

KAHO‘OLAWE ISLAND RESERVE BIOSECURITY IMPLEMENTATION PLAN



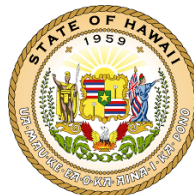
Fire Ant (*Wasmannia auropunctata*)

G. Brilmyer

Ship Rat (*Rattus rattus*)

© Ernie Janes / www.photoshot.com

Prepared by
LYMAN L. ABBOTT, JAMES C. BRUCH AND PAUL K. HIGASHINO
VER. 10 JANUARY 2018



Kaho'olawe Island Reserve Biosecurity Plan

<u>Version</u>	<u>Date</u>	<u>Authors</u>
1	February 15, 2016	Lyman L. Abbott and James C. Bruch
2	March 15, 2016	“ “ “ “ “ “ “ “
3	May 1, 2016	“ “ “ “ “ “ “ “
4	August 1, 2016	“ “ “ “ “ and Paul K. Higashino
5	September 15, 2016	“ “ “ “ “ “ “ “
6	January 15 2017	“ “ “ “ “ “ “ “
7	February 10, 2017	“ “ “ “ “ “ “ “
8	June 1, 2017	“ “ “ “ “ “ “ “
9	December 1, 2017	“ “ “ “ “ “ “ ”
10	January 1, 2018	“ “ “ “ “ “ “ ”

Recommended Citation;

Kaho'olawe Island Reserve Biosecurity Implementation Plan, 2018. Kaho'olawe Island Reserve Commission, 811 Kolu St., Suite 201, Wailuku, HI 96793.

Contributors: Lyman L. Abbott¹, James C. Bruch¹, Paul K. Higashino¹, Dean Tokishi¹, Chad Hanson², Pete McClelland³, Forest Starr⁴ and Kim Starr⁴ and James Stanford⁵.

¹Kaho'olawe Island Reserve Commission, ²Island Conservation, ³Pete McClelland Environmental Services, ⁴Starr Environmental, LLC, ⁵USFWS, Pacific Islands Fish and Wildlife Office.

Prepared for: Kaho'olawe Island Reserve Commission, Hawai'i Invasive Species Council, National Fish and Wildlife Foundation.

Reviewed by: Kaho'olawe Island Reserve Commission, Island Conservation, and USFWS.

Grant Funding: Hawai'i Invasive Species Council, National Fish and Wildlife Foundation.

TABLE OF CONTENTS

LIST OF TABLES..... 7

LIST OF FIGURES..... 8

LIST OF ACRONYMS..... 9

EXECUTIVE SUMMARY..... 10

I. BIOSECURITY (PROBLEM / NEED)..... 11

 Need for Biosecurity..... 11

 Global and Pacific Island Impacts..... 11

 Impact to the Hawaiian Islands and Kaho'olawe..... 11

 KIR Biosecurity Plan Objective and Actions..... 12

 Prevention..... 12

 Detection..... 13

 Response to IAS on Kaho'olawe and Preventing Re-introductions..... 14

 Kaho'olawe Base Camp..... 14

 Biosecurity Threats to Kaho'olawe..... 14

 Types of Rodents and IAS Plant Seeds..... 15

 Alien Aquatic Organisms..... 16

II. INTRODUCTION AND BACKGROUND..... 18

 Natural History..... 18

 Land Use and Land Owners..... 18

 Protect Kaho'olawe Ohana (PKO)..... 20

 KIRC Management Support..... 20

 Vectors and Pathways..... 20

 Kihei Boathouse Property..... 22

 Biosecurity Planning Concepts..... 24

 Hawaii Interagency Biosecurity Plan (HIBP) 2017-2027..... 26

 Hawai'i Invasive Species Council (HISC)..... 27

 Cultural Protocols and Ceremonial Offerings..... 28

 Kaho'olawe Island Reserve (KIR) Biosecurity Advisory Committee..... 29

 Biosecurity for Parsons-UXB Clearance Project (1998 - 2003)..... 30

III. CURRENT OPERATIONS..... 31

 Volunteer Orientation and Biosecurity Protocols..... 31

 KIRC and PKO Websites..... 31

Kaho'olawe Island Reserve Biosecurity Plan

Biosecurity Signs	32
Protocol for the Prevention of IAS Introduction	32
Land Based Biosecurity and Standard Operating Protocols	33
Recommended Actions	34
IAS Rapid Response Kit	36
IAS Rapid Response Kit Contents	36
IAS Encounter Form	37
Kihei Boathouse Rodent Control.....	37
Kihei Boathouse and Nursery Ant/Arthropod Control.....	39
Ant Bait Treatments for the Kihei Boathouse	39
Bait Treatments.....	40
Barrier Treatments	40
Co-operative Agricultural Pest Survey (CAPS)	41
Ant Taxa Observed at Kihei Boathouse and Nursery.....	43
IAS Plant Control at the Kihei Property	44
Kaho'olawe Island Reserve (KIR)	46
Standard Operating Protocols for the Transportation of Plants into the KIR	47
Plant Nurseries on Maui.....	47
Transportation of Cultural Material.....	48
Integrated Pest Management.....	48
Kihei Nursery	49
Ocean Based Biosecurity.....	50
Virkron® for Hull Fouling and Anchors.....	51
Dive Gear.....	52
Personal Gear.....	52
Early Morning Inspection Conditions.....	52
Contractor Specific Biosecurity	53
Capital Improvement Project (CIP)	53
Ala Loa Construction.....	53
IV IAS PRESENT ON KAHO'OLAWE	54
Kaho'olawe Botanical Surveys and Results.....	54
IAS Observed on the Four Botanical Surveys.....	55

Kaho'olawe Island Reserve Biosecurity Plan

Island-wide Eradication of Invasive Mammals	56
Detection on Kaho'olawe	57
Native Fauna on Kaho'olawe	57
Non-native Fauna on Kaho'olawe	57
List of Arthropods on Kaho'olawe	57
V. PROPOSED FUTURE ACTIONS	58
Kihei Boathouse Actions	58
Cargo Management	59
Use of Vessels	60
Follow Up CAPS	60
Field Guides.....	60
Kanapou Bay Marine Debris Clean-up.....	60
Helicopter Operations	61
VI. KNOWN GAPS/ DEFICIENCIES	62
Faunal IAS Observed at Kihei Boathouse.....	62
Examples of IAS on Board the 'Ōhua	63
VII. CONCLUSIONS.....	65
LITERATURE CITED	67
Internet Resources	71
APPENDIX A - Goats, Sheep and Cattle on Kaho'olawe	73
APPENDIX B - KIR Biosecurity Signs	74
APPENDIX C - Biosecurity Quarantine Self Check Sheet.....	76
APPENDIX D - Invasive Alien Species (IAS) Encounter Form - Kaho'olawe	77
APPENDIX E - Rodent Control Log	78
APPENDIX F - Amdro® Instructions for Control of Ants.....	79
APPENDIX G - List of Ants in Hawai'i and Kaho'olawe.....	84
APPENDIX H - Pesticide Use Log	87
APPENDIX I - KIRC Plant Specifications	88
APPENDIX J – FIFRA and US EPA Worker Protection Standards	90
APPENDIX K - Four Botanical Surveys performed on Kaho'olawe in 2015	92
APPENDIX L - Flora Survey of Kaho'olawe	95
APPENDIX M - Native Fauna Recorded on Kaho'olawe.....	100

Kaho'olawe Island Reserve Biosecurity Plan

APPENDIX N - Non Native Fauna Recorded on Kaho'olawe..... 101
APPENDIX O - Arthropods Recorded on Kaho'olawe..... 102
APPENDIX P- Hawai'i Administrative Rules - State Regulations 112

LIST OF TABLES

Table 1 Examples of IAS present in Hawai'i with the greatest potential to threaten the Biosecurity of Kaho'olawe 15

Table 2 Three invasive fish found in the KIR..... 16

Table 3 Algal taxa in the KIR..... 16

Table 4 IAS Algal taxa not observed in the KIR 17

Table 5 Vector, Departure Location and Entry Points on Kaho'olawe for IAS 20

Table 6 Members of the KIR Biosecurity Advisory Committee 29

Table 7 Types of Ant Baits 40

Table 8 Potential habitat for ants for CAPS..... 43

Table 9 Ant taxa found at Kihei Boathouse and Nursery during 4 CAPS in 2016 43

Table 10 Botanical Survey of Kihei Boathouse Property, January 2016 45

Table 11 IAS present on Kaho'olawe 54

Table 12 Known Gaps in the State of Hawai'i 62

Table 13 Faunal IAS observed at the Kihei Boathouse Property 62

Table 14 Date of occurrence and action taken of IAS observed on 'Ōhua vessel..... 64

LIST OF FIGURES

Figure 1 State of Hawaii 12

Figure 2. DAR sign posted at Kihei Boat Ramp February, 2016 17

Figure 3 Final Clearance Map of Kaho'olawe..... 19

Figure 4 Biosecurity risks form Locations of Departure on Maui and Entry Points on Kaho'olawe..... 21

Figure 5. Double-hulled canoes such as the Hokule'a will visit Honokanai'a bay for ceremony. 22

Figure 6 Eight acre Kihei Boathouse property and adjacent public boat ramp 23

Figure 7. Kihei Boathouse and surrounding urban habitat 23

Figure 8. Clutter along the Boathouse fence line 24

Figure 9 Ho'okupu on Kaho'olawe 29

Figure 10 A slide from the KIRC volunteer orientation presentation on Biosecurity 31

Figure 11 KIR Biosecurity signage and information to address the objective and three actions..... 32

Figure 12. KIRC vessel 'Ohua at Kihei Boathouse 34

Figure 13. Ant nest in stored lumber at Kihei Boathouse 35

Figure 14. An example of inspecting supplies for IAS before departure to Kaho'olawe 36

Figure 15. IAS Rapid Response Kit..... 37

Figure 16. Contrac® Blox® bait..... 38

Figure 17. Protecta® Rodenticide Bait Station 38

Figure 18. Location and numbers of labeled bait stations at Kihei Boathouse and Nursery..... 39

Figure 19. Granular Bait Treatment (orange) and Ant barrier treatment (blue) at the Kihei Boathouse and Nursery..... 41

Figure 20. CAPS stations at the Kihei Boathouse and Nursery (Protein and Sweet Baits). 44

Figure 21. Seed (nutlet) and flower of Puncture Vine (*T. terrestris*) 46

Figure 22. Boundaries of Zone A and B in the KIR 46

Figure 23. Work Area and Tables at the Kihei Nursery in 2017 49

Figure 24. Weed cloth beneath coarse gravel under Kihei Nursery tables..... 50

Figure 25. Pressure washing hull of NOAA vessel 51

Figure 26. Location of recent Fountain grass control at Lua 'O Kealialalo 56

Figure 27 Kihei Boathouse shelves 58

Figure 28 Norway rat (*R. norvegicus*)..... 63

LIST OF ACRONYMS

CAPS - Cooperative Agricultural Pest Survey
CISR – Center for Invasive Species Research
CGAPS - Coordinating Group on Alien Pest Species
DAR - Department of Aquatic Resources
DBEDT - Department of Business and Economic Development and Tourism
DLNR – Department of Land and Natural Resources
DOFAW - Department of Forestry and Wildlife
DOT – Department of Transportation
ED/RR – Early Detection/Rapid Response
FIFRA - Federal Insecticide, Fungicide, and Rodenticide Act
HDOA – Hawai'i Department of Agriculture
HEAR - Hawai'i Ecosystems At Risk
HIOSH - Hawaii Occupational Safety and Health
HISC - Hawai'i Invasive Species Council.
HPWRA - Hawai'i Pacific Weed Risk Assessment
IAS - Invasive Alien Species
IPM – Integrated Pest Management
KIR - Kaho'olawe Island Reserve.
KIRC - Kaho'olawe Island Reserve Commission.
LITTLE FIRE ANT - Little Fire Ant (*Wasmannia auropunctata*)
OSHA - Occupational Safety and Health Administration
PKO - Protect Kaho'olawe Ohana
PPE - Personal Protective Equipment
RBP- Regional Biosecurity Plan for Micronesia and Hawai'i
RCRA - Resource Conservation and Recovery Act
UH – University of Hawai'i
USDOA - United States Department of Agriculture
USDOD - United States Department of Defense
USDOI - United States Department of Interior
UXO – Unexploded ordnance
WPS - Worker Protection Standards

EXECUTIVE SUMMARY

Hawai'i receives on average 15 new introductions of non-native species annually, which is the most of any state in the United States. An invasive alien species (IAS) is defined as a species that is non-native (alien) to the ecosystem under consideration, and whose introduction causes, or is likely to cause economic or environmental harm, or harm to human health. This Biosecurity Plan for the Kaho'olawe Island Reserve (KIR) was written for a Hawai'i Invasive Species Council (HISC) grant entitled "Biosecurity Implementation Plan for the Island of Kaho'olawe". It details Pre-Border, Border and Post-Border biosecurity detection and highlights IAS pathways and vectors. A KIR Biosecurity Advisory Committee comprised of personnel from the Kaho'olawe Island Reserve Commission (KIRC) and Protect Kaho'olawe Ohana (PKO) guides this document and established protocols and ensures the objective and actions are met. This Biosecurity Plan has one objective of keeping new Invasive Alien Species (IAS) from entering the KIR and three (3) actions using an Early Detection/Rapid Response (ED/RR) approach to obtain the objective. The three ED/RR actions are Prevention, Detection and Response and are crucial to a successful Biosecurity Plan preventing new IAS from entering the KIR. Prevention is key and does not allow IAS to enter the KIR. Detection consists of keen observations and monitoring from KIRC Staff and Volunteers, PKO, and Passenger/Cargo Transport Companies. Education and engagement is an essential component of all three actions. Rapid response includes Quarantine and Eradication which occurs on site and is an immediate mitigation of IAS with the Rapid Response Kit.

