Executive Summary

A Study on Coconut Rhinoceros Beetle, Indigenous Farming Systems, Sulfur, and Coconut Grove Health

Overview and Purpose

Hawai‘i experienced the first human settlement about 1500 years ago, which established a permanent connection between ecology, agriculture, and environmental systems (Harries & Clement, 2014).The coconut palm stands as one of the most iconic, important, and environmentally crucial plant species in Hawai‘i because it provides essential cultural value, nutritional resources, and economic benefits to the region (Chan & Elevitch, 2006). The coconut rhinoceros beetle (CRB), Oryctes rhinoceros, which entered Hawai‘i through military activities since 2014, has become a significant threat to palm species (*Hawai‘i Invasive Species Council, & Coordinating Group on Alien Pest Species*, 2025).

The Hawaiian Islands exist as one of the most isolated land masses on the planet, creating unique ecological vulnerability to invasive species (M. W. Burnett et al., 2024). Coconut palms have become integral to Hawaiian ecological and agricultural systems, with measurable impacts on biodiversity and nutrient systems (Young et al., 2017).

The primary research goal of this project was to evaluate the effectiveness of new combinations of CRB control methods and management strategies, contributing sustainable, evidence based, scalable solution systems for coconut palm protection.

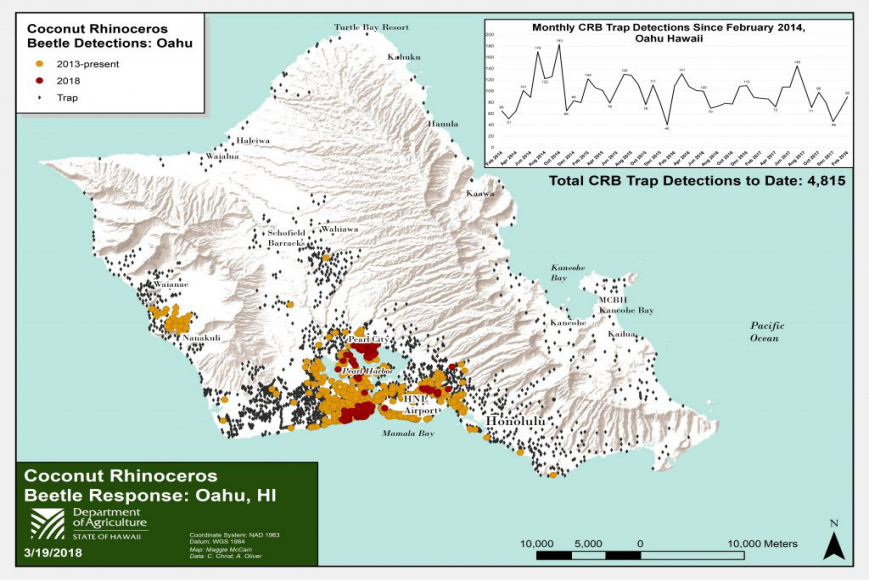

Figure 1. *Map showing the spatial distribution of coconut rhinoceros beetle detections and pheromone trap locations across Oahu. The inset chart displays monthly trap detections since February 2014, illustrating trends in CRB monitoring and response efforts. Source: Hawaii Department of Agriculture. (2018). Coconut rhinoceros beetle response: Oahu, Hawaii detection map. State of Hawaii Department of Agriculture.*

Research Questions and Objectives

The goals and objectives for this project can be summed up in three main research questions:

1. Does the addition of a sulfur liquid solution help prevent or inhibit CRB infestations
2. Does the usage of tree care kits and sulfur combinations increase the grove's health
3. Does educating and engaging the community support result in tree preservation and protection

These questions expanded into management effectiveness, detection and monitoring, biological control optimization, and community engagement (Paudel et al., 2021).

Project Description and Approach

This internship project is dedicated to combating the growing threat of the Coconut Rhinoceros Beetle, an invasive pest causing widespread damage to coconut trees and agricultural systems across Hawai'I (Marshall et al., 2023).

