ASSESSMENT OF EFFECTS OF RODENT REMOVAL ON ARTHROPODS, AND DEVELOPMENT OF ARTHROPOD MONITORING PROTOCOLS, ON CONSERVATION LANDS UNDER US ARMY MANAGEMENT

Annual Statement of Work, September 2015

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Background

Invasive black rats are believed to exert severe predatory pressure on native arthropod species, but the effects of this pressure on arthropod populations has not been quantified in the field. Because rats are now nearly ubiquitous in natural areas of Hawaii, the most effective way to assess their impacts on arthropod species and communities is to monitor the response of arthropods to rat removal. The Oahu Army Natural Resource Program (OANRP) has implemented rat removal operations in several areas in the Waianae Mountains. In conjunction with these efforts, I have been conducting standardized, quantitative arthropod sampling before and after rat removal in two of these areas (Kahanahaiki and Palikea), as well as in adjacent control sites where rats will not be immediately removed, to measure arthropod responses and estimate the impacts of rats on native and introduced arthropod populations. This sampling will also serve as an arthropod inventory, providing important information on the biodiversity of these management areas. Thirdly, the sampling conducted in this project will be used to help develop broader arthropod monitoring protocols for the OANRP management units, as desired under the Makua and Oahu Implementation Plans.

FY15 progress

During fiscal year 2015, the samples from the final sampling event, conducted in July 2014, were sorted, and final data analysis and write-up for the project was started. In total, 2160 samples were collected from the two sites and sorted, and 305,848 specimens belonging to 582 species or morphospecies have been databased. July 2014 specimens still need to be databased.

Results to date

Analysis of patterns after three years of rodent trapping at Kahanahaiki and two years of trapping at Palikea suggest that with some exceptions, rodent impacts on arthropod populations are likely to be context dependent and variable among sites. These patterns are summarized in Figure 1, and more detailed results are shown in Table 1.

Arthropod groups that showed some evidence of responding to rodent trapping at either site include spiders (Araneae), beetles (Coleoptera), springtails (Collembola), true bugs (Hemiptera), caterpillars (Lepidoptera), crickets and katydids (Orthoptera), and bark lice (Psocoptera). However, many of these groups did not respond consistently across the two sites, suggesting either that these responses are context-dependent and may often be inconsistent between sites or specific situations, or possibly that some of the measured responses may have been caused by factors other than the rodent trapping. Several groups did show quite consistent responses across sites, however, lending support to the interpretation that many or most of the arthropod population changes were caused either directly or indirectly by rodent suppression. Such consistent responses included decreases in abundance in ground-active caterpillars and arboreal bark lice, and increases in abundance in arboreal springtails, native crickets and katydids, and native predatory *Eupithecia* caterpillars. Although Figure 1 and Table 1 suggest that increases in orthopteran abundances did not occur in all situations, increases were in fact consistent for all sampling methods that captured substantial numbers of individuals of this group at each site (vegetation sweeps at Palikea and pitfalls at Kahanahaiki).

In general, changes in abundance tended to be more common and stronger at Kahanahaiki compared to Palikea. It is unknown whether this is related to the less comprehensive sampling methods used at Kahanahaiki, or to differences in food-web dynamics between the two sites. For example, a stronger positive response by birds to rodent trapping at Palikea could result in weaker arthropod abundance increases at that site, since birds have strong top-down effects on arthropod populations.

Analysis of changes in arthropod species richness provide evidence of some increases in diversity among spiders, beetles and arthropods overall (including native species) at Kahanahaiki following rodent trapping. At Palikea, evidence for changes in species richness was weaker, but included possible trends of increasing diversity among Hemiptera, and decreasing diversity among spiders (Table 2).

Analysis of changes in trophic structure following rodent trapping suggest that while some changes in arthropod biomass may occur, they tend to be relatively small and have relatively weak effects on the percent composition of different trophic groups.

Overall, the results to date suggest that rodent suppression using snap-trap grids in mesic forest habitats on Oahu tends to result in population-level changes for certain arthropod groups, some of which may vary among sites or situations, rather than dramatic community-wide changes in arthropod abundance, biomass or trophic structure.