The island of Kaho'olawe, the smallest of eight Main Hawaiian Islands, is under the jurisdiction of the State of Hawai'i and the KIRC. The KIRC is currently mandated to manage all activities occurring on island including land use and public access, which is only permitted in conjunction with restoration activities and cultural practices of the Native Hawaiian people. The island was a US Navy bombing range between 1941 and 1990 and the island was left littered with thousands of unexploded ordnance (UXO) of almost every type used in warfare at the time. When the Title to the island was returned to the State of Hawai'i by the Navy in 1994, the US Navy completed a partial clearance of UXO in November 2003 (Parsons-UXB Clearance Project), after which the State gained full control of access to the island. Land Based biosecurity involves checking all supplies, equipment, personal gear and ceremonial offerings used during cultural practices. These must be carefully inspected before bringing any plant material to island. Baseline botanical surveys have been established on Maui at the Kihei Boathouse property as well as several main ports of entry on Kaho'olawe. Results of floral and faunal (vertebrate and arthropod) surveys on Maui and Kaho'olawe are included in this Plan. Protocols for plant nurseries on Maui are established as well as methods for control and eradication of existing IAS. Ocean based biosecurity protocols outline responsibilities of captains and boaters entering into Zones A and B of the KIR, and lists invasive seaweed species not in the KIR.

I. BIOSECURITY (PROBLEM / NEED)

Need for Biosecurity

IAS in the United States cause major environmental damage and losses adding up to more than \$138 billion per year (Pimental et al., 1999). Biosecurity refers to measures that are taken to stop the spread or introduction of IAS to animal and plant life, and is the set of measures taken to manage the risk from IAS to the economy, environment, and health and lifestyle of the people.

Global and Pacific Island Impacts

An IAS is a non-native organism (plant animal, fungus, bacteria) that can establish a population with the potential to spread and cause harm. IAS that are plants and animals can represent serious threats to the survival of native organisms and natural communities (KICC, 1992a). Their introduction causes or is likely to cause, economic or environmental harm, or harm to human health.

IAS account for more than \$130 billion in annual losses in the United States (CISR, 2017). IAS in new regions can pose a significant invasion threats to human health, agriculture, biodiversity and natural ecosystems. Species and community outcomes tend to decline following invasions, especially those for plants (Pysek et al., 2012). Pysek (2012) also mentions the impact of invasive plant species on resident species, communities and ecosystems reducing species richness and abundance of native biota and decreasing local species diversity. IAS decrease the distinctiveness of biological communities.

Potential harm from IAS may cause disease, predation, competition, habitat destruction, or hybridizing with local species. Examples of harm from disease and its effect on human health is the Dengue and Zika virus spread by the *Aedes* mosquito. Habitat destruction from *Miconia* (*M. calvescens*) has been documented in Tahiti and has spread into Hawai'i. Competition may be observed in the Barn Owl (*Tyto alba*) affecting the availability of food resources for the native Pueo (*Asio flammeus sandwichensis*). Habitat destruction is exemplified by ungulates, (goats) eating native vegetation and impacting coastal and near shore ocean resources. Hybridization can take place between the native Koloa Duck (*Anas wyvilliana*) and introduced Mallard Duck (*Anas platyrhynchos*).

Impact to the Hawaiian Islands and Kaho'olawe

Hawai'i (Figure 1) receives an average of 15 new introductions of non-native (alien) species on an annual basis.

Kaho'olawe Island Reserve Biosecurity Plan

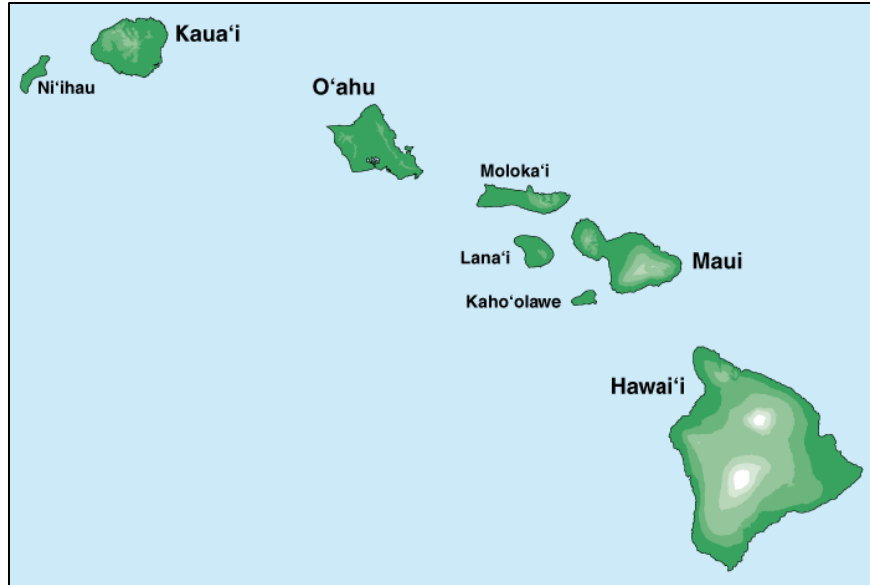


Figure 1 State of Hawaii

KIR Biosecurity Plan Objective and Actions

The transfer of IAS within Hawai'i is real, ongoing, and an increasing problem that must be addressed (US NAVY, 2015) and IAS in Hawai'i's natural areas is as critical now as it was in 1992 (Stone, 1992). Therefore one (1) objective and three (3) actions in an Early Detection/Rapid Response (ED/RR) format have been adopted to address this problem.

Using the ED/RR format, there is one objective of the KIR Biosecurity Plan.

- **KEEP IAS FROM ENTERING THE KIR.**

The three actions to accomplish this objective are;

- **Prevention**
- **Detection**
- **Response**

Prevention

Due to the issues with locating, identifying and eradicating IAS once they are on island, (including cost and feasibility of removal), the emphasis of the plan/focus of resources should be on preventing IAS getting to the island rather than trying to detect and eradicate them once they are present. Prevention is the most operationally efficient and cost effective way to prevent IAS establishing, especially for rodents, invertebrates and reptiles (a management action occurs at the Kihei Boathouse). Animal IAS are

Kaho'olawe Island Reserve Biosecurity Plan

often cryptic, hard to detect, relatively mobile and have the reproductive ability to reach unmanageable levels before they are detected.

Awareness and understanding is key to the importance of the Biosecurity Plan and have long term impacts and/or consequences if it is not implemented. It will be the objective of all personnel entering the KIR to implement this adaptive process. Prevention of IAS is key, from getting into Kaho'olawe Island Reserve (KIR) by ocean vessel or air. (Pre and Post-launch check will be conducted using IAS Inspection Form and quarantine self-check sheet).

Education and engagement of the public and staff is a key component to a successful Biosecurity Plan. Pertinent Information should be disseminated to all staff and volunteers of the KIRC, PKO, and other companies involved in transport of cargo and people to and from Kaho'olawe (Helicopter, ocean transport). The main message is that IAS are detrimental to native ecosystems and prevention is the most cost effective and efficient approach to control them. Information should be included in orientations and safety briefings regarding prevention, remaining vigilant, and keeping channels of communication open to report biosecurity risks.

Detection

Pre-Border Detection – A record of remedial actions taken with an IAS prior to entering the transportation network to Kaho'olawe should be kept and entered into a KIR Biosecurity Inspection database. Any IAS quarantined and eradicated should be noted on the IAS Encounter Form. End results will include heightened engagement in IAS recognition to improve biosecurity activities.

Border Detection - Remedial actions taken with an IAS after entering the transportation network to Kaho'olawe points of entry are a last defense. End results will include education of personnel in the vector and pathway of the IAS and entry point on Kaho'olawe. If a rat is observed on a vessel, the Captain **shall** turn around and go back to Maui or its home island eg. Moloka'i (California Islands Biosecurity Program, 2013). Do not throw the rat overboard as they can swim in the ocean and potentially reach land.

Post-Border Detection - Remedial actions taken with an IAS on Kaho'olawe should be recorded and then monitored for a sufficient duration to ensure it has not become established at the entry point. End results include quarantine and/or eradication of the IAS contained with the IAS rapid response kit. All occurrences will be documented on the IAS Biosecurity Inspection Form and entered into the KIR Biosecurity Inspection database.

With early detection, removing recent plant introductions may be possible. However, the options for response to many animal incursions are very limited. Mobile animals are especially problematic. In the time it takes to determine their current localities, they may have spread even further. Once there is an incursion, a social and political reaction for

Kaho'olawe Island Reserve Biosecurity Plan

response and eradication should be anticipated. If Pre-Border, Border, and Post-Border biosecurity detection is not successful, Kaho'olawe has the potential habitat for sustaining populations of high risk species.

Response to IAS on Kaho'olawe and Preventing Re-introductions

This requires an appropriate standard of biosecurity to prevent re-invasions. The high economic cost of undertaking most eradications and the impracticality of eradicating many species once they are established, along with the impact that new species may have on ecological and cultural values makes it crucial to ensure that additional IAS do not invade the island or that any species which is able to be eradicated does not re-establish on Kaho'olawe. This requires an appropriate standard of biosecurity to prevent re-invasions.

Response actions will be initiated when an IAS is detected at any one of the ports of departure and/or on Kaho'olawe. During Response, quarantine the IAS in the most efficient and expedient manner to mitigate the potential introduction. Eliminate an IAS threat immediately on site.

To achieve the objective of keeping new IAS from entering the Kaho'olawe Island Reserve, these three actions in the ED/RR format need to be learned and performed by all personnel involved entering Kaho'olawe and supporting logistical operations. Education and engagement and adequate time management needs to be considered in thoroughly performing these three actions.

Kaho'olawe Base Camp

Located in Honokanai'a on the South western side of Kaho'olawe, the KIRC field base camp has a significant amount of infrastructure (buildings, vehicles) and is usually serviced using the KIRC vessel 'Ōhua which is the landing craft.

Biosecurity Threats to Kaho`olawe

Since historical times Kaho'olawe has been increasingly susceptible to IAS introductions. Vitousek (1988) states the accidental or intentional introduction of IAS is one of the most serious threats facing island ecosystems. Although feral ungulates have been eradicated, predatory mammals still occupy the island and include the invasive Polynesian Rat (*Rattus exulans*), mice (*Mus musculus*) and feral cats (*Felis catus*). Endemic species on islands are highly susceptible to local extinction, especially if they are exposed to IAS such as feral cats (Koch, et al, 2016) and ground nests of Pue`o on Kaho`olawe have not been observed. Examples of IAS present in Hawai'i with the greatest potential to threaten the ecology of Kaho'olawe are listed in Table 1.

	Common Name	Taxa	Form
1	Mongoose	<i>Herpestes auropunctatus</i>	Mammal
2	Rat	<i>Rattus rattus, R. norvegicus</i>	Mammal

Kaho'olawe Island Reserve Biosecurity Plan

	Common Name	Taxa	Form
3	Little Fire Ant	<i>Wasmannia auropunctata</i>	Ant
4	Gorilla Ogo	<i>Gracilariaria salicornia</i>	Seaweed

Table 1 Examples of IAS present in Hawai'i with the greatest potential to threaten the Biosecurity of Kaho'olawe

Mongoose (US DOA, 2010) and rats (Hathaway and Fisher, 2010) are well known to have severe effects on ecosystems they invade. These animals have been observed at the Kihei Boathouse. The Little Fire Ant was first observed in March, 1999 on Hawai'i Island by a resident of Hawaiian Paradise Park in the Puna District and submitted to the Hawai'i Department of Agriculture (Conant et al. 2007). There have been recent outbreaks on Maui and they can cause blindness in pets and severely disrupt human activities (Hawai'i Ant Lab, 2016). To avoid establishing Little Fire Ant in new areas of Hawai'i, Vanderwoude (2008) states knowingly moving material and equipment infested with Little Fire Ant is an offense under Statute (HRS 150A) and Rule (HAR Chapter 4-72).

Failure to abide by the biosecurity protocols addressed in this Biosecurity Plan could allow the introduction of any one of these organisms, and would cause a huge negative impact to the ecological balance of Kaho'olawe, due to the nature of the animals and limitations of eradication tools and resources currently available. For example, on June 21, 2016, a few white footed ants (*Technomyrmex difficilis*) were inadvertently brought to the kitchen of the KIRC office in Wailuku, Maui on individual bananas and taro (*Colocasia esculenta*) corms. While already present of Kaho'olawe and a medium threat level (<http://idtools.org/id/ants/pia/>), this is an example of how easily new invasive ants species could be introduced to Kaho'olawe without knowing they were present in the edible food items presented to KIRC Staff. A series of Biosecurity signs have been posted at the boathouse entrance as a reminder to people entering the premises to be vigilant.

At the Kihei Boathouse, landscape plants such as Mexican fan palm (*Washingtonia robusta*) from neighboring urban housing and Hotels present a threat and should be evaluated. Also, landscaping materials around these structures might allow Little Fire Ant to arrive in the vicinity of the Boathouse.

Types of Rodents and IAS Plant Seeds

It is important to note that each species brings with it different and often cumulative impacts. While the Polynesian rat (*R. exulans*) is already present on Kaho'olawe, any Black Rat would likely have a greater impact as they are good climbers and so are more likely to affect tree nesting birds. The Norway Rat is much larger and can have a greater impact on ground nesting birds. The seeds of many plants are difficult to differentiate. Therefore, it is an important Pre-Border Biosecurity detection to minimize unplanned transfers of IAS plant seeds rather than try and differentiate between species.

Alien Aquatic Organisms

Alien aquatic organisms are species that pose a serious problem in Hawai'i, and are a significant threat to people as well as to native ecosystems (State of Hawai'i, 2003). Up to 346 alien marine algae and invertebrate species are currently established in Hawai'i State waters (DLNR, 2017) and IAS may consume, outcompete or hybridize with local native species which can result in a loss of biodiversity and ecosystem alteration (Abbott 2001, Vitousek et al., 1997). From HRS 187A 6.5, "*the department or its agents may seize, confiscate, or destroy, as a public nuisance, any fish or other aquatic life found in any waters of the State and whose importation is prohibited or restricted pursuant to rules of the department of agriculture.*" Table 2 lists the three invasive fish species found in the KIR that prey on native fish species.

	Taxa	Common Name
1	<i>Lutjanus kasmira</i>	Ta'ape
2	<i>Lutjanus fulvas</i>	To'au
3	<i>Cephalophalus argus</i>	Roi

Table 2 Three invasive fish found in the KIR

Nearly 50 years has passed since the introduction of roi and ta'ape, and they spread rapidly (DAR, 2003). In 2015, over 700 pounds of these three fish were removed from Honokanai'a Bay in support of a KIRC Hawai'i Community Foundation grant.

Table 3 lists the algal taxa that are present in the KIR. This list is compiled from the KIRC Ocean Management Plan (Dames and Moore, 1997).

