invasive slugs continue to be a major problem in consuming bait placed on rat traps. Slugs are able to consume a quarter sized glob of peanut butter in one night, consume a half of macadamia nut in three nights, and a 3/4" square chunk of

coconut within a week. A variety of baits have been used in an effort to find a bait that is less susceptible to slug consumption, weathers well and is still attractive to rats. Baits that have been used include: peanut butter, coconut chunks, macadamia nuts, flavored wax coils, chocolate chips, Ferafeed® (non-toxic pre-feed bait from Connovation Ltd., New Zealand), sponges with food grade flavor concentrates, and peanut butter flavored rodent chew tab census tag wax. Slugs were able to consume all baits except the wax coils and sponges, both of these bait types had few captures. Slugs were not deterred from consuming rock salted peanut butter and Ferafeed®. In many instances, slugs would consume the salted baits and die on the trap. In an effort to keep slugs from consuming bait, some trap boxes were elevated 6 inches above the ground on rebar with 2 inches of copper tape. Slugs were able to breach the copper tape within a few days.



Rat trap with no bait, consumed by slugs (Left photo). *Limax maximus* consuming peanut butter (Right photo).

7.6.2.2 Tracking Tunnel Monitoring (Kahanahaiki MU)

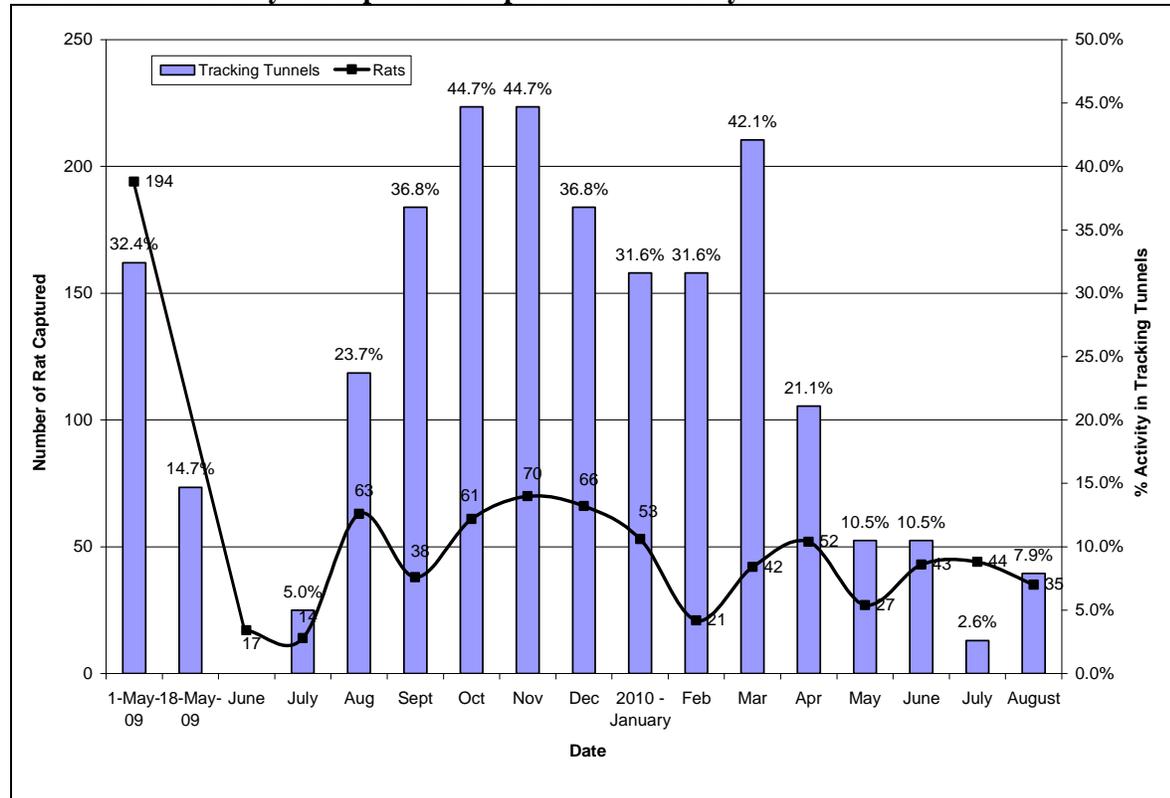
Study design

A total of 38 tracking tunnels have been run at the Kahanahaiki MU 16 times over a 16 month period (01 May – 21 August 2010) (See figure below). During each tracking tunnel session, tunnels are baited and run for one night. The initial running of tracking tunnels occurred four days before the start of the trapping grid, with tunnels being run approximately monthly thereafter.