The vegetation sampling on specific trees as Kahanahaiki and Pahole also allowed me to perform an assessment of the potential effects of invasive ants on arthropod communities in these forests. This analysis indicated that while 10 different ant species occurred on the sampled trees during the three-year study period, their incidence rates and abundances were usually quite low, and therefore these species probably have relatively insignificant impacts on arthropods. However, the results also suggested that if their densities increased substantially, their effects may be more similar to those typically documented for invasive ants in Hawaii and elsewhere. These results are reported more fully in the paper "Ecology of some lesser-studied introduced ant species in Hawaiian forests", Journal of Insect Conservation 19(4): 659-667 (http://manoa.hawaii.edu/hpicesu/DPW/PEC-2015/default.htm).

Future plans

While sampling for this project is now complete, I will continue to work on producing comprehensive write-ups of various aspects of the project for journal articles and/or technical reports.

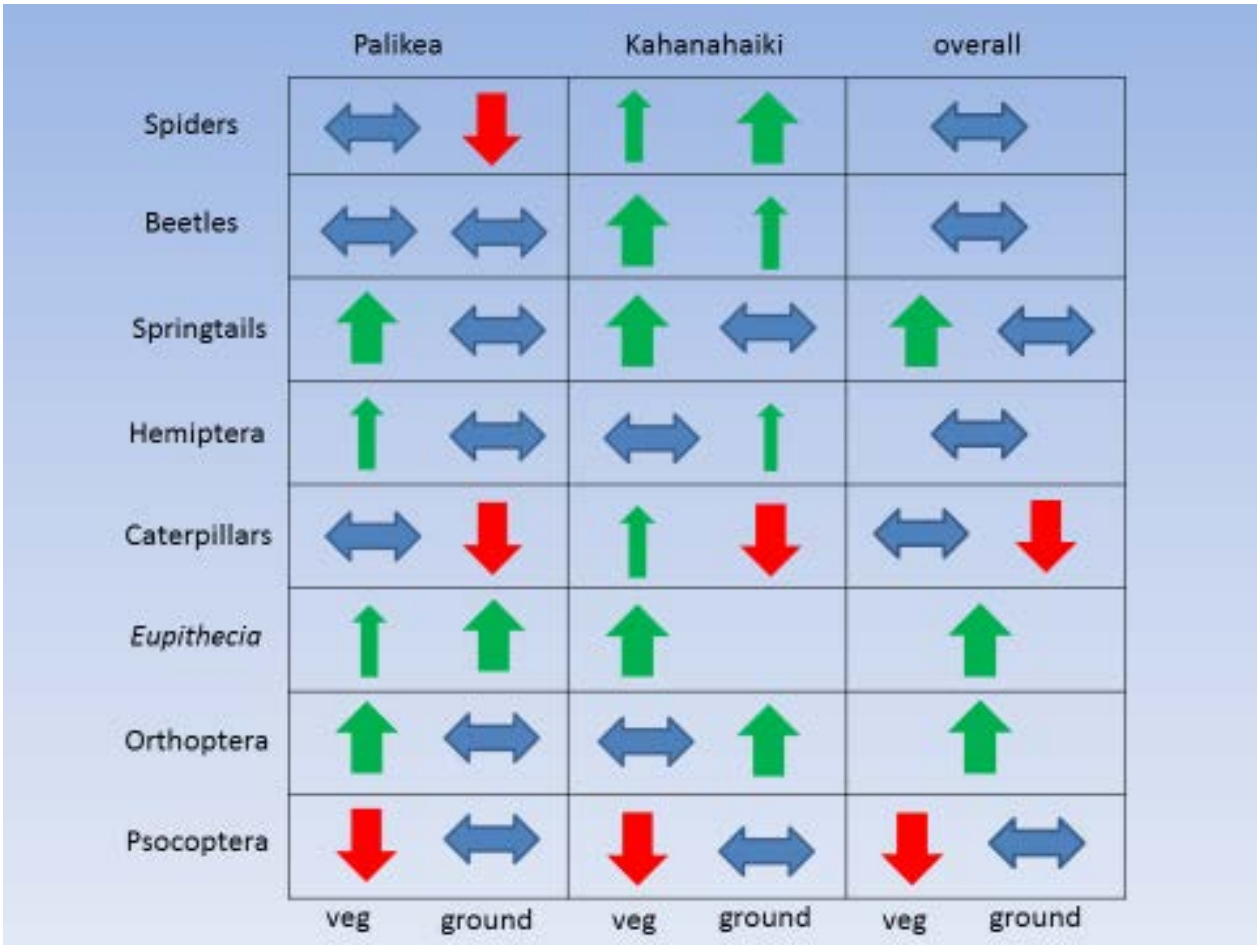

Figure 1. Summary of changes in abundance in rodent-trapping areas relative to adjacent untrapped areas at each site, for select arthropod groups. Taxonomic groups not shown exhibited less consistent changes in abundance. Green arrows indicate general trends of increases in abundance after trapping, red arrows indicate decreases in abundance after trapping, blue arrows indicate no significant trends or inconsistent trends in abundance. Thickness of arrows give a relative indication of the strength of each pattern in terms of level of statistical significance and/or consistency of trend over multiple time intervals (thicker arrows indicate stronger patterns). “Veg” refers to vegetation sampling (vegetation beating/sweeping), “ground” refers to ground sampling (pitfalls and leaf litter extraction). The first two columns indicate patterns at Palikea and Kahanahaiki, respectively, whereas the third column indicates overall patterns for each taxonomic group, considering trends at both sites.

Table 1. Median change in abundance at rodent trapping sites relative to adjacent untrapped sites, for different sampling types and time intervals. Colored cells (green = increase, red = decrease) indicate changes statistically significantly different from zero (Mann-Whitney U test, $p < 0.05$).