Algae in the Kaho'olawe Island Reserve			
No	Taxa	Hawaiian Name	Color
1	<i>Codium reediae</i>	'a'ala'ula (wawae'iole)	Green
2	<i>Ahnfeltia concinna</i>	'aki'aki	Red
3	<i>Dictyota sp.</i>	alani	Brown
4	<i>Grateloupia filicina</i>	huluhuluwaena	Red
5	<i>Sargassum echinocarpum</i>	limu kala	Brown
6	<i>Laurencia succisa</i>	lipo'epe'e	Red
7	<i>Dictyopteris plagiogramma</i>	lipoa	Brown
8	<i>Gracilaria coronopifolia</i>	manauea	Red
9	<i>Laurencia nidifica</i>	mane'one'o	
10	<i>Porphyra sp.</i>	pahe'e	Green
11	<i>Ulva fasciata</i>	palahalaha	Green
12	<i>Codium edule</i>	wawae'iole	Green

Table 3 Algal taxa in the KIR

Table 4 lists the algal taxa not observed in the KIR. "Cryptogenic" is unclear whether the species is native or introduced.

IAS Algae not in the Kaho'olawe Island Reserve			
No	Taxa	Common Name	Comment
1	<i>Acanthophora spicifera</i>	Prickly Seaweed	
2	<i>Avrainvillea amadelpha</i>	Leather Mudweed	Cryptogenic ¹
3	<i>Cladophora sericea</i> ²	Green Slime Weed	
4	<i>Dappaphycus spp.</i>	Smothering Seaweed	
5	<i>Dictyosphaeria cavernosa</i> ²	Green Bubble Algae	
6	<i>Gracilaria salicornia</i>	Gorilla Seaweed	Cryptogenic ¹
7	<i>Hypnea musciformis</i>	Hookweed	
8	<i>Nemacystus decipiens</i>		Cryptogenic ¹
9	<i>Wrangalia bicuspidata</i>		Cryptogenic ¹

Table 4 IAS Algal taxa not observed in the KIR

¹DAR, 2003.

²Personal Communication, D. Tokishi, Ocean Resources Specialist, KIRC

Also, *Eucheuma sp.*, *Kappaphycus sp.* and *Ulva reticulata* are introduced seaweeds in Hawai'i (Gulko, 1998), and once they establish a foothold and grow atop coral beds, they are very difficult to eradicate. The smothering seaweeds (*Kappaphycus sp.*) have the ability to overgrow and kill corals. Green Slime Weed, (*Cladophora sericea*) and Green Bubble Algae (*Dictyosphaeria cavernosa*) would also be undesirable introductions into the Reserve. Figure 2 is a Department of Aquatic Resources (DAR) sign that was posted on a KIRC gate at the Kihei Boat Ramp in February, 2016 for other boaters to observe.



Figure 2. DAR sign posted at Kihei Boat Ramp February, 2016

II. INTRODUCTION AND BACKGROUND

Natural History

The island of Kaho'olawe is a single shield volcano and is 1.03 million years old. It is located 11.2 km (7 mi.) southwest of the island of Maui. Kaho'olawe is 17 km (10.6 mi.) long, 11 km (7 mi.) wide and 11,520 ha (28,800A) in size (45 mi²). Its highest peak reaches 450 m (1477 ft.). Kaho'olawe consists of eroded uplands of exposed, unfertile hardpan with severe gullying, drainage basins lined with predominantly alien dry shrub land vegetation, and ephemeral streams, which discharge sediment laden waters into a variety of marine environments, including coral reef ecosystems. Temperatures on the island range from 19°C to 31°C (66 °F to 88°F) and there are 24 watersheds. Average rainfall is 60 cm/yr. (25 in/yr.) and streams are ephemeral. Kona (southerly) storms generally bring the heaviest rainfall from November to March. Wind speeds range from 8 to 50 km/h (5 to 31 mph) with occasionally higher gusts.

Kaho'olawe is comprised of mainly of dry forest and coastal habitat. Hawaiian Dry Forests are ranked 10th of the 21 most endangered ecosystems in the United States. This is based upon decline in original area since European settlement, present area, and imminence of threat and number of federally listed endangered and threatened species (Noss and Peters, 1995). Although much of the habitat is denuded, the island is home to rare and endangered species such as the Hawaiian Hoary Bat (*Lasirurus cinereus semotus*), Band-rumped storm petrel (*Oceanodroma castro*) and also is an important site for Hawaiian monk seal (*Neomonachus schauinslandi*) pupping. Endangered plants naturally occurring on Kaho'olawe include the 'Ohai (*Sesbania tomentosa*) and akoko (*Chamaesyce celastroides* var. *amplectans*). Endangered insects include two yellow faced bees (*Hylaeus spp.*) and the Blackburn Sphinx Moth (*Manduca blackburni*).

Land Use and Land Owners

Kaho'olawe is under the jurisdiction of the State of Hawai'i, and the KIRC is currently mandated to manage all activities occurring on the island. This includes land use and public access, which is only permitted in conjunction with restoration activities and cultural practices of the Native Hawaiian people. The KIRC was established by the Hawai'i State Legislature in 1993 to manage the Kaho'olawe Island Reserve while it is held in trust for a future Native Hawaiian sovereign entity. The KIRC establishes policies and usage of the island and its surrounding waters through comprehensive restoration and monitoring programs. Its Cultural Program integrates a Native Hawaiian cultural perspective into all programs and activities. The organization is managed by a seven-member Commission and a committed staff.

The PKO are important stewards of the island and operate a base camp in Hakioawa on the northeast coast of the island. The PKO Vision & Mission statement is as follows; VISION: Aloha 'Āina, love of the land MISSION: To perpetuate Aloha 'Āina

Kaho'olawe Island Reserve Biosecurity Plan

throughout our islands through cultural, educational, and spiritual activities that heal and revitalize the cultural and natural resources on Kanaloa-Kaho'olawe.

The majority of Kaho'olawe is currently off limits due to the presence of UXO. Therefore, restoration activities and cultural access have only been allowed in areas defined as Tier I (where there has been UXO surface clearance only) and Tier II (where clearance was completed to 4 feet depth).

The entire island of Kaho'olawe is listed on the National Register of Historic Places, and contains over 3000 archaeological features and 544 archaeological sites. Pre-contact settlement of Kaho'olawe began around the year AD1000 when small communities flourished around the coastline (KICC, 1993). Severe loss of vegetation and significant soil erosion started with the introduction of goats (*Capris hirca*) in 1793. In 1880, at the beginning of the Ranching Period, Mouflon sheep (*Ovis musimon*) and cattle (*Bos taurus*) were also introduced and numbered 900 and 12,000 animals respectively in 1890 (Appendix A).

The goat population reached approximately 50,000 animals at its peak (KIRC, 1998) and goats were subsequently eradicated by 1993. This period of grazing left an island with a severely denuded landscape and areas exposed to high winds and rain with no vegetation cover. The island became a US Navy bombing range between 1941 and 1990. Explosions on the soil left barren from grazing, accelerated the pattern of erosion on the plateaus and high grounds on the island, leaving an exposed hardpan and very little topsoil to promote vegetation growth. In addition, the island was left littered with thousands of UXO of almost every type used in warfare at the time. When the Title to the island was returned to the State of Hawai'i by the US Navy in 1994, they completed a partial clearance of UXO (Figure 3) in April 2004 (Parsons-UXB Clearance Project), after which the State gained full control of access to the island.

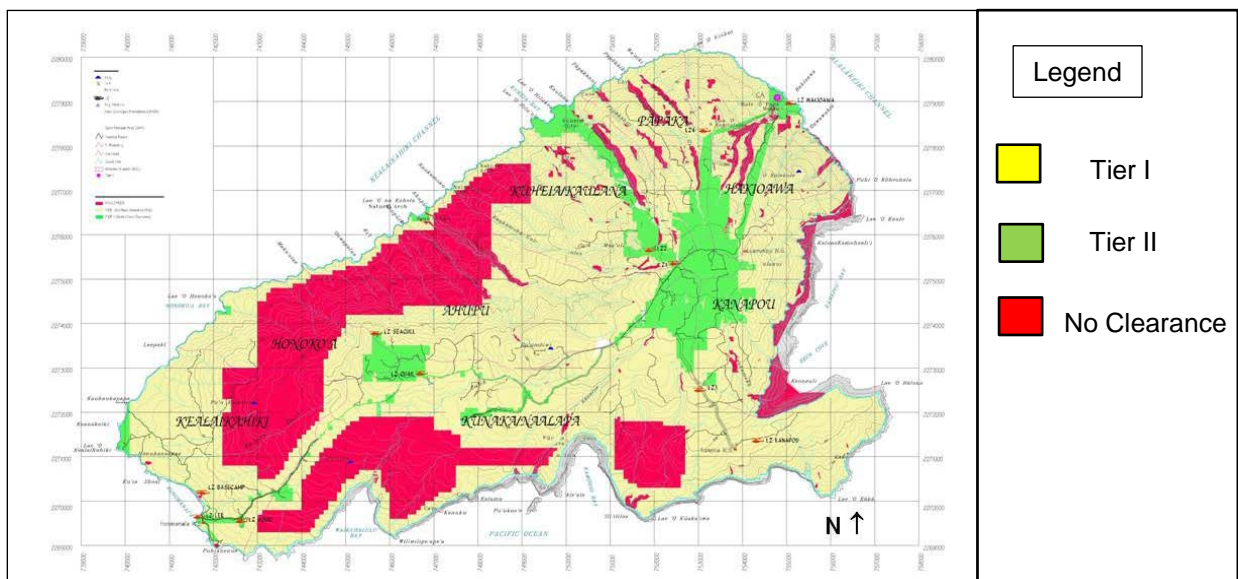


Figure 3 Final Clearance Map of Kaho'olawe

Kaho'olawe Island Reserve Biosecurity Plan

Protect Kaho'olawe Ohana (PKO)

A crucial partner in implementing any effective biosecurity for Kaho'olawe is the PKO, an independent group working to re-establish the native Hawaiian cultural link with the island. The base on the northeastern side of the island in Hakioawa is used for monthly visits to the island for cultural purposes including utilizing volunteer groups for restoration purposes.

The PKO is the most important partner with the KIRC and has shown a good level of biosecurity in logistics and procedures leading up to and during an access (Pete McClelland Environmental Services, 2017). For example, all food was packaged in plastic bags shortly after purchase. For both the KIRC and the PKO, the transport of plant material does pose a significant risk which must be managed, and actions should include;

- Include all current biosecurity practices in this Biosecurity Plan
- Audit on the ground practices in this Biosecurity Plan
- Alter the practices and/or Biosecurity Plan so that they are consistent
- Share Knowledge and Experience through KIR Biosecurity Advisory Committee

KIRC Management Support

There is a high level of support at all levels in the KIRC management for biosecurity for Kaho'olawe (McClelland, 2017). This support generates compliance from KIRC and PKO personnel and makes biosecurity part of the organizational ethos.

Vectors and Pathways

Vectors are means of travel for an IAS to get to Kaho'olawe. Pathways are departure locations and entry points with biosecurity risks of IAS on Kaho'olawe. These pathway locations and their associated vectors are listed in Table 5.

Vector	Departure Location	Entry Point on Kaho'olawe
Helicopter	Kahului Heliport, Pu'u Nene Airfield	LZ Base Camp, LZ Quail LZ-1
Boat	Kihei Boat Ramp, Ma'alaea, Lahaina, Kaunakakai, Kaneohe	Honokanai'a, Honoko'a, Kuhe'eia, Hakioawa, Kanapou
Wind	Maui Nui (Maui, Moloka'i, Lana'i)	Kaho'olawe
People	All of the above	All of the above
Personnel Gear	All of the above	All of the above

Table 5 Vector, Departure Location and Entry Points on Kaho'olawe for IAS

Kaho'olawe Island Reserve Biosecurity Plan

If resources allow, all reasonable and manageable vectors and pathways will be covered by this Biosecurity Plan, and will be considered equally but not necessarily be given the same priority for resources, if the risks differ between them. Risk being defined as likelihood times impact.

Biosecurity risks from locations of departure (boat harbors and air fields) on Maui and entry points on Kaho'olawe are illustrated in Figure 4.

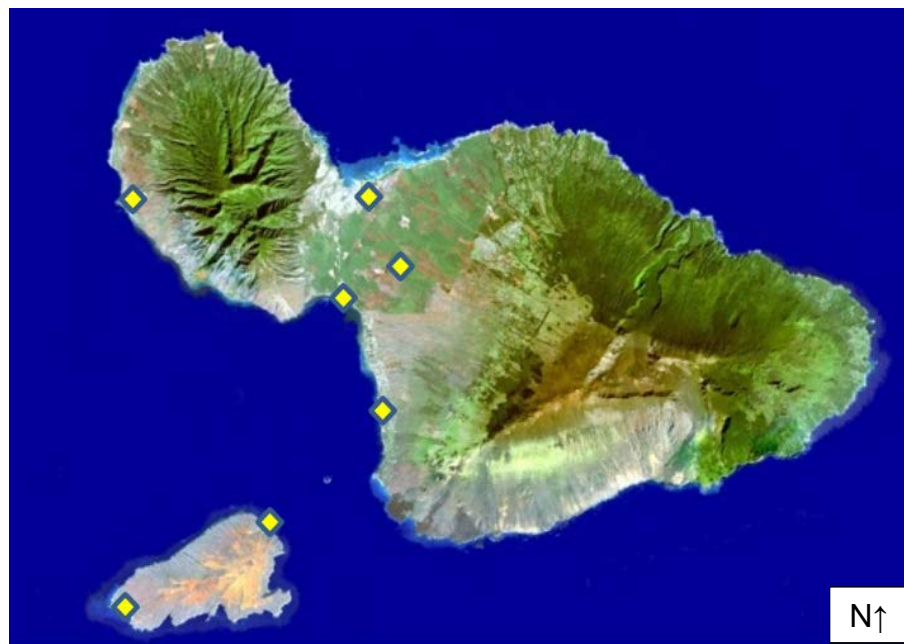


Figure 4 Biosecurity risks from Locations of Departure on Maui and Entry Points on Kaho'olawe

The island has two main entry points at Hakioawa with PKO and Honokanai'a with the KIRC. If Post-Border inspections in these entry points reveal an IAS, the Pre-Border and Border protocols on Maui (and other islands) were not successfully implemented. In case of an IAS introduction in either one of these entry points, the Post-Border protocols described in this Biosecurity Plan for Kaho'olawe should be implemented.