Results

Tracking results have been variable with the peak in rat activity occurring in October and November 2009. The lowest level of rat activity detected occurred in July of 2009 and 2010. Mouse activity tracked similarly to rat activity over the same time period. The high rat activity occurring in the fall and winter appears to have been tracking the natural cycle of the rat population outside of the grid. The perimeter to the interior of the grid is approximately 125 meters which allows for incursion of rats in a short period of time. We don't have rat activity levels prior to the start of rat control, so the continued monthly running of tracking tunnels will give us a better understanding of rat activity within the grid.

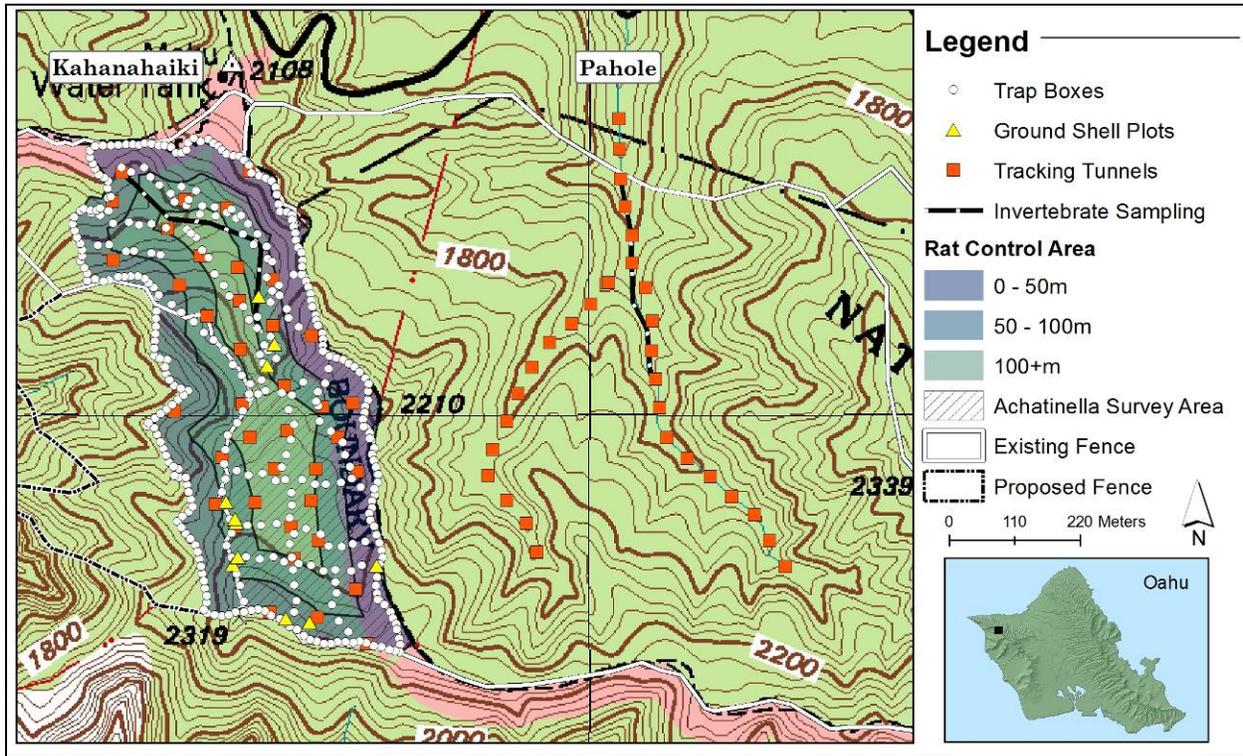
Kahanahaiki monthly rat captures and percent rat activity