In partnership with Aloha Organic, this research evaluated the efficacy of Armor, a sulfur based, organically aligned foliar spray developed in alignment with Korean Natural Farming and indigenous practices.

CRB pressure was monitored through pheromone traps, mulch dissection, and visual surveys (Hall et al., 2022). In parallel, Aloha Organic initiated an education and outreach campaign including product flyers, bundled kits, and hands on learning opportunities.

Group	Treatment Type	n (Trees)	Application Frequency	Products Applied	Study Duration	Location Proximity
A	Control (No Treatment)	4	None	None	6 Weeks	Outside treatment zone
B	Armor Only	4	Weekly / Biweekly	ARMOR (Sulfur Solution)	6 Weeks	Within treatment zone
C	Indigenous Mix Only	4	Weekly / Biweekly	FEED, GROW, BALANCE, ABUNDANCE, LIVING, ONE	6 Weeks	Within treatment zone
D	Full Combination	4	Weekly / Biweekly	ARMOR + Full Indigenous Mix (All 7 Products Combined)	6 Weeks	Within treatment zone

Study duration: 6 weeks (January – August 2025). All groups: n = 4 trees. Groups B, C, and D applied treatments weekly or biweekly for the full study period.

Figure 2. *The table summarizes the experimental groups used in the field study, including treatment types, number of trees per group, application frequency, and product combinations applied. Source: Author compiled experimental design for the Punaluu coconut palm treatment study.*

Key Findings

Quantitative data remained relatively unchanged due to environmental variability and reinfestation pressure. However, qualitative observations provided meaningful indicators.

Treated groups maintained full tree survival and improved health scores, while untreated control trees experienced decline and elevated CRB pressure. These findings align with integrated pest management approaches combining multiple control strategies (R. Emaiya et al., 2022).