There are six (6) different methods for accessing Kaho'olawe.

- 1.) KIRC access via 'Ōhua
- 2.) KIRC Access via a different vessel (NOAA, Charter)
- 3.) PKO Access via charter vessels
- 4.) Helicopter access including supply
- 5.) Other vessels and groups including canoe clubs
- 6.) Larger vessels for Construction Projects involving a large amount of equipment and supplies.

Kaho'olawe Island Reserve Biosecurity Plan

Other vessels that transport personnel to and from Kaho'olawe include PKO vessels, catamarans from Lahaina and Ma'alaea, and occasionally, double hulled canoes (Figure 5) escort fishing boats and outrigger canoes from local Canoe Clubs.



Figure 5. Double-hulled canoes such as the Hokule'a will visit Honokanai'a bay for ceremony.

The transport of passengers, materials and supplies for cultural protocols and vegetation restoration presents a high risk that any rodents present on Maui (or source island) will eventually reach Kaho'olawe (Parkes, 2009). Due diligence from all parties is required to maintain a significant biosecurity barrier from rodents reaching Kaho'olawe. Only through education and engagement, introduced through volunteer orientations and pre-trip briefings, will ensure that rodents do not breach biosecurity measures and make it onto the island. In addition to volunteer briefings, a biosecurity tab was created on the KIRC website.

Kihei Boathouse Property

Acquired in 1999 for future use as an office/information center, Boathouse/storage facility, and native Hawaiian plant nursery (Executive Order No. 3963) an 8.2 acre parcel was used to build a Boathouse for the KIRC vessel Hakilo. It is now developing a Hale Ho'oulu Mea Kanu (Plant Nursery) and Kalamalama (Education center), in a "Building Bridges Between Kaho'olawe and Kihei" Project granted through the Kūkulu Ola (*Build Life*): Living Hawaiian Culture grant program from the Hawai'i Community Foundation and Hawai'i Tourism Authority, Atherton Family Foundation and Alu Like, Inc.'s Native Hawaiian Career and Technical Education Program. The Kihei Nursery is under development and may be providing native flora to Kaho'olawe. The Boathouse is the main point of departure and supports the operations of the current KIRC vessel 'Ōhua to transport materials and passengers to Kaho'olawe. Figure 6 illustrates the

approximate boundary of the 8.2 acre Kihei Boathouse property (and Kihei Boathouse and Nursery in Yellow) located at 2780 S. Kihei Rd., Kihei, HI 96753.

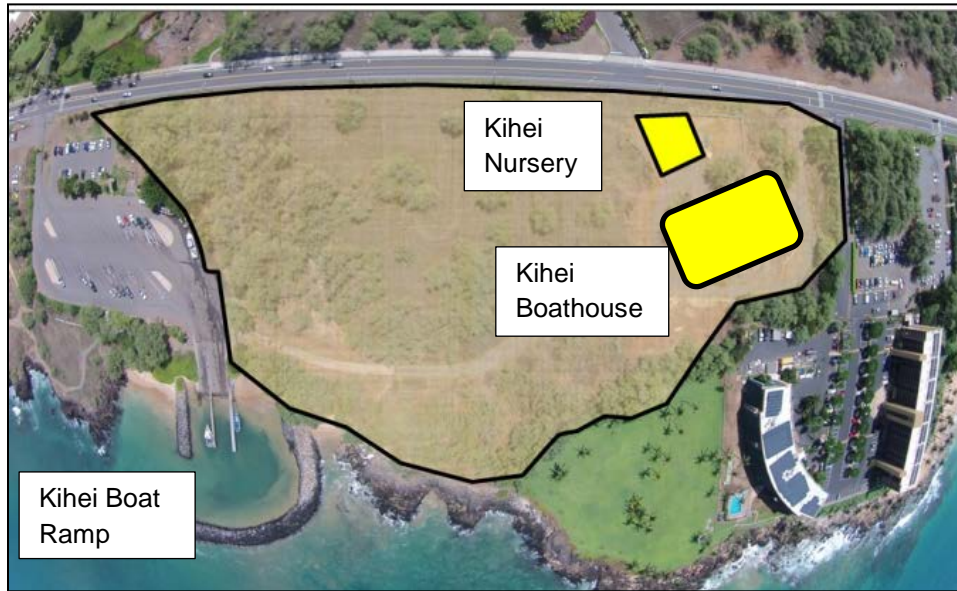


Figure 6 Eight acre Kihei Boathouse property and adjacent public boat ramp

Figure 7 illustrates the Kihei Boathouse and surrounding dry Kiawe (*P. pallida*) forest habitat.



Figure 7. Kihei Boathouse and surrounding urban habitat

Figure 8 illustrates clutter along the Boathouse fence line where rodenticide bait has consistent uptake. The discovery of Giant African Snails (*Achatina fulica*) also demonstrates that there is abundant cover and moisture in this area providing habitat for additional IAS.



Figure 8. Clutter along the Boathouse fence line

Biosecurity Planning Concepts

In order to be effective a Biosecurity Plan must be;

- Affordable
- Sustainable
- Effective
- Achievable
- Acceptable/Justifiable
- Enforceable
- Understandable
- Supportable

The Biosecurity Plan should be fully implemented with the available financial and personnel resources and remain logistically achievable within the available resources and time frames. The KIRC must be able to resource the establishment of the proposed on-going protocols and systems, and to purchase equipment and develop educational material. While it is not necessary all protocols and standards clearly stated in the Biosecurity Plan occur at one time, any proposed phase-in must also be appropriately audited and reviewed. If biosecurity measures are proving to be ineffective, the actions could target only higher risk species or specific vectors and pathways. The Biosecurity Plan should state what is able to be achieved and highlight any facets that will be implemented later if and when resources become available. This will allow auditing of the procedures that are supposed to be in place at the given time.

The objective and actions of the Biosecurity Plan should be supported by visitors, partners, and staff. In order for them to be fully engaged it should be readily understandable and clearly stated and disseminated in a thorough and timely manner. If the requirements of the Biosecurity Plan are too arduous and impractical to comply with,

Kaho'olawe Island Reserve Biosecurity Plan

and personnel do not become engaged and accept the necessity of the protocols, visitors on access and staff will circumvent the biosecurity process. Therefore, the Biosecurity Plan should be kept as simple as possible while still covering all the required detail. Once biosecurity protocols become established as standard practice and part of the management, the requirements may become more stringent.

Acceptance and support of the Biosecurity actions by personnel is one of the overall desired outcomes. However, it is highly likely that some individuals will not fully engage with what is required. Also, due to time constraints, biosecurity protocols may fail to be the priority they should be. Therefore, a Biosecurity Officer responsible for the implementation of the Biosecurity Plan will also have the ability to perform periodic checks of personal gear, equipment, off-highway vehicles, vessels, barges, helicopters, vectors and pathways. Examples of non-compliance should be used as an educational tool for the group and future orientations.

The Biosecurity Plan should have support and priority at all levels within the KIRC Staff and the Commission, especially at management level. Staff should feel like they have management support, so they will not be inclined to step up and make any hard decisions necessary to maintain the set standards for biosecurity, even if it is inconvenient or at a financial cost. If staff believes that set biosecurity standards are supported by management they will not be inclined to do what is easiest/cheapest possibly at the expense of biosecurity. In order to maintain the set biosecurity standards, it is quite possible that an access would need to be postponed, or at least containers of equipment and supply not taken to island delaying work programs. This has an operational/ financial cost but all personnel must see that cost as secondary to maintaining the standards.

This Biosecurity Plan provides background information that will assist with the various aspects of biosecurity, but does not record in detail the current level of biosecurity in place that is happening in the field regarding the biosecurity process undertaken by KIRC staff and the PKO. While the level of biosecurity are currently good (McClelland Environmental Services, 2017), and there is a high standard of biosecurity built into the normal operations of servicing the island, there will be opportunities to make improvements. The KIRC staff and the PKO need to always be aware of the impacts of IAS and consequently the importance of biosecurity to protect the island from additional IAS.

The first and most important step in improving biosecurity for Kaho'olawe is to document what actions are currently taking place. Documenting what is currently being done allows these processes to be standardized allowing for logistical differences between groups across all visitors and accesses and reviewed formally and informally to look for possible improvements as new opportunities, technology and resources are identified. It allows for on-going audits of the processes to ensure that the agreed standards are being followed.

Kaho'olawe Island Reserve Biosecurity Plan

All groups will be treated equally so no one feels like they are being singled out. The KIRC will lead by example and not be hypocritical by not following their rules. This Biosecurity Plan states here that “Everyone and Every Group Should Be Treated Equally” and what the KIRC is doing can be readily shown to all parties, partners and funders. The ability to enforce strict biosecurity (comprehensive inspection of all equipment and supplies) is limited so improving biosecurity requires education and engagement with acceptance from all visitors.

Hawaii Interagency Biosecurity Plan (HIBP) 2017-2027

The HIBP 2017-2027 addresses the most critical biosecurity gaps in the State and provides a coordinated, interagency path for actions to be taken by government agencies and partners. It increases support for local agriculture, protection for our environment, and safeguards for the health and lifestyle of Hawai'i's people. The HIBP was created for a stronger IAS policy, infrastructure and capacity by 2027. The Biosecurity Vision is for Hawai'i's people, visitors, economy, agriculture, and natural environment to be protected from the impacts of IAS. Achieving this will require hard work, policy development, and financial commitment (HIBP, 2016). Five (of the ten) highlights in the HIBP (2016) which are the keys to a successful Biosecurity Plan align with the KIR Plan and are as follows.

- Inspection facilities – Well-lit secure containment area for inspection, quarantine, treatment, and pest destruction capabilities and refrigerated area for produce.
- Emergency response capacity – Interagency Plans, protocols, and funding in place for timely and effective response to new pest incursions.
- Enhanced control of established pests – Adequate field staff at HDOA, DLNR, DOH, and UH to control established IAS, improved laboratories to support effective biocontrol.
- Minimized interisland spread – Increased staff and inspections for interisland goods, support to local farms and nurseries through certification programs and import substitution programs.
- Educated and engaged supportive community- Targeted outreach to different stakeholder groups to increase awareness through education and engagement in biosecurity programs.

Although Hawai'i is the most isolated archipelago in the world, IAS impact our local economy, environment, human health and our quality of life. In Hawai'i, \$378 million will be requested by the HDOA over a ten year time span for IAS (HIBP, 2016). Federal agencies such as the USDOA, US Customs and Border Protection and the USFWS play a key role in Hawai'i's biosecurity and they regulate foreign imports and provide technical and funding support to state and private landowners to manage IAS (HIBP, 2016). The USDA Animal and Plant Inspections Service, US Department of Homeland Security and Customs and Border Protection are responsible for intercepting pests from foreign points of origin.

Kaho'olawe Island Reserve Biosecurity Plan

From the executive summary of the HIBP, Red Fire Ants are predicted to cost Hawai'i \$211 million per year, and the Brown Tree Snake could cause upward of 2.14 billion per year in economic damages (HIBP, 2016). In 2001, the Hawaii legislature stated that the invasion of Hawai'i by IAS is the greatest threat to the economy, natural environment and health and lifestyle of the people (HIBP, 2016). Hawai'i's flora has one of the highest rates on endemism in the world, with an estimated 10,000 endemic species (HISC, 2015) and it's IAS problem is also the most severe of any state (HISC, 2004). The resulting uncontrolled population growth and spread causes economic or environmental problems (CISR, 2016). Governor Ige has a Sustainable Hawai'i Initiative (<http://governor.hawaii.gov/sustainable-hawaii-initiative/>) which includes strengthening our waters, land and food for Hawai'i's communities and includes the HIBP.

Hawai'i Invasive Species Council (HISC)

Established in 2003 by the Hawai'i State Legislature, the Hawai'i Invasive Species Council (HISC) is a State interdepartmental collaboration that was formed in response to a Legislative Reference Bureau report (Ikuma et al., 2002). A Senate concurrent resolution (No.45 H.D.1, 2001) directed the Legislative Reference Bureau to conduct a study on policy recommendations and funding options for a comprehensive IAS protection and control program for the State of Hawai'i. Gaps were identified in IAS management statewide, exposing the risks to Hawai'i's Biodiversity (a measure of the variety of organisms present in different ecosystems). A highlight from the report states

"The alien invasive species problem in Hawaii is both serious and daunting. The damage that invasive species cause and may potentially cause affects the State's health and safety, as well as its economic and environmental well-being." Also "invasive species pose a constant and costly threat to Hawai'i's native ecosystems functions, biodiversity, watersheds, industries including tourism, agriculture, aquaculture, shipping, public health and the quality of life of residents and visitors" (<http://dlnr.hawaii.gov/hisc/info/>).

The HISC was authorized by Chapter 194, Hawai'i Revised Statutes (HRS-194) and was created to provide policy level direction, coordination, and planning among state departments, federal agencies. Also, to develop international and local initiatives for the control and eradication of harmful IAS infestations throughout the State, and for preventing the introduction of other IAS that may be potentially harmful.

The HISC is co-chaired by the Department of Land and Natural Resources (DLNR) and the Hawai'i Department of Agriculture (HDOA) and includes the members from the University of Hawai'i (UH), the Hawaiian Department of Business and Economic Development and Tourism (DBEDT), the Hawai'i Department of Health (DOH) and the Hawaii Department of Transportation (DOT). The HISC is composed of five working groups chaired by member agencies dealing with prevention, established pest management, public awareness, research and technology and natural resources. The HISC seeks to maintain a comprehensive overview of issues and supports state wide IAS prevention, early detection and control programs in the effort to provide a testing

Kaho'olawe Island Reserve Biosecurity Plan

ground for innovation in methods and capacity to address IAS which can be adopted permanently by other funded agencies.

In addition, the leaders of the following Departments and organizations are non-voting participants in HISC meetings for interagency dialogue: State Senators and Representatives, Additional state agencies, County Mayors, Federal agency representatives from the US Departments of the Interior (US DOI), US Department of Agriculture (US DOA), and the US Department of Defense (US DOD). Hawai'i Ecosystems at Risk (HEAR, 2016) assists with identifying IAS for plants and animals in Hawai'i. Finally, the Coordinating Group on Alien Pest Species (CGAPS) is a statewide partnership of agencies and organizations working together to promote policy and procedural change to close the gaps in Hawai'i's biosecurity. The Vision statement from HISC's Strategic Plan for 2015-2020 protects Hawai'i's unique natural environment from the impact of IAS.

