

The Effect of Rats on the Foraging Location of Birds in Hawaiian Forests Fragmented by Lava Flows

By: Anna Buckardt Mentor: Dr. David Flaspohler, SFRES

Background. Rats (*Rattus* spp.) were accidentally introduced to the Hawaiian Islands in the 1700 and 1800s and have been shown to impact food webs and interspecific interactions¹. Like most rodents, rats are omnivorous and forage mainly on insects but will also eat native bird eggs, nestlings and adults¹. Rats are capable of suppressing insect populations in Hawaiian forests and this can negatively impact insectivorous birds, many of which are endangered in Hawaii⁶. Previous research by Dr. Flaspohler has shown that in native Hawaiian forests, rats commonly forage up to 12 meters above the ground (unpublished data). Insectivorous birds typically forage from 5 meters to the top of the highest canopy, sometimes 25 meters above the ground⁵. As part of Dr. Flaspohler’s ongoing study, rats have been trapped out of half of 34 forest fragments on the Big Island of Hawaii⁴. These forest fragments of varying size are known as *kipukas*, and were once part of a vast contiguous forest before being fragmented by a volcanic eruption in the mid-1800s⁴ (Fig.1). The requested SURF funds will allow me to measure the effect of rat presence or absence on bird foraging location. Given that rat predation is concentrated in the lower canopy strata, my prediction is that after rats are removed from a *kipuka*, birds will begin to forage lower in the canopy as insect populations recover. The forest fragments span a range of sizes, allowing me to also examine the role of fragment size on the birds’ behavioral response to rat presence or absence.

Significance. This research project will shed new light on how invasive rats influence the foraging behavior of Hawaiian birds, the most imperiled group of birds in the world⁸. Such information is needed by forest managers and conservation biologists to help preserve these species. This research examines basic ecological theory related to fundamental versus realized niches, and provides new knowledge with clear applications for management of imperiled birds. The findings of this study will have significance for other species and areas and will yield new insights into interspecific competition and food web interactions. This project is an extension of Dr. Flaspohler’s research and will look at a new aspect of rat and bird interaction that he has not been able to study due to lack of personnel. This SURF will leverage the extensive preliminary descriptive data on the Hawaiian *kipuka* landscape as well as considerable logistical support associated with Dr. Flaspohler’s ongoing study⁵.

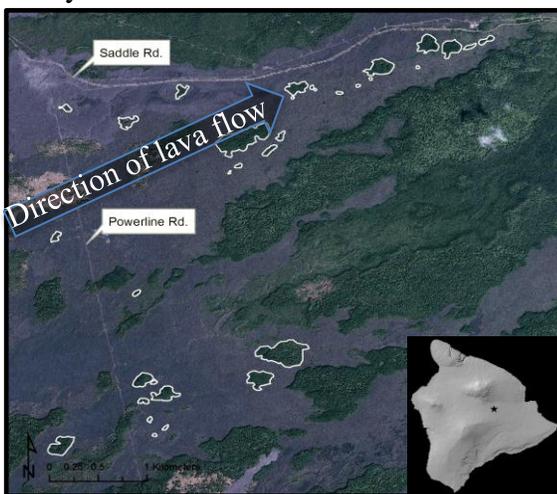
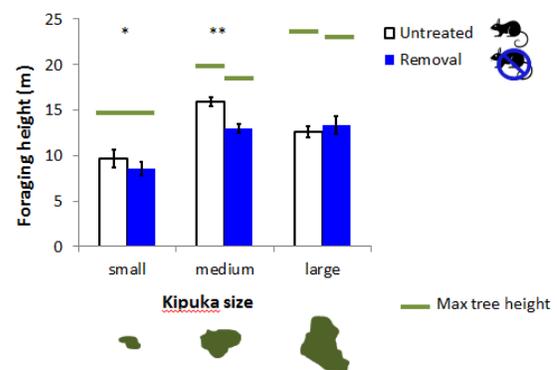


Figure 2. Kipuka study landscape on the Big Island showing gray lava and green forest fragments (kipuka).



Rat: $F_{1,328} = 9.2, p < 0.01$, Area: $F_{2,328} = 25.9, p < 0.001$

Figure 1. In small and medium sized kipuka (<1ha), the average foraging height of all birds is lower in forest fragments without rats compared to fragments with rats.

Question. In 2012, a small pilot study provided data that suggested that birds in rat-free *kipukas* were foraging lower in the forest canopy (Fig. 2). This SURF would allow me to collect data full-time from early May to the end of June, 2013, to expand the pilot study findings. By examining the influence of rat presence on birds foraging across a range of *kipuka* sizes, I will be able to look at the effect of fragment size on the birds' response to rat presence. This experience would be invaluable in developing my skills as a young scientist and would advance the MTU goal of increasing participation of women in science careers.