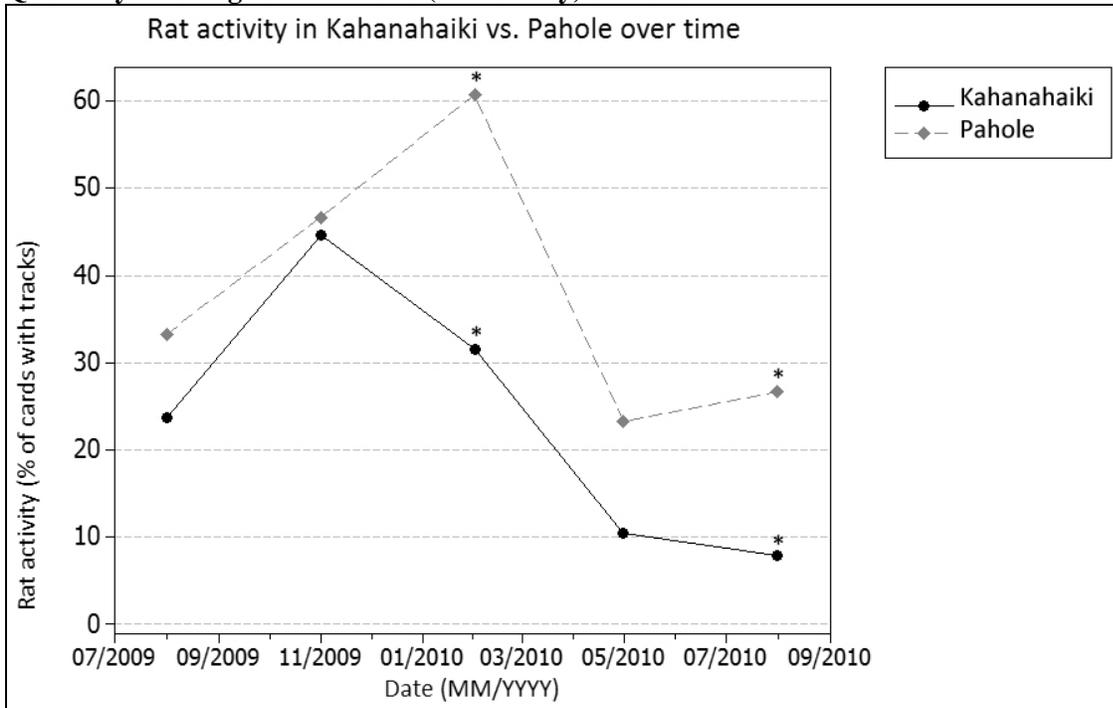
7.6.2.3 Tracking Tunnel Monitoring – Kahanahaiki vs. Pahole

Starting on Day 106 (18 August 2009) tracking tunnels were simultaneously run quarterly at both the Kahanahaiki MU (38 tracking tunnels) and the Pahole NAR (30 tracking tunnels; See map below) to compare the two sites (Management vs. Control). Rat activity did not differ significantly between sites three out of the five time periods sampled (see graph below), though it was consistently higher outside of the trapping grid. There were significant differences in rat activity between sites in February and August of 2010. Another year of data collect will help in determining trends in rat activity for both sites. Some of this data was presented by S. Mosher at the 2010 Hawaii Conservation Conference (HCC 2010) in Honolulu, HI in a talk titled: Controlling Invasive Rats (*Rattus* spp.) with a Large Scale Trapping Grid for Endangered Species Conservation on Oahu Hawaii (<http://manoa.hawaii.edu/hpicesu/DPW/HCC-2010/default.htm>).

Location of tracking tunnels at Kahanahaiki MU and Pahole NAR



Quarterly tracking tunnel results (rat activity) at Kahanahaiki vs. Pahole



* = significant difference between groups <0.05 (Chi-Square analysis).