The HDOA which is the only agency with a mandated biosecurity program, and the DLNR which is empowered by the HIBP, are the two primary state agencies responsible for biosecurity, but received less than 0.4% and 1% respectively of the \$13.7 billion state operating budget in FY 16-17 (HIBP, 2016). State agencies such as the DOH and UH, as well as Federal agencies including the United States Department of Agriculture (USDOA) and the United State Fish and Wildlife Service (USFWS), also play a role in Hawai'i's biosecurity.

Cultural Protocols and Ceremonial Offerings

It is recommended that individuals thoroughly inspect and clean by hand all items to be transported to KIR and when feasible soaking/cleaning items in saltwater and/or freezing. All items for transport will be inspected by trained staff prior to entry into the transportation system and debarkation. Items which may pose an unacceptable risk of transporting pest to island will be refused transport.

Recommendations include thoroughly inspecting and cleaning by hand or soaking and cleaning in saltwater or, if appropriate, freezing. Any IAS observed must be removed from the item before transporting to island.

All plant matter (ti, ferns, banana, breadfruit, sweet potato, coconuts) must be inspected for any animals, invertebrates (especially ants), scale, moss or fungus that might be transported to island.

Chapter 6K Hawai'i Revised Statutes [§6K-3] states that, "The Kaho'olawe island reserve shall be used solely and exclusively for the following purposes; Preservation and practice of all rights customarily and traditionally exercised by Native Hawaiians for cultural, spiritual, and subsistence purposes". The KIRC has pledged to provide for the meaningful and safe use of Kaho'olawe for the purpose of the traditional and cultural practices of the Hawaiian people (KICC 1993, KIRC 1995). Several cultural ceremonies are performed annually on Kaho'olawe including Makahiki, the Rain Ceremony (Ka Holo

Kaho'olawe Island Reserve Biosecurity Plan

i ka lani) and monthly volunteer trips by both the KIRC and the PKO. It is imperative ceremonial offerings (ho'okupu) in Figure 9, as well as individual field gear are thoroughly inspected by PKO access leaders and/or KIRC staff for IAS before they are brought to Kaho'olawe.



Figure 9 Ho'okupu on Kaho'olawe

Kaho'olawe Island Reserve (KIR) Biosecurity Advisory Committee

Managing IAS on Kaho'olawe involves prevention of pest establishment and controlling those already there (Broome, 2007). To establish protocols for the KIRC Biosecurity Plan, a KIR Biosecurity Advisory Committee has been formed to guide the document and established protocols, and ensure the one objective and three action items are met. The members name, title, and affiliation are as follows (Table 6).

KIR Biosecurity Advisory Committee			
Member Name	Title	Affiliation	Comments
Mike Naho'opi'i	Executive Director	KIRC	
Paul Higashino	Natural Resource Specialist V	KIRC	Program Manager
James Bruch	Natural Resources Specialist III	KIRC	Restoration
Lyman L. Abbott	Natural Resources Specialist III	KIRC	Restoration
Dean Tokishi	Ocean Resource Specialist III	KIRC	Program Manager
Lopaka White	Natural Resources Specialist II	KIRC	Boat Captain
Grant Thompson	Kaho'olawe Island Reserve Specialist III	KIRC	Boat Captain/Kihei Boathouse
TBD	Biosecurity Specialist	HISC/HDOA/DLNR	
TBD	Access Leaders	PKO	
TBD	Access Leaders	PKO	

Table 6 Members of the KIR Biosecurity Advisory Committee

Kaho'olawe Island Reserve Biosecurity Plan

The first meeting of the KIR Biosecurity Advisory Committee took place in April, 2017. A biosecurity specialist from the HISC, HDOA or DLNR would be beneficial.

Biosecurity for Parsons-UXB Clearance Project (1998 - 2003)

Biosecurity measures during the Parsons UXB Clearance Project, for IAS vectors included inspecting personnel boots, socks, pants and hats. Prior to boarding aircraft, daily self-inspection as well as Natural Resource Specialists observing personnel foot gear and back packs occurred. Equipment, containers and transportation vehicles (helicopters) were also inspected. Large barge inspections took place on O'ahu and small barge inspections on Maui.

III. CURRENT OPERATIONS

Volunteer Orientation and Biosecurity Protocols

The first step of anyone who accesses Kaho'olawe is the mandatory volunteer orientation which occurs before the trip. Access begins at the orientation. This occurs on the home island of the group or individual and covers expectations and behaviors of the volunteer while on Kaho'olawe. During orientation, volunteers are provided with details regarding their role in supporting KIR biosecurity standards. For IAS, this addresses **Prevention, Detection and Response** and includes pictures of key detrimental organisms that can severely impact the ecology of the island (Figure 10).



Figure 10 A slide from the KIRC volunteer orientation presentation on Biosecurity

KIRC and PKO Websites

Biosecurity standards are provided on the KIRC (<http://www.kahoolawe.hawaii.gov/home.php>) and PKO (<http://www.protectkahoolaweohana.org/>) websites. They are also available as needed for volunteers on arrival at the location of departure. The Biosecurity page stresses the importance of protecting the KIR from IAS using the three actions of **Prevention**,

Detection and **Response**. The PowerPoint presentation is available on the KIRC Website on the Biosecurity page.

Biosecurity Signs

A simplified 1 page KIR Biosecurity Sign (Appendix B) for the KIRC and PKO has been created to present a visual image in volunteer orientations at the Kihei Boathouse, where personnel congregate before the island access, and on Kaho'olawe as reminder of biosecurity protocols. They were designed to be conspicuous, and to remind people how to inspect their personal equipment before going to Kaho'olawe.

Biosecurity signage is posted at the KIRC Boathouse in Kihei (Figure 11).



Figure 11 KIR Biosecurity signage and information to address the objective and three actions

The concrete slab is a Biosecurity Checkpoint (Pre-loading/loading quarantine area) to inspect incoming materials to be stored at the Boathouse, and outgoing materials to Kaho'olawe. Volunteers and visitors place their bags and equipment on this slab for IAS **Detection** before it is loaded onto the KIRC vessel.

Protocol for the Prevention of IAS Introduction

In addition to the updated KIRC Biosecurity tab with information for visitors, volunteers and researchers at <http://kahoolawe.hawaii.gov/biosecurity.shtml> The KIRC website (<https://kahoolawe.hawaii.gov/>) lists the following information for Biosecurity Procedures;

Kaho'olawe Island Reserve Biosecurity Plan

“Control of introduced plants and animals and restoration of native plants and animals are principal goals of the KIRC to restore Kaho'olawe. New accidental entries to the island add to an already extensive list of alien species, resource management workers, with increased urgency, call for stricter control measures to prevent alien ingress (prevent introducing unwanted IAS) into natural areas. Every person is a possible vector (transmitter or carrier) of alien species. Taking preventative measures to hinder the introduction of alien invasive species to Kaho'olawe is crucial to preserving the native environment.

These measures include:

- *Inspecting all clothing, gear, and equipment before coming to Kaho'olawe. Field pests include weed, seeds, and insects. Thoroughly clean footwear, socks, pant legs, jackets, rain gear, tools, packs, and other containers.*
- *Thoroughly wash and dry all swim clothes and gear. Dip snorkel and fins in a light bleach solution prior to your Kaho'olawe access. Invasive algae are just as dangerous as terrestrial weeds.*
- *Become acquainted with Hawai'i's invasive species, their status, and locales. Learn which are localized to your area and be alert for those established on other islands or natural areas.*
- *Keep localized infestations from becoming established on other islands or in other preserves. Avoid spreading pests from your home that your destination may not have, and vice versa, by inspecting and cleaning.”*

This information and a Quarantine Self-Check Sheet (Appendix C) guides the volunteer through a list of personal and cultural items to inspect for IAS before the trip. The form can be completed as the person packs their gear, and then signed. This will reinforce the observation of seeds (and other unwanted items) in their preparation, and make them accountable for their actions even if no further inspection takes place. The signed checklist could become a part of the overall access and volunteer registration process. Having all personnel, regardless of whether they are staff, regular visitors or volunteers complete the form reinforces the priority that everyone (KIRC and PKO, canoe clubs) is treated the same.

Land Based Biosecurity and Standard Operating Protocols

Land Based Biosecurity will implement the ED/RR approach using the three actions to achieve the objective. A quarantine self-check sheet will be made available to the staff and volunteers to fill out before a trip to island.

The transport of personnel and equipment to and from Kaho'olawe is performed by the KIRC vessel 'Ōhua (Figure 12). It is a 39 foot ALMAR® with twin Cummins diesel engines.



Figure 12. KIRC vessel 'Ōhua at Kihei Boathouse

Recommended Actions

The KIRC has identified priority target fauna and flora species (mongoose, rats, ants, Khaki weed, puncture vine) at the Kihei Boathouse property to be managed for quarantine and possible eradication.

The 'Ōhua is a primary vessel and vector (carrier of IAS) to Kaho'olawe, so it is imperative observant eyes support the action of **Prevention** and **Detection** of any IAS in cargo. This is key. When loading in the early morning hours, it is important to have bright lights in the Boathouse and on board to visually inspect the gear so that is free from any ants, insects or rodents. Sticky Traps should be collected and disposed of properly. Education for all personnel involved should be included as follow up once the IAS Quarantine Form is completed and updates made to this Biosecurity Plan as appropriate.

KIRC staff will thoroughly inspect and load equipment (stored in the Boathouse in plastic bins) onto the deck of the vessel and then transport to Kaho'olawe. All stored lumber (in the fore ground in Figure 12) must be inspected for IAS before loading onto the vessel for transport to Kaho'olawe. Ideally lumber should not be stored on the ground as ants can nest in the wood stack (Figure 13).



Figure 13. Ant nest in stored lumber at Kihei Boathouse

All cardboard and boxes sitting in or outside the Boathouse must be inspected for IAS before loading onto 'Ōhūa. Also, reduced clutter, use of metal trash bins, control of water supplies and properly discarded food will help eliminate resources for rodents. It should be realized exclusion of IAS from property and storage units is never permanent and must be maintained on a continual basis (Hoddenbach, 2005). The 'Ōhūa should not have anything hanging off the side of the vessel such as lines or webbing. Ladders should not be stored leaning against the vessel in which rats or mongoose could crawl up and into the holds. Rats have been known to be able to jump 4 feet high.

Using a "Rapid Response" approach, if there is a **Detection** of IAS, they need to be quarantined immediately in proper containment (glass jar, plastic vile). Figure 14 illustrates an inspection of bananas.



Figure 14. An example of inspecting supplies for IAS before departure to Kaho'olawe

IAS Rapid Response Kit

The IAS Rapid Response Kits will be on vessels, locations of departure and entry points to Kaho'olawe. This includes the 'Ōhua, the Kihei Boathouse and Honokanai'a Base Camp. The PKO will be provided with one kit for accesses to Hakiowa.

IAS Rapid Response Kit Contents

The IAS Rapid Response Kits should consist of insecticides, sticky traps, collection jars and vials (Figure 15) and other appropriate equipment (aspirator) to capture and dispatch organisms. This will ensure a "Rapid Response" to Quarantine the IAS threat.



Figure 15. IAS Rapid Response Kit

Appropriately stocked and readily accessible kits will help improve Rapid Response to a variety of potential IAS.

IAS Encounter Form

The IAS Encounter Form will be used to document the ED\RR (including Quarantine and Eradication) actions taken for dispatch and identification of the IAS. With **Response**, the date, time and location of the Quarantine action will be filled out on the IAS Encounter Form. Also take a picture of the organism, list what organisms were observed, disposition (captured, stored, escaped), number of organisms encountered, type of cargo/equipment it was associated with, and how encounter occurred (during inspection, loading, in transit). Other information such as who was involved should be documented if possible. If eradication of the IAS occurs on site (on a vessel, departure location or entry point), it should be accomplished with the IAS Rapid Response Kit. The IAS Encounter Form is available in Appendix D.

Kihei Boathouse Rodent Control

To control rodents at the Kihei Boathouse, Contrac® all-weather Blox® rodenticide is currently used (Figure 16) and recorded in the Rodent Control Log (Appendix E).



Figure 16. Contrac® Blox® bait

The active ingredient is Bromadiolone 0.005% which is less toxic to non-target animals in primary and secondary poisoning Target pests: Norway rats (*R. norvegicus*), Roof rats (*R. rattus*).

Contrac® bait blocks are a multi-edged, single feeding Rat and Mouse bait. It is formulated with an optimal blend of food grade ingredients and low wax to yield a highly palatable, weatherable bait that is very attractive to rodents. The Blox® is placed in a tamper resistant Protecta® Bait station (Figure 17) to keep non-target animals such as dogs and cats from the bait.



Figure 17. Protecta® Rodenticide Bait Station

The number grams of bait maintained within bait stations will follow the manufactures recommendation on the product label. Stations will be placed at densities according to specifications from the manufacturer. To control for mice and rats permanent bait boxes are spaced out at roughly 25 meters apart including 2 inside the boathouse (Figure 18).



Figure 18. Location and numbers of labeled bait stations at Kihei Boathouse and Nursery

Boxes are kept stocked with 8-16 oz. of fresh bait in accordance with the “Contract® Specimen Label”. In addition, on Kaho’olawe bait boxes are located at the Honokanai’a and Hakioawa Base Camp to control seasonal rodent irruptions that impact sanitization of the base camps. Rodent stations are serviced in accordance with the “Contract® Specimen Label” and recorded with a Rodent Control Log. If rodent activity is noted traps are also set out.

Kihei Boathouse and Nursery Ant/Arthropod Control

Controlling the spread of invasive invertebrates is crucial and ants are notoriously difficult to control around structures. They can cause huge ecological damage when they are introduced to new locations (Vanderwoude, 2008). The KIRC is currently using the ant bait (Amdro®) and barrier (Talstar®). The ants present in the Kihei Nursery typically nest in clutter and utilize the growing medium for potted plants. Using a general insecticide may not always be available for the treatment of plants, field gear, supplies and equipment. Also, some pests may not be affected by the general treatment. Therefore, to minimize the risk of incursions, the KIRC is using the comprehensive and adaptive strategy of the ED/RR approach.

Ant Bait Treatments for the Kihei Boathouse

Several ant bait treatment products are available and have been tested by the Hawai’i Ant Group (Table 7) with the Pacific Cooperative Studies Unit of the University of Hawai’i.

