

Studying the Effects of Removing Non-native Herbivores on Lehua Island's Vegetation

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The accidental or intentional introduction of alien species is one of the most serious threats faced by island ecosystems. Among herbivores, rabbits (*Oryctolagus* spp.) alone have been released on over 800 islands worldwide (Flux & Fullager 1983). Loss of vegetative cover as a result of grazing and burrowing by rabbits has rendered substantial areas of some islands vulnerable to erosion. For example, rabbits introduced to Phillip Island, Australia destroyed 80% of the vegetation, causing the loss of all soil except from a few flat areas (Watson 1961). Rabbits also exert selective control on vegetation, altering species composition and vegetation structure (Gilham 1961; 1963; Chapuis et al. 1989; North et al. 1994). Rats (*Rattus* spp.) have been more extensively distributed to islands throughout the world (Atkinson 1989). These herbivores are not only major seed predators, but also consume seedlings, young shoots, flower buds and other vegetative parts (Norman 1970; Campbell et al. 1984; Campbell & Atkinson 2002). Campbell and Atkinson (2002) have shown that introduced rats are capable of altering entire vegetation communities through selective herbivory, but research is just beginning in this area.

Introduced herbivores are believed to play a key role in island communities, where plants lack a history of vertebrate herbivory. Plants evolve defenses in direct proportion to the risk of herbivory (Rhoades 1979; Marquis 1991); because defenses are costly, production decreases when herbivores are absent (Rhoades 1979). Consequently, insular endemic plants that evolved in the absence of vertebrate herbivores typically lack defenses against herbivory making them more palatable and susceptible to extirpation (Bowen & Van Vuren 1997).

Seabirds that depend on islands for nesting habitat are also affected by introduced vertebrates. Rats are notorious predators of eggs and small chicks and have decimated

entire seabird colonies (Atkinson 1989). Although it may seem unlikely, rabbits also affect seabird nesting success. They contend for nest sites, alter existing burrows, and cause physical damage to eggs and chicks (Gilham 1963). Seabirds may also be affected indirectly as rabbits alter soil and vegetation as is the case with Gould's Petrel (*Pterodroma leucoptera*) on Cabbage Tree Island, Australia. As rabbits destroyed the forest understory, the burrowing petrels became exposed to predators and vulnerable to entanglement in sticky fruits of the bird-lime tree (*Pisonia umbellifera*) (Priddel & Carlisle 1998).



Nesting Black-footed albatross on Lehua Photo by Eric VanderWerf

Eradication complications-What can go wrong?

Recent advances and successes in removing introduced mammals from islands have made it a viable, and often dramatically successful, management option. However, recent research has shown that species removal in isolation can also result in unexpected changes to other ecosystem components (North et al. 1994; Priddel et al. 2000). In a review of alien eradications Zalvetta et al. (2001) found that nearly all documented cases where exotic plants co-occur with exotic herbivores on islands, herbivore removal has had mixed results for native vegetation. For example, feral herbivore removal from Santa Catalina Island, Channel Island National Park, led to an increase in native species richness, but also to large absolute and relative increases in cover by exotic annuals (Laughrin et al. 1994). Rabbit eradication on Round Island, Mauritius, led to strong recovery of three endemic tree species in addition to six reptile species. However, rabbit removal also caused the spectacular release of a previously sparse exotic grass *Chloris barbata*, rendering it a significant component of the vegetation on the island (North et al. 1994).

Exotic herbivore removal can potentially lead to cascading changes in entire ecosystems. After eliminating rabbits from Monunau Island, Australia, Boxthorn (*Lycium ferocissimum*) became abundant and the shrub's long thorns snared many Fairy Prions

(*Pachyptilla turtur*) and White-faced Storm-petrels (*Pelagodroma marina*) (Taylor 1968). The most dramatic exotic plant release involved a single species whose presence was unknown prior to exotic mammal eradication. Following removal of feral goats and pigs from Sarigan Island in the Commonwealth of the Northern Mariana Islands, the exotic vine *Operculina ventricosa* rapidly became abundant and now covers much of the island (Kessler 2002). Secondary effects of alien removal become more likely as the number of interacting invaders increases in ecosystems and as aliens in late stages of invasion usurp the functional roles of native species. (Zalvetta et al. 2001; Bullock et al 2002; Donlan et al. 2002).

Lehua Island Research Site

Lehua, renowned for its diversity of nesting seabirds, is a 290-acre tuff crater that lies 1.2 kilometers north of Niihau in the Hawaiian Islands. (Watson 1961). The island is designated as a Hawaii State Seabird Sanctuary and hosts at least 8 species of nesting seabirds, including the only Black-footed Albatross (*Phoebastria nigripes*) colony in the main islands and the largest known Brown Booby (*Sula leucogaster*) colony in the world (Wood et al. 2002). Additionally, 4 more species may be attempting to nest, including the endangered Newell's Shearwater (*Puffinus auricularis newelli*) and the Band-rumped Storm-petrel (*Oceanodroma castro*) (a candidate for listing). Rat predation is strongly suspected to be preventing successful nesting by these and other seabird species. Twenty-six native plant species have been documented on the island, but alien vegetation largely dominates. No terrestrial mammals are native to Lehua. Rabbits and rats were reported during the first survey of the island's flora and fauna in 1931 (Caum 1936). There is little historical data on rat or rabbit presence on the island and their impacts on the island community remain largely unknown. However, a survey by Wood in 2002 revealed drastic changes in the island ecosystem including a leap from 6 nonnative plants in 1931 to 27, which now dominate the island's flora. Seabirds have also experienced a change since 1931 with two species becoming locally extinct (Caum 1936; Wood et al. 2002).



Aerial photo of 290-acre Lehua Island

The goal is to eradicate both rats and rabbits from the island. However, Lehua, like most of Hawaii's offshore islets, has been long invaded by a multitude of species, creating a new equilibrium with the modified environment. Under these circumstances, secondary

effects from herbivore removal are to be expected. During a preliminary study on Lehua, we found several rat husking stations (sheltered area rats use repeatedly for eating and defecating) filled with Sandbur (*Cenchrus echinatus*) seeds. Through granivory, rats may be controlling this highly invasive species. Close monitoring will help reduce unexpected negative consequences aiding in the protection of critical nesting habitat, safeguarding native plant species and avoiding further degradation of the ecosystem.

Progress to Date on Lehua

In 2002, we set up a series of transects on the island to monitor vegetation change. We collected baseline data in April (after the wet season) and again in September (after the dry season) between 2002 - 2005. Rabbits were removed from the island in January 2006 and we immediately saw a response in the vegetation, although this coincided with an unusually rainy year. There was a dramatic increase in plant cover and diversity on the south side of the island where most rabbits were removed. There were increases in some native species (ahinahina, *Artemisia australis* and ilima, *Sida fallax*) most of the increase was in non-native species. However, invasive Buffel grass, *Cenchrus ciliaris*, and Bristly foxtail, *Setaria verticillata* were particularly abundant. Also of concern was the detection of a patch of Golden Crown-beard, *Verbesina encellioides*. Recent efforts have focused on eradicating the *Verbesina* before it spreads. This invasive plant in the sunflower family has caused devastating effects to native vegetation and nesting seabirds in the Northwest Hawaiian Islands. Although vegetation changes were evident, heavy rainfalls in 2006 make it impossible to immediately separate effects of increased rainfall and rabbit removal. Data collected over the next few years will provide a better estimate of rabbit effect. Rat eradication is scheduled for 2007 or 2008.

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