Taxon	Palikea				Kahanahaiki/Pahole					
	Vegetation sampling		Ground sampling		Vegetation sampling			Ground sampling		
	1 year	2 years	1 year	2 years	1 year	2 years	3 years	1 year	2 years	3 years
Chilopoda	1.00	-1.00	-1.00	-2.00				0.00	0.00	0.00
Diplopoda	5.00	-3.00	**18.00**	**17.00**	0.00	0.00	0.00	**-2.50**	-0.93	-0.50
Amphipoda	1.50	**-0.50**	-22.50	**-54.50**	0.00	0.00	0.00	-9.50	17.00	15.00
Isopoda	-5.00	-1.50	-53.50	-63.50	0.00	1.00	0.00	2.73	2.00	-2.00
Acari	-50.00	2.00	-5.50	133.00	-0.50	0.00	0.00	-0.50	0.00	0.00
Araneae	-16.50	16.50	**-19.00**	-9.00	1.00	2.25	1.25	**4.00**	**5.00**	2.00
native Araneae	-19.00	7.00	0.00	-1.00	0.50	0.00	0.00	0.00	**0.50**	0.00
adv Araneae	-1.00	-0.50	**-12.00**	**-6.00**	0.50	**1.50**	**1.00**	0.00	0.00	**-1.00**
Archaeognatha	-0.50	0.00								
Blattaria	-2.00	-1.50	0.00	0.00	0.00	0.00	0.00			
Coleoptera	-0.50	1.50	0.50	8.00	-0.50	**2.00**	**2.50**	1.00	8.75	**35.00**
native Coleoptera	0.50	-0.50	-0.50	3.00	0.00	**0.50**	1.00	0.00	0.00	0.40
adv Coleoptera	0.50	2.50	1.00	**2.50**	-0.50	**1.00**	0.50	-3.45	-1.00	**16.30**
Collembola	58.00	**62.50**	-108.50	-101.00	13.25	**17.50**	**21.00**	-3.50	8.00	-0.50
Dermaptera			-1.00	1.00				0.50	-0.50	**1.50**
Diptera	-1.00	3.50	10.00	-1.50	0.00	0.00	0.00	**4.25**	1.00	**2.50**
Hemiptera	14.50	17.00	-1.00	0.50	-3.00	3.00	4.50	0.57	0.50	**2.03**
native Hemiptera	**12.50**	10.00	0.50	0.50	-3.25	2.50	3.50	0.40	0.00	0.00
adv Hemiptera	1.50	2.50	0.50	0.00	-0.50	-0.50	-0.50	0.50	0.58	**2.00**
Hymenoptera	**11.00**	**22.00**	0.50	-1.00	0.50	1.50	1.00	0.50	0.00	**1.33**
Lepidoptera	1.00	0.50	-7.50	**-26.50**	**1.00**	**1.00**	**1.00**	**-2.00**	0.00	**-2.00**
immature Lepidoptera	0.00	1.00	-9.50	**-26.50**	0.50	**0.50**	0.50	**-1.50**	0.00	**-2.00**
Hyposmocoma	-4.00	-2.00	4.00	**8.50**	0.50	**0.00**	0.00	-0.20	0.00	-0.50
Eupithecia	0.00	**1.00**	**0.50**	**0.50**	**0.50**	**0.50**	0.00	0.00		
Neuroptera	0.00	-0.50			0.00	0.00	**0.50**			
Orthoptera	**4.50**	**5.00**	0.00	0.00	0.00	0.00	0.00	0.00	**2.00**	**2.00**
Gryllidae	**4.00**	**5.00**	0.00	0.00	0.00	0.00	0.00	0.00	**2.00**	**2.00**
native Tettigoniidae	0.50	1.00								
adv Tettigoniidae	0.00	0.00			0.00	0.00	0.00			