	Name	Description	Comment
1	¹ Amdro®	Ant Bait, Consistently Effective	Very popular
2	Probait®	Consistent Performer	Similar to Amdro®
3	¹ Maxforce Complete®	Extremely Effective	Expensive
4	Extinguish Plus®	Not as Effective	Moderately attractive
5	Advion Fire Ant Bait®	Professional Use Only	Inconsistent Results
6	¹ Tango®	Concentrate	Forms a gel
7	¹ Talstar®	Barrier Protection	Requires a sprayer

Table 7 Types of Ant Baits

¹ Recommended Use at Kihei Boathouse and Nursery.

The Hawai'i Ant Group was formed to develop a better understanding of ants and their impacts in Hawai'i as well as facilitate and exchange of information, monitor and report new introductions and increase public awareness. Amdro®, MaxForce Complete®, Tango® and Talstar® may all be used at the Kihei Boathouse. Appendix F lists the proper techniques and precautions for using the Amdro® bait. Dry days are better than wet ones to apply bait. It is important to treat the entire property and systematically apply the bait to each section. It is also very important to apply bait treatments 2 weeks before barrier treatments. Ant species recorded in Hawai'i and Kaho'olawe are listed in Appendix G.

Two methods are used at the Kihei Boathouse and Nursery for ant/arthropod control. Bait treatments and barrier treatments.

Bait Treatments

Insect baits are very different from contact sprays or liquids. Baits have a lower toxicity so that they don't kill the insect outright, and they are disguised as attractive food, encouraging the worker to share the pesticide with the rest of the colony, including queens and developing larvae. There are two different types of action for the recommended Little Fire Ant products: *toxicant* and *growth regulation*. While both bait treatment and barrier treatment may be applied with a spreader, it is important to have two labeled spreaders to keep them separate.

Barrier Treatments

Ant barrier treatments are insecticides that are sprayed or sprinkled around areas where ants are to be excluded. They should not be mixed with bait treatments and should be applied to wet soil or when rain is expected, making a wide band 3 - 6 feet wide. Granular barrier treatments are easiest to apply because there is no mixing required. It is important to apply the barrier treatment two weeks after the bait treatment so the ants taking the bait poison back to the colony will not be killed. Any ants that come into contact with the chemical will die. Barrier treatments usually have a residual activity and can be effective for months. Figure 19 illustrates the area in the Kihei

Kaho'olawe Island Reserve Biosecurity Plan

Boathouse and Nursery for ant and other insect pests barrier protection using 1% Talstar P (Bifenthrin) in water. Usage is recorded in the Pesticide Use Log (Appendix H).



Figure 19. Granular Bait Treatment (orange) and Ant barrier treatment (blue) at the Kihei Boathouse and Nursery.

Co-operative Agricultural Pest Survey (CAPS)

The CAPS are performed in cooperation with the USDA Animal and Plant Health Inspection Service (APHIS), to detect high risk pests before they have a chance to cause significant damage. This ensures that new introductions of harmful plant pests and diseases are detected as soon as possible. In January, June, September and December of 2016, four CAPS were completed at the Kihei Boathouse and Nursery primarily to detect the presence of Little Fire Ant. The Little Fire Ant is a common ant species located throughout northern and central South America, the West Indies, the warmer portions of Mexico and the Southeastern United States (<http://entnemdept.ufl.edu>). The CAPS procedures for conducting standardized surveillance and monitoring for exotic ants (and Little Fire Ant) at Hawaiian Points of Entry are as follows;

Kaho'olawe Island Reserve Biosecurity Plan

- Targets are Little Fire Ant and Red Imported Fire Ants (*Solenopsis invicta*) not yet in Hawai'i, and other invasive ant species.
- Surveillance of ants is accomplished by placing vials (Biolab® 60cc) baited with attractive food items in a grid pattern over the entire area to be surveyed, and collecting the vials after 30-60 minutes exposure.
- While baits are in the field, any ants foraging nearby will be attracted to the baits and these can be sealed inside the vials and identified in the laboratory.
- Procedures that specifically target Little Fire Ants or Red Imported Fire Ants for delimiting, monitoring and general surveillance are different.

For follow up surveys, work out the area to cover and obtain a map or aerial image of the site. Plan to do the survey every three months during clear weather when rain is not expected. Each team should be made up of three (3) people and one team should be able to place and collect around 200-400 vials in a day. When preparing baits, make approximately 100 per person working in the survey. Different ants are attracted to different food types so a mixture of bait types is used. It is best to make only enough bait for a days' work. This way the baits will be fresh and attractive to ants (ants are not interested in old baits). If possible, make them up the day before and store in a refrigerator overnight. Two types of bait (protein and sugar) are made and laid out in alternate fashion in the field. Use vials with different colors for each bait type and keep in separate bags. When placing the vials, keep in the shade if possible, pointed away from the prevailing wind, and angle downward to keep any potential rainwater out. If it begins to rain, it is good to collect the vials already out. Protein balls contain a smear of peanut butter on the inner side of the bait container and a small cube of luncheon meat inside the vial. The sugar baits contain a smear of light colored jelly or jam (no seeds, lumps or rinds) on the inner side of each bait container.

The aim of the survey is to thoroughly sample the ants at the site. This is done by placing baits approximately spaced in a grid pattern appropriate for each survey type. For example sections that are concrete or asphalt (bitumen) do not need to be sampled. Potential ant habitats are listed in Table 8 and it is important that all these are sampled.

Potential Habitat for Ants		
	Location	Comments
1	Tree Trunks	visual inspection and bait at base if appropriate
2	Flowers	
3	Shrubs and poles	
4	Building edges and foundations	
5	Concrete slab edges	
6	Cracked concrete	
7	Disturbed sites	
8	Drains and culverts	
9	Electrical generators and fittings	
10	Exposed rocks	

Kaho'olawe Island Reserve Biosecurity Plan

Potential Habitat for Ants		
	Location	Comments
11	Fence palings	
12	Grass areas	
13	Verges	
14	Hot water pipes and heaters	
15	Isolated weeds	
16	Logs	
17	Loose gravel	
18	Low vegetation	Including grass
19	Plant pot bases	
20	Road margins	
21	Rubbish piles	
22	Shiny surfaces	
23	Soil	
24	Tree crotches and hollows	
25	Vertical Surfaces	
26	Weed and plant re-growth	
27	Wooden Structures	
28	Underneath stones or concrete rubble	

Table 8 Potential habitat for ants for CAPS

Ant Taxa Observed at Kihei Boathouse and Nursery

Table 9 lists the eight (8) ant taxa found during the four 2016 surveys at the Kihei Boathouse and Nursery in accordance with CAPS protocols.

	Kihei Boathouse - June 15, 2016	Present on Kaho'olawe 2016		RISK (PIA)
		Yes	No	
1	<i>Anoplolepis gracilipes</i>	X		Medium
2	<i>Brachymyrmex obscurior</i>		X	NA
3	<i>Cardiocondyla obscurior</i>		X	Low
4	<i>Camponotus variegatus</i>	X		TBD
5	<i>Monomorium bicolor (destructor)</i>	X		Medium
6	<i>Ochetellus glaber</i>	X		Low
7	<i>Paratrechina longicornis</i>	X		High
8	<i>Tetramorium simillimum</i>	X		Medium
9	<i>Pheidole megacephala</i>	X		Medium

Table 9 Ant taxa found at Kihei Boathouse and Nursery during 4 CAPS in 2016

Kaho'olawe Island Reserve Biosecurity Plan

Also listed is whether or not it has been observed on Kaho'olawe and the Pacific Invasive Ant (PIA) Risk Assessment. This information serves as a baseline of ants present in 2016. If follow up surveys detect a new ant species, the baseline data will improve Pre-Border Biosecurity for Kaho'olawe. Starr Environmental has been assisting the KIRC staff acquiring the data with ant identification on Kaho'olawe and at the Kihei Boathouse property.

The Carpenter ant (*C. variegatus*) was not initially observed at the Kihei Boathouse property during the surveys, although it was then observed April 15, 2016 and collected April 22, 2016. This may be due to the nocturnal behavior of this particular ant species. Figure 20 illustrates the locations of the sweet and protein baits during the CAPS.

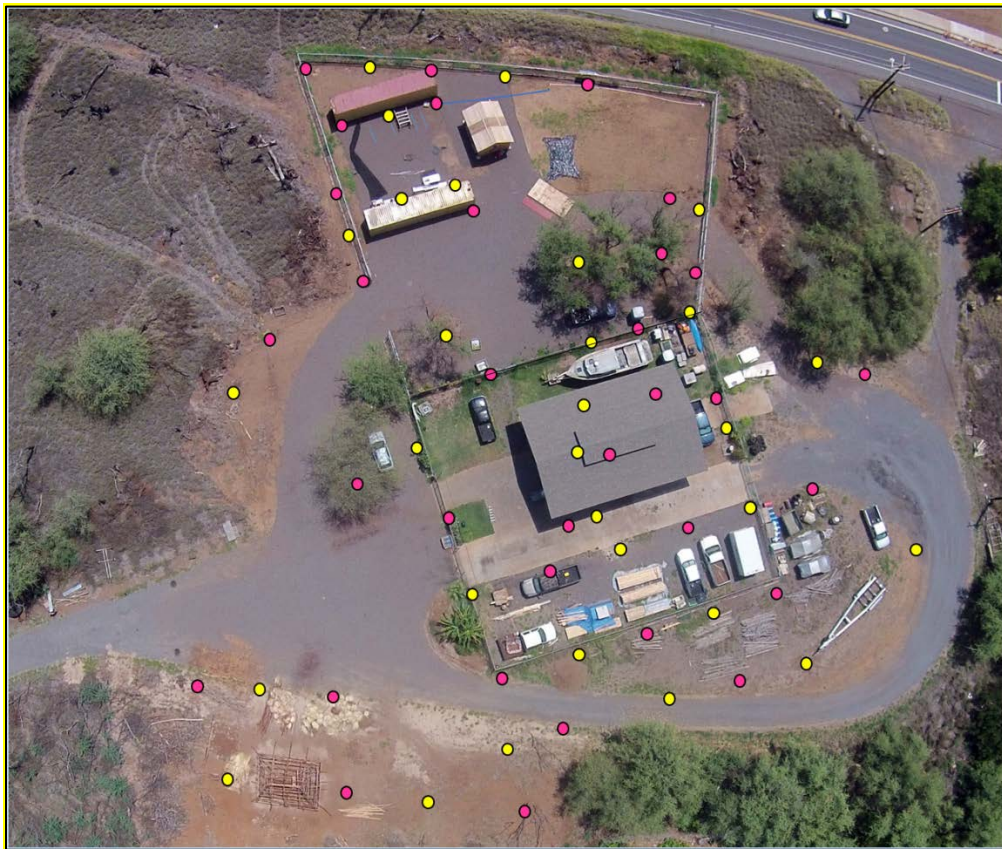


Figure 20. CAPS stations at the Kihei Boathouse and Nursery (Protein and Sweet Baits).

IAS Plant Control at the Kihei Property

Table 10 lists fifty (50) botanical species observed at or near the Kihei property in January, 2016.

Kaho'olawe Island Reserve Biosecurity Plan

Taxa	Taxa
<i>Abutilon incanum</i>	<i>Ipomoea pes-caprae ssp brasiliensis</i>
<i>Abutilon menziesii</i> (E)	<i>Jacquemontia ovalifolia</i>
<i>Alocasia sp.</i>	<i>Leucaena leucocephala</i>
<i>Aloe vera</i>	<i>Macroptilium lathyroides</i>
<i>Alternanthera pungens</i>	<i>Malvastrum coromandelianum</i>
<i>Amaranthus spinosus</i>	<i>Merremia aegyptia</i>
<i>Bonamia menziesii</i> (E)	<i>Musa x paradisiaca</i>
<i>Bothriochloa pertusa</i>	<i>Panandus tectorius</i>
<i>Cenchrus ciliaris</i>	<i>Panicum maximum (Megathyrsus maximum)</i>
<i>Chloris barbata</i>	<i>Paspalum conjugatum</i>
<i>Cordyline fruticosa</i>	<i>Pluchea indica</i>
<i>Cynodon dactylon</i>	<i>Prosopis pallida</i>
<i>Cyperus sp.</i>	<i>Ricinus communis</i>
<i>Desmanthus pernambucanus</i>	<i>Samanea saman</i>
<i>Digitaria insularis</i>	<i>Schefflera actinophylla</i>
<i>Dodonaea viscosa</i>	<i>Sida fallax</i>
<i>Eluesine indica</i>	<i>Sporobolus africanus</i>
<i>Erigeron bonariensis</i>	<i>Synedrella nodifolia</i>
<i>Euphorbia hirta</i>	<i>Tribulus terrestris</i>
<i>Ficus sp.</i>	<i>Tridax procumbens</i>
<i>Gossypium tomentosum</i>	<i>Trifolium sp.</i>
<i>Heliotropium curvassavicum</i>	<i>Verbesina encelioides</i>
<i>Hibiscus clayii</i>	<i>Vitex rotundifolia</i>
<i>Indigofera spicata</i>	<i>Waltheria indica</i>
<i>Indigofera suffruticosa</i>	<i>Washingtonia robusta</i>

Table 10 Botanical Survey of Kihei Boathouse Property, January 2016
E = Federally Endangered

Priority target species are highlighted in yellow. Also observed in 2017 on the Kihei Boathouse property was a Shower Tree (*Cassia sp.*), Lions tail (*Leonotis leonurus*) and obscure Morning Glory (*Ipomoea obscura*).

Since 2015, Puncture Vine (*Tribulus terrestris*) and Khaki Weed (*Alternanthera pungens*) have been manually removed from the Kihei Boathouse and Nursery or treated with herbicide. These have been designated as **Priority Target Species** for eradication by the KIRC. They continue to be monitored and removed when observed to prevent an IAS introduction to Kaho'olawe. Puncture vine became a pest problem at the Boathouse area in the first half of 2016 (Figure 21).

Kaho'olawe Island Reserve Biosecurity Plan



Figure 21. Seed (nutlet) and flower of Puncture Vine (*T. terrestris*)

Puncture Vine was treated with RoundUp® (2% in water), collected and bagged. However, the seeds are viable for years and both Puncture Vine and Khaki Weed need to be managed on the property area for an extended time. **Priority Target Species** need to be reevaluated by the KIR Biosecurity Advisory Committee on an annual basis.