7.6.2.4 Slug Monitoring (Kahanahaiki MU & Pahole NAR)

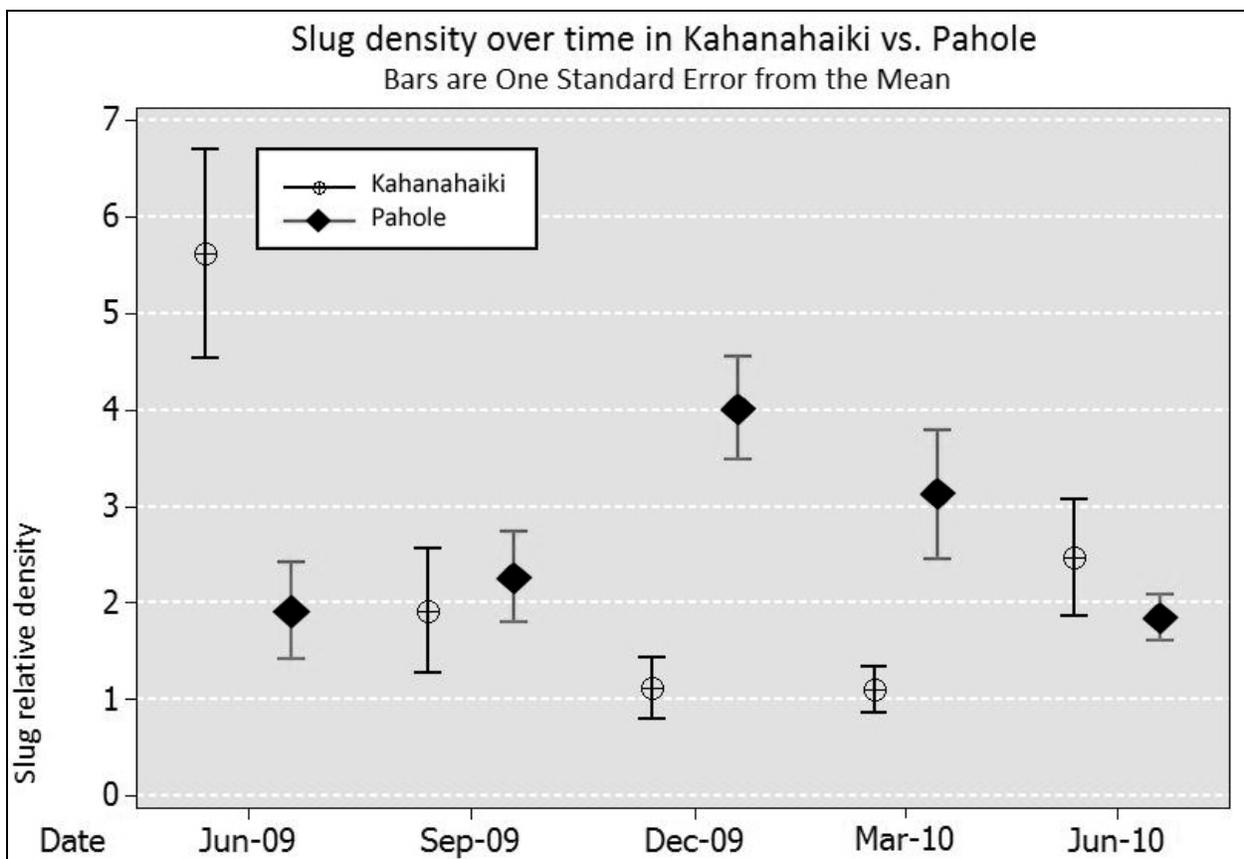
Study design

Slugs found in beer baits left out for one week were used to estimate slug numbers. Forty 8 ounce jars were deployed at 25 meter intervals along a 400 meter transect in the Kahanahaiki gulch bottom and in the main drainage of the Pahole NAR (Gulch 2). Once a quarter (in March, June, Sept. and December) traps were baited with 5 ounces of Guinness beer and the number and species of slugs caught recorded.

Results

Data from April 2009 extending through June 2010 shows no correlation between rat activity and relative slug density in either site (Pearson's correlation $r^2=13\%$; $P=0.39$). High variability in slug numbers over time and between sites was observed.

The graph below shows the relative slug density (mean number of slugs per beer trap) by site over time. No clear patterns are evident. Slug numbers fluctuate between sites and do not track one another seasonally. In Pahole slug numbers peak in December while in Kahanahiki the highest density of slugs is observed in June (both years). In September 2009, and June 2010 slug numbers at both sites were the same. The inconsistent numbers of slugs over time and between sites might be due to microhabitat (soil moisture or leaf litter).



7.6.2.5 *Euglandina* Monitoring (*Kahanahaiki MU & Pahole NAR*)

Study design

Euglandina were sampled using timed searches (one person hour) at 10 discrete points along the 400 meter transect established for slug sampling. Each of the ten points marked the center of a 75 m² plots along which three people searched for *Euglandina* over 20 minutes (total time equal to one person hour per plot). Live *Euglandina* were counted, shell length recorded (mm) and left in place so as to not artificially control populations via manual removal. *Euglandina* shells were scored for damage (rat damaged or whole) and destroyed so as to not be re-counted at a later time.

Results

Seasonal variation in *Euglandina* over time was fairly consistent between sites despite differences in rat control effort (see graph below). As with slugs, no correlation between rat activity and predatory snails (*Euglandina*) was evident (Pearson's correlation $r^2=16.7\%$; $P=0.31$). With one exception (June 2009) numbers of *Euglandina* were the same at both sites. This exception may have occurred because of a 4 day (rather than 1 day) interval in sampling between sites. Our failure to detect a relationship between rat activity and either *Euglandina* or slugs, however, suffers from a low number of sampling points over time (5 times per site).