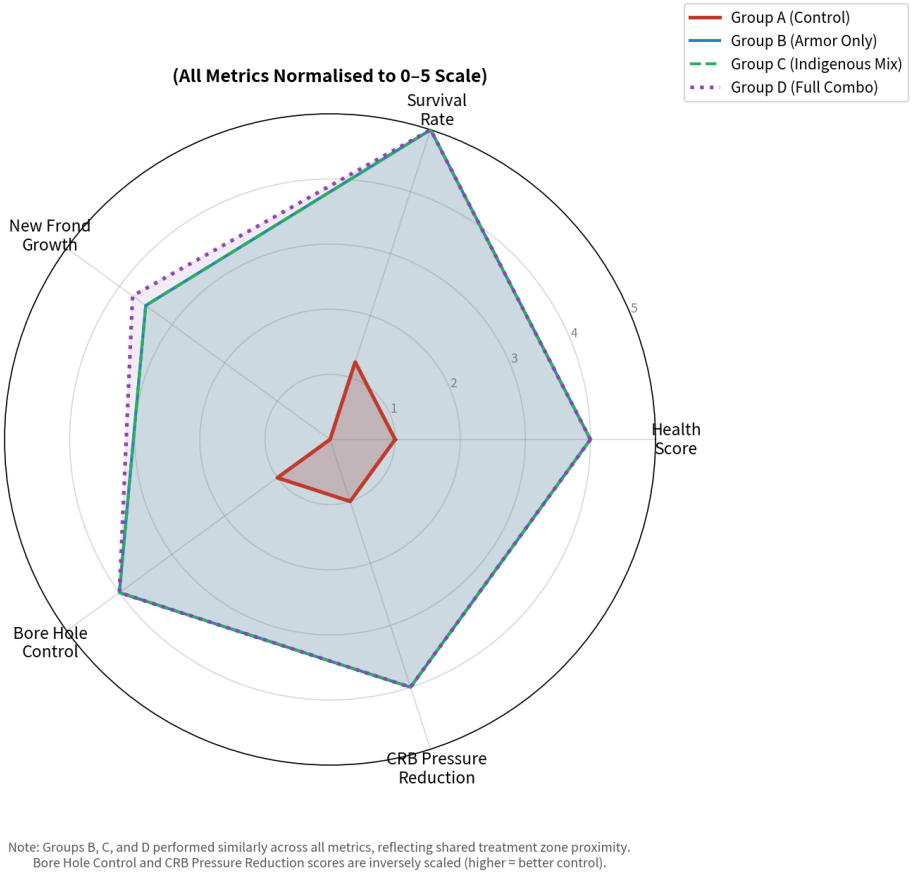

Figure 3. *Radar chart comparing overall performance of the four treatment groups at the conclusion of the six-week coconut rhinoceros beetle mitigation study conducted at the Punaluu site on Oahu. Source: Author generated chart based on study monitoring data.*

Integrated Management System

Effective CRB suppression requires a multi tactic system including sanitation, monitoring, biological control, and community participation (Paudel, Jackson, Boulekouran, et al., 2023; Paudel, Jackson, Mansfield, et al., 2023).

Biological control mechanisms such as Metarhizium fungi have shown high mortality rates in CRB populations (Prastowo et al., 2022). This integrated system combines sulfur treatments, biological controls, and community engagement tools to create a scalable solution.

Community Engagement and Impact

Community engagement increased awareness, adoption of organic practices, and participation in monitoring systems. Participatory science approaches improve long term implementation and data collection (Paudel et al., 2022).

This table represents the contributions of myself and the project to the organization and the benefits realized by Aloha Organic. The contributions include scientific research, operational system development, strategic planning support, knowledge management, and community capacity building. Together, these activities strengthened the organization's ability to implement and scale community-based coconut rhinoceros beetle mitigation programs across Hawaiʻi.

Category	Contribution	Impact on Host Organization
Scientific	Designed and implemented a field trial testing organic CRB control tools (Armor sulfur solution, indigenous mixes, and Metarhizium "Attack") and documented qualitative tree and grove health responses.	Expanded the evidence base for non-chemical CRB management in Hawaiʻi and strengthened the organization's scientific credibility when engaging agencies, arborists, and community partners.
Operational	Built and populated a CRB ArcGIS mapping system, standardized tree and site intake form, and created step-by-step field and workshop protocols for data collection and treatment.	Increased organizational efficiency, consistency, and data reliability for tracking infestations, guiding site visits, and supporting future monitoring across islands.
Strategic	Helped position Aloha Organic as a leader in community-based CRB response by integrating geospatial data, cultural priorities, and workshop feedback into an adaptive management framework.	Informed strategic decisions on where to focus limited staff, products, and outreach, while supporting long-term planning for expansion to additional islands and Pacific partners.

Knowledge Management	Compiled and synthesized scientific literature, government reports, community observations, and internal sales/usage data into a single internship report and internal reference set on CRB and organic control systems.	Enhanced organizational memory and accessibility of information to support future grants, partnerships, and training around CRB and other invasive species.
Capacity Building	Developed and delivered community workshops, created educational flyers and CRB web content, and trained arborists, land stewards, and staff in trap use, mapping, and organic treatment protocols.	Added durable human and institutional capacity for early detection, non-chemical response, and culturally grounded outreach within Hawai‘i’s conservation and local food system networks.

Limitations

The project faced constraints including short duration, small sample size, environmental variability, and limited quantitative data. These limitations required a shift toward qualitative analysis and reflect challenges noted in invasive species management research (Moore & Siderhurst, 2022).

Implications and Recommendations

The project highlights the importance of place based, integrated approaches combining indigenous knowledge, scientific methods, and community participation.

Recommendations include extended studies, biological control research, and scalable nonchemical management systems (K. Burnett & Wada, 2016).

Conclusion

The project demonstrates that combining biological control, organic inputs, sanitation, and community engagement can create a scalable and culturally aligned system for managing invasive species in Hawai‘i.

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