Kaho'olawe Island Reserve (KIR)

Protocols for Ocean Based Biosecurity will be strictly enforced to prevent the spread of unwanted algae in the shallow water benthic habitat of Zones A and B in the KIR (Figure 22).

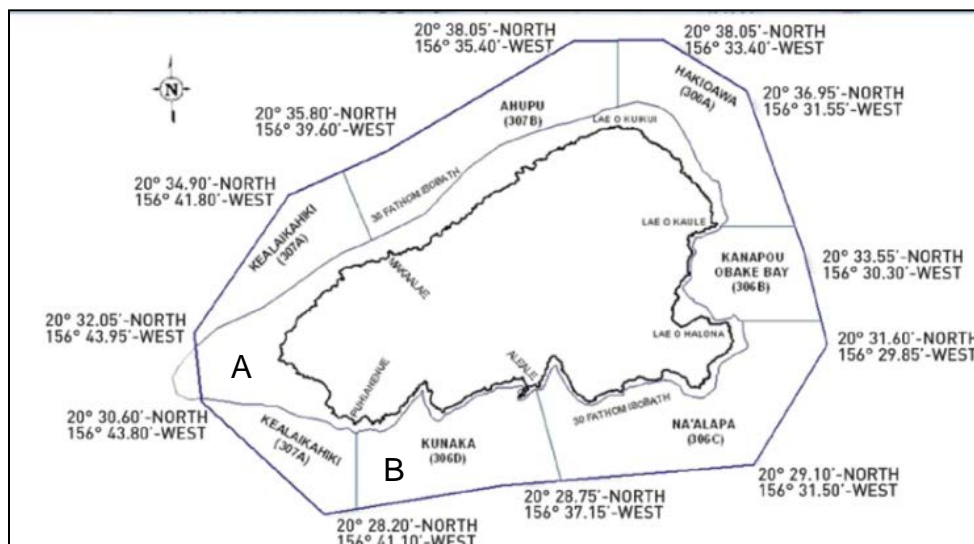


Figure 22. Boundaries of Zone A and B in the KIR

The KIR (defined as the submerged lands and waters within two nautical miles of the island) is divided into two zones; Zones A and B.

Zone A: Includes the island of Kaho'olawe and all the submerged lands and waters between the shoreline of Kaho'olawe and the 30-fathom (180 ft.) depth which surrounds Kaho'olawe (HAR13-261). Unauthorized entry into Zone A is prohibited at all times except in case of emergency.

Kaho'olawe Island Reserve Biosecurity Plan

Zone B: All waters and submerged lands between the 30-fathom (180 ft.) depth surrounding Kaho'olawe and two nautical miles from the shoreline of the island. Unauthorized entry into Zone B is prohibited at all times except for trolling as authorized by KIRC on the days stipulated by the Permitted Trolling Schedule or in case of emergency. Trollers must remain underway, making way at all times while in Zone B.

Standard Operating Protocols for the Transportation of Plants into the KIR

Plant Nurseries on Maui

KIRC has had a standard for IAS in place when ordering and receiving plants since 1998, and they are to be free of nematodes, slugs, ants, and other insects. All plants will be grown on either raised benches, weed cloth or plastics covered ground, cement slab or in a certified nursery. Plants will be grown in a sterile medium. No compost will be used that contains sewage sludge. Upon delivery, all plants will be free of IAS, fungal or other diseases, and any other type of organism that may be harmful to the restoration efforts on Kaho'olawe. If the shipment does not meet these standards, the plants will be rejected and placed in a quarantined area. Once notified it is the responsibility of the vendor to remove the plants from the Kihei Boathouse designated quarantined area within 24 hours.

All plants will be inspected at the Kihei Boathouse for IAS by the KIRC personnel prior to shipment to island. Grasses, shrubs and trees should be delivered to the boathouse as close to the access as possible (the day before) to minimize the risk of IAS. Plants in containers will be checked again just before loading onto the vessel and all plants should be visually inspected before they are loaded. Once plants are cleared they will be signed off with a date and time, 24 hours or less before the vessel leaves for Kaho'olawe.

Nurseries and Farms supplying plants to the Kihei Boathouse property need to be a registered facility with the KIRC and acknowledge they will deliver IAS free material in agreement with the KIRC plant protocols (Appendix I) in this Biosecurity Plan. Also, they will provide a docket of the common plant name, taxa (*Genus species*) and variety if known, and location the plant is from.

Ho'olawa Farms in Haiku specializes in Hawai'i's endemic and indigenous plants and supply over 100 species for landscaping and ecological restoration. Maui Nui Botanical Gardens in Kahului is dedicated to the protection of Maui Nui's rich native plants and cultural heritage. Finally, Native Nursery, LLC in Kula is committed to providing the highest quality plant material for statewide reforestation. Plant materials from these nurseries on Maui will be visually inspected at the Nursery and before packing and shipping to Kaho'olawe. Three potential sources of IAS will be from these Nursery facilities. The KIRC restoration department has given these three Nursery facilities the protocols for the condition of the plant deliveries.

Kaho'olawe Island Reserve Biosecurity Plan

The horticultural industry is a vector of alien snails and slugs in Hawai'i. An Amber snail (*Succinea tenella*) was found during a survey on plants destined for the Kaho'olawe restoration effort (Robert H. Cowie, University of Hawai'i, Personal Communication, November, 2017). Cowie (et al., 2008) stated limited quarantine measures for small species of snails have not prevented their inadvertent spread and predation and extinction of Pacific and other island snail species is suspected by Rosy Wolf Snail (*Euglandina rosea*).

Transportation of Cultural Material

KIRC and PKO entry points present one of the greatest biosecurity risks identified. The transport of cultural plant material, including banana stumps (with soil), ti leaves, fern and forest materials for lei to Kaho'olawe for ceremonial purposes has the high potential to introduce everything from seeds and invertebrates to geckos and rodents. It is important to establish a Pre-Border process that will minimize this risk. This can include immersion of materials in salt water or treatment with an insecticide (pyrethroids).

Rooted plants in soil present a major risk for both invertebrates and pathogens. Therefore, no soil is allowed for transport and plants. If needed, plants can be re-potted with a sterile soil (Perlite) at the Kihei Nursery prior to their transport to island.

Integrated Pest Management

Integrated Pest Management (IPM) is a strategy that prevents pest damage with minimum adverse impact on human health (MDAR, 2010) and refers to diseases, insects, mites, slugs, snails, nematodes and weeds. In the IPM approach, the grower uses their knowledge of pest biology to take actions that reduce pest establishment and increases in populations. IPM uses monitoring techniques and combinations of biological, mechanical, chemical, environmental and physical control. Pesticides are utilized only if monitoring stipulates they are needed. If pesticides are chosen, they are applied that avoids disrupting other IPM methods.

Limit the amount of pesticides stored. The storage area should be properly labeled with signs that say "Pesticide Storage Area". A list of product being stored should be posted on the outside of the storage facility. A shelf life for pesticides longer than two years is unpredictable, so pesticides can be labeled with the date purchased. Containers should be kept off the ground to prevent the accumulation of water in or under the containers. Separation of pesticides by hazard and function is essential. Flammable product should be stored separately in a fire proof cabinet away from non-flammable materials, dry pesticides should be stored away from wet. Fungicides, herbicides and insecticides should be stored in separate locations of the storage area to prevent cross contamination and accidental misuse. Safety is the key element in pesticide storage. Accidents involving pesticide spills or leakages have serious health and environmental consequences. It is important the storage facility be locked and access limited only to those personnel who are properly trained in the use of pesticides.

Kaho'olawe Island Reserve Biosecurity Plan

“To protect seeds and cuttings from pests the area should be closed in with secure shade cloth walls (or stainless steel screen mesh). It helps to have the entire propagation area closed. Native plants do not respond well to harsh insecticides, use botanical insecticides as much as possible. The most damaging pests to cultivated native Hawaiian plants are the introduced insects, aphids, mealybugs, mites, scale, thrips (DLNR, 2013), whiteflies, nematodes and ants. The new growth is for sucking insects. They produce honeydew, which in turn is harvested by ants to feed their nest mates. Keeping a consistent and regular application regime is important part of keeping the pests under control” (Lilleeng-Rosenberger, 2005).

Kihei Nursery

The Kihei Nursery is a State of Hawai'i run facility and therefore needs to be managed according to State of Hawai'i and US Federal regulations and pesticide storage and ant bait and barrier protocols are required. The US EPA Workers Protection Standard and the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA) apply (Appendix J). Strict biosecurity will be implemented according to this Biosecurity Plan and the Kihei Nursery Facility Manager will keep it on site for all personnel working at the Kihei Nursery to read.

Construction began on the Kihei Nursery in 2016, and will need constant monitoring for any IAS that may become established during propagation of native plants. A separate document entitled "KIRC Kihei Nursery Management Plan", has been developed and discusses in detail how to safely administer and store pesticides, and prevent IAS from entering the KIR. Some of the Kihei Nursery protocol information is presented here. The Kihei Nursery (Figure 23) is currently being used for propagation of plants around the Kihei Boathouse property and for training staff, interns and volunteers until biosecure SOP's are in place.



Figure 23. Work Area and Tables at the Kihei Nursery in 2017

The Sunshine Mix #4 (right) attracts ants when opened and will be placed into garbage cans and sealed with a secure lid. Weed cloth will be laid down beneath the plant tables (Figure 24) and potted plants moved up and off the ground. Hoses should not be left lying on the ground.



Figure 24. Weed cloth beneath coarse gravel under Kihei Nursery tables

Management of pest ants in the Kihei Nursery will reference Vanderwoude (2008) when they are observed. Vanderwoude identifies three ways ants can enter a plant nursery system, 1.) Purchase of infested plants, 2.) Potting media or other items, ants traveling on cars and trucks driven by staff and personnel and 3.) Ants spreading from a neighboring property. To protect plant stock two products may be utilized. Sevin® is a soil drench and foliar spray. It provides short term control provided the foliage and medium is thoroughly treated. Talstar Pro® is used at 1 oz. per gallon of water and can be used pot drench or for barrier treatments. Standard procedure is to always wear PPE and also be sure other personnel are kept away from the sprayed plants until they are dry.

Ocean Based Biosecurity

Ocean Based Biosecurity will implement the three actions (**Prevention, Detection and Response**) to achieve the objective of keeping IAS from reaching the KIR. Individual boat operators are responsible for implementing the biosecurity protocols presented in this Biosecurity Plan.

Furthermore from section 7 of the KIRC form for Permitted Trolling in Zone B, it now states; *Prevention of Invasive Alien Species (IAS). The permittee will be held accountable to prevent any invasive alien species, plant or animal (i.e. invasive algae,*

*barnacles, etc.) into the Reserve in regard to the marine environment. **It is the responsibility of the vessel operator to ensure vessel hulls are free of any IAS.***

Vir Kron® for Hull Fouling and Anchors

The most common pathway for the introduction of non-native marine species is from hull biofouling (HIBP, 2016). Vir Kron® Aquatic (hydrogen peroxide) is highly effective against many strains of virus, bacteria, and fungi and also fish pathogens. It should be used in conjunction with hot water (>40°C) for hulls and anchors. Wear a face shield and chemical splash goggles to avoid contact to face when spraying the mixture. Applicator should wear a Tyvek style full body suit. Also, a dust mask should be worn when handling the powder form. It is available from Western Chemical (800) 283-5292. Figure 25 illustrates personnel from NOAA pressure washing the hull of their vessel (Kohola).



Figure 25. Pressure washing hull of NOAA vessel

Kaho'olawe Island Reserve Biosecurity Plan

Vessel biofouling is the attachment of organisms to wetted areas of a ship or boat, usually below the waterline; this can include the hull, propeller, bilge keel, keel coolers, thruster, inlet gratings, anodes, sea chests. The DLNR has a web site under Aquatic Invasive Species for additional information for ballast water and biofouling (<http://dlnr.hawaii.gov/ais/ballastwaterbiofouling/biofouling/>).

Dive Gear

All skin diving and scuba gear needs to be inspected and disinfected before using in Kaho'olawe waters. The process should be disseminated to personnel before coming to island as sometimes tabi's, fins and masks are needed to swim into the beach at Honokanai'a during large surf. Wipes with ammonium chloride (Clorox® or Lysol®) should be used to clean and remove any organic matter and all gear should be soaked in a 3-10% solution of Clorox® for a minimum 10 minutes. They should be rinsed with fresh water and hung to dry. Any scientific equipment used to study the ocean environment needs to be clear of any foreign organisms before using in the KIR including dive bags, spears, measuring tapes, and camera housings.

Personal Gear

Another weak link in biosecurity for all groups is personal gear for both the staff and volunteers. While the KIRC and PKO procedures to reduce the risk of IAS via the supply pathway are in place, more attention needs to be given to personal gear. Levels of inspection may include every item and bag, but this is sometimes impractical. Therefore, greater ownership has to be put onto the individual staff member and volunteer, to eliminate the IAS pathway on personal gear (boots, backpacks, clothing, fins and snorkel gear). This involves simple procedures everyone can follow, and reminding people as early as possible what is expected, so that biosecurity procedures become a normal part of the access of Kaho'olawe. A quarantine self-check sheet is available in Appendix C.

Early Morning Inspection Conditions

Managing and ensuring all equipment is clean in the early morning hours in the dark is problematic, but reinforcing the need to clean and inspect all gear is an important first step. New bright LED lights at the boathouse have been installed (with a spotlight pointed onto the deck of 'Ōhua) so that loading the vessel in the hours before sunrise can still detect an IAS. Personnel dropped off at the Kihei Boat Ramp early in the morning of an access should place their gear on asphalt or cement and not on the far side near bushes growing below the boat wash area.

Canoe club members coming from Maui must be sure to inspect their gear carefully so they are not bringing IAS with them as they pack up their tents, sleeping bags and campsites before they launch for Kaho'olawe.

Kaho'olawe Island Reserve Biosecurity Plan

Contractor Specific Biosecurity

Biosecurity is essential to ensure that pest incursions to Kaho'olawe are prevented. If and when they do occur, they must be managed appropriately and in a timely manner. While this Biosecurity Plan may not effectively manage and target all the aspects of a specific project, a Sub-Plan may address future non-standard operations specific to Independent Contractors. In the event that an island access will need a separate Sub-Plan to address the needs of a separate project, it can define the concerns related to that operation. Sub-Plans should be drafted before the contract is authorized and completed in conjunction with the contractor to ensure it is practical and achievable. The Sub-Plan can be generated to include how biosecurity affects the group and what they have to do to meet the standards set in place.