Psocoptera	**-24.50**	**-18.00**	9.00	-7.50	**-6.00**	-1.50	-3.50	0.00	0.00	-0.10
Thysanoptera	4.50	5.50	-9.00	-14.00	0.00	0.50	0.50	-0.25	0.00	0.00
Arthropoda total	36.50	93.50	-182.00	-194.50	8.50	**36.75**	**32.00**	2.25	43.75	**82.00**
native Arthropoda	5.00	32.00	1.50	**10.00**	-3.00	5.50	**7.50**	0.00	**2.50**	1.95
adv Arthropoda	6.00	4.00	-86.00	-120.00	1.00	**8.00**	**3.75**	-5.25	24.65	**48.25**
unk Arthropoda	45.00	72.50	-83.00	-19.50	8.00	**16.50**	**14.50**	12.50	**27.65**	**21.50**

Table 2. Median change in species richness at rodent trapping sites relative to adjacent untrapped sites, for different sampling types and time intervals. Colored cells indicate changes statistically significantly different from zero (Mann-Whitney U test, $p < 0.05$).

Taxon	Palikea				Kahanahaiki/Pahole					
	Vegetation sampling		Ground sampling		Vegetation sampling			Ground sampling		
	1 year	2 years	1 year	2 years	1 year	2 years	3 years	1 year	2 years	3 years
Araneae	**-2.50**	-1.50	-0.50	**-1.50**	0.00	**1.50**	0.00	0.50	**1.00**	0.00
native Araneae	**-2.00**	**-1.50**	0.00	-0.50	0.00	0.50	0.00	0.00	**0.50**	0.00
adv Araneae	-0.50	0.50	0.00	-1.00	0.00	0.50	0.00	0.00	0.00	**-1.00**
Coleoptera	-0.50	1.00	1.00	**3.00**	0.00	**1.50**	1.00	-1.00	0.00	**1.50**
native Coleoptera	0.50	0.50	1.00	1.00	0.00	**0.50**	**0.50**	0.00	0.00	0.43
adv Coleoptera	-0.50	0.50	0.00	1.00	0.00	**1.00**	0.00	-0.50	-0.43	0.50
Hemiptera	**3.00**	3.00			0.00	0.00	0.00			
native Hemiptera	**2.50**	2.00			0.00	0.00	0.00			
adv Hemiptera	1.00	**2.00**			-0.25	-0.50	0.00			
Arthropoda total	-1.00	3.00	2.00	4.50	1.00	**6.00**	2.00	-1.00	2.50	**3.50**
native Arthropoda	0.00	-1.00	**2.00**	**3.00**	1.00	**2.00**	1.00	0.00	0.50	0.50
adv Arthropoda	0.50	**3.00**	-0.50	1.00	-0.50	**2.00**	1.00	-0.95	0.30	1.00
unk Arthropoda	-1.00	0.00	1.00	0.50	0.00	**2.00**	0.50	-0.52	**1.47**	**1.50**