Experimental Restoration of ‘Ōhi‘a-Koa Forest Hawai‘i Volcanoes National Park, Kahuku Unit

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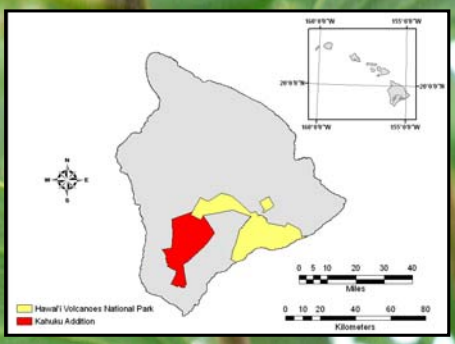
Introduction

Restoration of the unique and diverse koa-‘ōhi‘a forest which once dominated the pastures of the Kahuku Unit presents a large restoration challenge. Creation of cattle pastures has decimated much of the forest. The native vegetation that remains is limited to small forest fragments and inaccessible pit craters. The perpetuation of park biodiversity and restoration of native habitat depends on developing effective methods to re-establish the forest as grazing is phased out.



Successful forest recovery following cattle removal depends on reducing or eliminating common barriers:

- **competition with grasses**
- **depleted seed bank**
- **limited seed dispersal**
- **harsh microsite conditions**

How will the vegetation recover after cattle are removed?

In anticipation of cattle removal we constructed four (4 ha) exclosures to keep out grazing animals and evaluate recovery of native forest in different areas within 7,000 acres of currently grazed pasture. Within the exclosures we are testing three different grass removal techniques to facilitate natural recovery of native plants from the soil seed bank, and reduce competition by alien grasses. Monitoring was conducted to evaluate changes in species richness, vegetation cover and seedling recruitment.

Control	Herbicide	Herbicide	Herbicide + Soil Turnover
Herbicide + Soil Turnover	Soil Turnover	Control	Soil Turnover

Fence (200 m)

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Forest recovery may be limited by a depleted seedbank and limited seed dispersal. Under these circumstances we need to determine which species can be established through seed additions or planting nursery reared seedlings. Across four sites we broadcast 875,000 seeds of four common native species.
In addition, over 10,000 seedlings were planted including koa, ‘ōlapa, pilo, kolea, māmaki, and hōawa.

Community Vegetation Changes

Two years following treatment natural recovery of koa has been extremely high in areas where remnant koa trees were present. Overall the highest seedling recruitment was in the combination herbicide and soil turnover treatment with an average ~20,000 stems per acre compared to 3,400 in the herbicide treatment, 2,200 in the soil turnover, and 300 in the control.

Natural koa recruitment two years following soil turnover + herbicide treatment

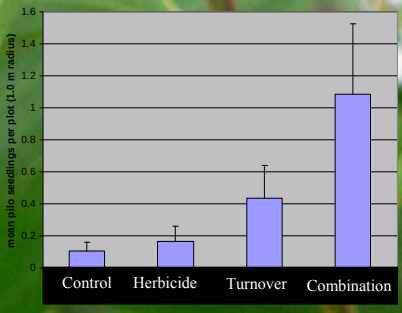
Within months seedlings of koa, naio, ʻōlapa, māmaki and pilo were observed within the exclosures. No native seedlings were found outside of the fence, in the grazed area with the exception of a few of ʻōhiʻa in the wettest site. However, overall recruitment was very low for species other than koa and no statistical differences were found between treatments in terms of species richness, vegetation cover, or natural seedling recruitment.

Fortunately, very few new weeds species appeared after fencing. Although alien grass species dominated all plots, alien woody species covered less then 2% of the plot area.

Plant and Seed Augmentation

Planting Survival of planted seedlings was very successful. Survival was high across sites and treatments (48-77%) and significantly increased species richness at two sites.

Seeding Two of the four augmented species, koa and pilo, had germinated across all sites and treatments after six months. Across sites there were differences in pilo seedling establishment among treatments ($p \leq 0.1$) with the highest number in the combination. There was little to no establishment of ʻōlapa and kawaʻu in augmented plots.



Implementation Plan

1. **Ungulate removal** is essential to facilitate the recovery of forest ecosystems. Native forest seedlings such as koa, pilo, māmaki, and ʻōlapa were only able to establish within the fenced exclosure.
2. **Grass manipulation** will greatly enhance the recovery of koa in areas where there is an existing seed source. Seed broadcast of pilo was more effective in the soil turnover and combination treatments.
3. **Seed and plant additions** will increase species richness and provide additional seed sources where they are lacking. Many species are dispersal limited and augmentation will be necessary to restore the forest.
4. **Prevent establishment of target weed species** to ensure continued forest recovery. Although establishment of disruptive weeds was low in the first two years, invasion prevention is vital to promoting forest development.
5. **Continued monitoring and experimentation** is needed to evaluate and improve restoration strategies and techniques.