Hypothesis. My hypothesis is that after rats are removed from a *kipuka*, insect populations should respond quickly to reduced predation pressure from rats and increase in density. Insectivorous birds have been shown to assess and respond to prey density by altering their foraging locations⁶. If insect populations do increase following rat removal, native Hawaiian birds should on average forage lower in forest fragments lacking rats than in fragments containing rats.

Methods. Using study sites near Hilo, Hawaii previously selected by Dr. Flaspohler for his research, I will conduct focal bird observations between dawn and 3 pm, five days a week. I will be working near the banding and nest searching technicians for his project and will be in regular contact using cell phones and walkie-talkies. In rat and rat-free *kipuka* of similar sizes, I will use a GPS and compass to walk transects through each *kipuka* and, using binoculars and a laser range finder, I will note the height, species, time of day, and substrate of any foraging bird encountered. I will take only a single height observation for each bird to ensure independence of observations². With these data, I will use t-tests and other statistical methods to test the null hypothesis that mean foraging height does not differ between rat and rat-free *kipukas*. As noted above, I will include *kipuka* size as a covariate in my analyses. I will examine these questions for each individual bird species including I'iwi (*Vestiaria coccinea*), Apapane (*Himatione sanguinea*), Oma'o (*Myadestes obscurus*), Hawaii Amakihi (*Hemignathus virens*), Hawai'i Elepaio (*Chasiempis sandwichensis*) and for all species pooled.

Timeline. This research will occur during May - June 2013 in Hawaii. I will collect data five days a week, weather permitting. Data analysis will take place at my home in Illinois in July and August. With the help of Dr. Flaspohler, I will have a manuscript written and ready to submit to a peer-reviewed journal (e.g., *Wilson Journal of Ornithology*, *Journal of Field Ornithology*) by December 2013. I also plan to prepare a scientific poster to present at the Undergraduate Research Expo hosted by the Honors Institute, The Wildlife Society's annual conference in October 2013, and any SURF-related opportunities to share my results.

Budget. A round trip ticket from Chicago O'Hare to Hilo Hawaii will cost about \$900. The remainder of the SURF funds will be used as a wage that will cover food and incidental costs while in Hilo, HI where the project has a rented house. My wage will be eight dollars an hour for eight 40 hour work weeks. For the two months in Hawaii: \$8/hour * 40 hours = \$320 * eight weeks = \$2,560. Housing and on-island transportation costs will be covered by Dr. Flaspohler's project budget. Total budget requested is \$2,560 + \$900 = \$3460.

Communication. To stay connected with the SURF program at Michigan Tech while I am in Hawaii and Illinois, I plan to attend meetings through phone and or Skype or other video chat. In addition, Dr. Flaspohler will be present for the first week of my project and his post-doc, Dr. Jessica Knowlton will act as a co-mentor, and will be available during every day of fieldwork. I recognize the importance of communication between myself and Drs. Flaspohler and Knowlton and will communicate regularly.

References

1. Amarasekare, Priyanga. "Ecology of Introduced Small Mammals on Western Kea, Hawaii." *American Society of Mammalogists* 75.1 (n.d.): 24-38. *JSTOR*. Web. 13 Jan. 2013. <<http://www.jstor.org/stable/1382233> .>.
2. Bibby, C., M. Jones, and S. Marsden. 1999. *Bird Census Techniques*, 2nd ed. Academic Press, London.
3. Fancy, Steven G. and C. John Ralph. 1997. Apapane (*Himatione sanguinea*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: <http://bna.birds.cornell.edu/bna/species/296>doi:10.2173/bna.296
4. Flaspohler, David J., C.P. Giardina, G.P. Asner, P. Hart, J.Price, C. Ka'apu Lyons, and X. Castaneda. 2009. "Long-term Effects of Fragmentation and Fragment Properties on Bird Species Richness in Hawaiian Forests." *Biological Conservation* 143 (2010): 280-88.
5. Fukami, T., Flaspohler, D., Giardina, C., and D. Gruner. *Collaborative Research: Interactive Effects of Predation and Ecosystem Size on Arthropod Food Webs in Hawaiian Forests Fragmented by Lava Flows. NSF Grant from the Division of Environmental Biology, 2010-2015.*
6. Holmes, R.T., and Schultz, J.C. 1988. Food availability for forest birds: effects of prey distribution and abundance on bird foraging. *Can. J. Zool.* 66(3): 720–728. doi:10.1139/z88-107.
7. "Listings and Occurrences for Hawaii." *Listings and Occurrences for Hawaii*. U.S. Fish and Wildlife Service, 13 Jan. 2013. Web. 13 Jan. 2013
8. Wilcove, David S., Rothstein, D., Dubow, J., Phillips A., and Losos, E. "Quantifying Threats to Imperiled Species in the United States." *BioScience* 48.8 (1998): 607-15. *JSTOR*. Web. 13 Jan. 2013. <<http://www.jstor.org/stable/1313420>>.