Capital Improvement Project (CIP)

A major refurbishment of the Base Camp including the installation of a solar power system is planned for 2017/2018 which will involve the transport of a large amount of equipment, supplies and additional personnel. Short of producing a separate biosecurity sub-plan for this CIP project, all personnel should be well briefed on the biosecurity protocols expected to be implemented during this CIP project on Kaho'olawe.

Ala Loa Construction

The Ala Loa is a coastal trail that will eventually circumnavigate the entire shoreline area of Kaho'olawe for cultural practices. Since 2003, several miles have been built from Honukanae to Lae o Paki and from Hakioawa to Kuhe'eia. Chainsaws, mechanical loppers and any other equipment brought in from Maui (or other islands) need to be inspected and completely cleaned of debris and sediment before bringing them to Kaho'olawe to work on the Ala Loa. If not addressed, seeds from IAS can remain imbedded in the equipment, and become established on Kaho'olawe from a different island. Biosecurity protocols apply to all other supplies that accompany cultural personnel and individuals and need to be thoroughly inspected.

IV IAS PRESENT ON KAHO'OLAWE

Kaho'olawe Botanical Surveys and Results

Several botanical surveys have occurred in the past on Kaho'olawe (US Navy 1979, DOFAW 1980, Gon and Chun 1992, Herbst et al., 1994, the Parsons-UXB Clearance Project from 1998 to 2004, and visiting botanists). In addition, four (4) botanical surveys were performed on Kaho'olawe in December, 2015 to update previous inventory and are listed in Appendix K. HPWRA scores will serve as baseline data for future IAS introductions, not only in these four primary points of entry (Base Camp, LZ Quail, LZ1, Hakioawa), but also potentially for all of Kaho'olawe.

Moodley et al., (2014) state the outcome of alien plant introductions is often considered invasive or non-invasive. Table 11 lists twenty three (23) site specific IAS present on Kaho'olawe with Hawai'i Pacific Weed Risk Assessment (HPWRA) Scores (HPWRA, 2016). Higher number is a higher risk.

Entry	Family	Taxa	Common Name	HPWRA Score	RISK Status
1	Verbenaceae	<i>Lantana camara</i>	Lantana (wild type)	32	High
2	Poaceae	¹ <i>Cenchrus setaceum</i>	Fountain grass	26	High
3	Poaceae	<i>Cynodon dactylon</i>	Bermuda grass	22	High
4	Asteraceae	<i>Verbesina encelioides</i>	Golden crown-beard	21	High
5	Poaceae	<i>Digitaria insularis</i>	Sour grass	20	High
6	Poaceae	<i>Chloris barbata</i>	Swollen fingergrass	20	High
7	Poaceae	<i>Cenchrus ciliaris</i>	Buffelgrass, Laredo buffelgrass	19	High
8	Fabaceae	<i>Prosopis sp.</i>	Mesquite (Kiawe)	19	High
9	Poaceae	<i>Panicum maximum</i>	Guinea grass	17	High
10	Fabaceae	<i>Neonotonia wightii</i>	Glycine, perennial soybean	16	High
11	Fabaceae	<i>Acacia mearnsii</i>	Black wattle	15	High
12	Fabaceae	<i>Leucaena leucocephala</i>	Leucaena (Koa Haole)	15	High
13	Solanaceae	<i>Nicotiana glauca</i>	Tree tobacco	15	High
14	Fabaceae	<i>Vachellia farnesiana</i>	Sweet acacia, Klu	14	High
15	Asteraceae	<i>Heterotheca grandiflora</i>	Telegraph weed	14	High
16	Poaceae	<i>Tragus berteronianus</i>	African bur grass, small carrot seed grass	13	High
17	Amaranthaceae	<i>Atriplex semibaccata</i>	Australian saltbush	13	High
18	Asparagaceae	<i>Agave americana</i>	American century plant	12	High
19	Fabaceae	<i>Acacia confusa</i>	Formosan koa	10	High
20	Bataceae	<i>Batis maritima</i>	Pickleweed, saltwort	9	High
21	Asteraceae	<i>Zinnia peruviana</i>	Field zinnia, wild zinnia	5	Evaluate
22	Proteaceae	<i>Grevillea robusta</i>	Silk oak	5	Evaluate
23	Myrtaceae	<i>Eucalyptus robusta</i>	Swamp mahogany	3	Low

Table 11 IAS present on Kaho'olawe

¹Syn. *Pennisetum setaceum* (Chemiquay et al., 2010)

IAS Observed on the Four Botanical Surveys

Using the HPWRA scoring order in Table 11, some of the IAS flora that were observed in the four botanical surveys are discussed: (32) Lantana (*L. camara*) only grows as a shrub less than 1m due to low precipitation levels and does not present the problem on Kaho'olawe it does on other wetter islands. (19) Buffel grass (*C. ciliaris*) was introduced in 1970's (KIRC, 1998) and is an African grass tolerant and adapted to fire and is also allelopathic. (19) Kiawe (*P. pallida*) introduced in 1918 (KICC, 1993) is nearly ubiquitous on the island and responds to cutting (chainsaw) the stump down to ground level and treating with Garlon. It is a phreatophyte (a deep-rooted plant that obtains a significant portion of the water that it needs from the phreatic zone of saturation) and competes for water resources with other surrounding vegetation. (16) Glycine (*N. wightii*) is present in the wetter areas of Pu'u Moa'ulanui and becomes dense after heavy rains. It has been a trip hazard for fire crew operations around LZ-1. (15) Koa Haole (*L. leucocephala*) is dense in some locations but is restricted to certain areas on Kaho'olawe. There is a consistent seed source that keeps it established. Treatment with Garlon after cutting is not as effective as manually pulling the plant out of the ground. (14) Klu or sweet acacia (*Vachellia farnesiana*) is spreading in range and poses a threat with large sharp thorns and should be monitored for control (13) Australian Salt Bush (*A. semibaccata*) was introduced in the 1918 (KICC, 1993) and serves as an erosion control mat in the hardpan areas of Kaho'olawe. (3) Eucalyptus (*Eucalyptus sp.*) trees also introduced in 1918 (KICC, 1993) occur below the northern face of Pu'u Moa'ulaiki on Kaho'olawe and formed an extensive grove of trees but has recently gone through a die back.

Other notable IAS not found on the four botanical surveys, but which occur on Kaho'olawe are discussed here: Fireweed (*Senecio madagascariensis*) has become established on Kaho'olawe, as has the biocontrol moth (*Secusio extensa*) for it. Observed in 1980, (10) Formosan koa (*A. confusa*) grows near the 1 acre rain catchment and has been periodically cut and treated but keeps persisting. Observed in 1992, Russian thistle (*Salsola tragus*) occurs along portions of the K1 road corridor and has been treated with Garlon in the past. Iron wood (*Casuarina equisetifolia*) grows in the windbreaks established in the 1970's and 1980's in the upper elevations of the island. Some of the population has been girdled and treated with Garlon. Observed in 1980 and 1992 surveys, Sisal (*Agave sisalana*) and Mauritius hemp (*Furcurea foetida*) occur in a few locations on Kaho'olawe and should be treated. Finally, (15) Black Wattle (*A. mearnsii*), (5) Silk Oak (*G. robusta*) and Banyan (*Ficus microcarpa*), have all been observed on Kaho'olawe and should be treated when found. Flora previously recorded on Kaho'olawe is in Appendix L.

Since the removal of goats (*C. hirca*) in 1993, significant amount vegetation has come back naturally in the summit area of Pu'u Moa'ulanui (Personal Communication, Paul Higashino, Natural Resources Specialist V, KIRC). While some of these plants are native species, some of the taxa are IAS, such as glycine (*N. wightii*) and koa haole (*L. leucocephala*). Management of koa haole is ongoing but will take generations to manage and completely eradicate. On the barren landscape, the koa haole is

preventing erosion, fixing nitrogen and should be replaced with a native plant if it is removed from an area.

Initially observed at Lua 'O Kealialalo in 1996, it is possible fountain grass came into the area as early as 1992. Identified as a priority threat, only a small population was known until surveys were initiated by the HISC grant. Approximately five hundred fountain grass (*C. setaceum*) plants have been treated in 209 acres in Lua 'O Kealialalo from October, 2015 through December 2016, including 207 mature plants (Figure 26).

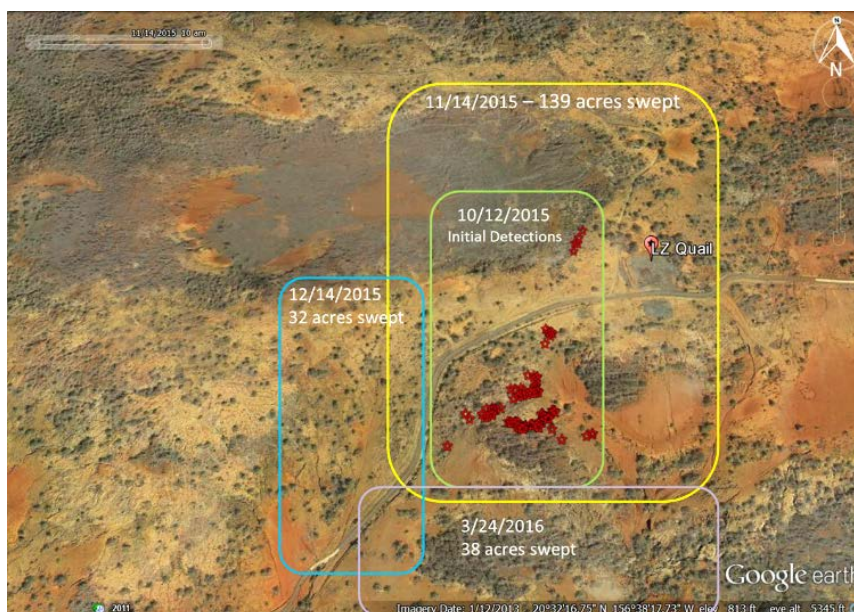


Figure 26. Location of recent Fountain grass control at Lua 'O Kealialalo

Fountain grass surveys should be performed quarterly to keep this priority IAS in check. There are other IAS of concern from Table 11 e.g. Koa haole. While occurring in specific locations on the island, IAS plant species have the potential to spread and increase its range on Kaho'olawe. Inadvertently transporting seeds by vehicle is a potential vector which must be avoided. There is also risk of spreading IAS from Kaho'olawe to other islands. Volunteers should be aware of this as they return to their home islands.

Island-wide Eradication of Invasive Mammals

For the proposed eradication of rodents and feral cats on Kaho'olawe it is vital that the required standard of biosecurity (i.e. preventing any rodent invasions) is put in place well in advance of the eradication effort so that the systems and processes can be vetted, reviewed and audited. The investment in a rodent eradication is significant and one of the requirements for an eradication (Cromarty et al., 2002) is that reinvasion can be managed to near zero. As Kaho'olawe is outside the swimming range for rodents, any reintroduction will be human assisted hence the need for a comprehensive biosecurity system to protect the eradication investment and to prevent the establishment of additional rodent species.

Kaho'olawe Island Reserve Biosecurity Plan

Eradication is not practical or even possible for many IAS currently on Kaho'olawe but where it is feasible and affordable, it is proposed to eradicate (or at least manage) some of them present including both plants and animals.

Detection on Kaho'olawe

Regular annual checks of the main access sites, Hakioawa and Honokanai'a by field biologists, should be undertaken and continued to detect any new species before they have the opportunity to spread. Removal of any new species should be made a priority.

When rodents do settle into a new habitat, they often do so near human habitation for food and shelter. The bait stations (or preferably traps so that detection can be recorded which is often not possible with toxic bait) should be set and maintained around the buildings and 2 landing sites. The bait stations should be numbered and the details of the locations, service schedule and job position responsible for them being recorded listed in an updated Biosecurity Plan. The type of trap used is important if the quantity, species, sex and breeding status of the rodent is desired. Procured traps should be set in a way where non target animals like birds won't get caught; The Goodnature A24 self-resetting trap may fulfill this requirement. The pre-trip Prevention measures have priority over Detection on Kaho'olawe methods as the purpose of this Biosecurity Plan is to Prevent IAS from getting to Kaho'olawe rather than trying to detect and eradicate them once they are present.

Native Fauna on Kaho'olawe

Appendix M lists the native fauna on Kaho'olawe.

Non-native Fauna on Kaho'olawe

Appendix N lists the non-native fauna (and IAS status) observed on Kaho'olawe (KIRC 1998, KIRC 2015).

List of Arthropods on Kaho'olawe

Appendix O lists the arthropods observed on Kaho'olawe.

V. PROPOSED FUTURE ACTIONS

Additional Recommendations to the Kihei Boathouse and Nursery are listed here (McClelland, 2017). This first action has been completed.

Kihei Boathouse Actions

1. The inside of the boathouse has recently been organized by getting everything up off the floor. Shelves are six (6) inches above the floor to reduce refugia for rodents, geckos and invertebrates (Figure 27).



Figure 27 Kihei Boathouse shelves

2. Designate a Biosecurity Officer well versed with this document and with experience in IAS Prevention, Early Detection and Rapid Response (including Quarantine and Extermination) protocols.
3. Remove (or at least organize) the clutter outside the boathouse and along fences as it provides major refugia for rodents.
4. Consider painting the floor of the boathouse white or light grey to facilitate locating invasive animals like a line of ants. Mammals are less likely to go onto a bright surface where they can be seen.

Kaho'olawe Island Reserve Biosecurity Plan

The following Future Actions will need to be maintained over time.

5. With a service schedule, periodically review the number and location of bait stations. Each station should be individually numbered so they can be located by anyone with a map.
6. If suitable bait and traps can be used, one that isn't eaten by ants, consider using bird safe rodent traps as well as bait stations inside and outside the buildings with details of all captures recorded. This will allow a risk profile of species locations, and times of year. The Goodnature A24 self-resetting trap may fulfill this requirement.
7. Remove invasive plants and trees from the Kihei boathouse and Nursery, storage areas and access roads which may drop seeds into vessels. This priority for the detection of unwanted seeds is more difficult with seeds from other plant species even if already on Kaho'olawe.

Cargo Management

1. Mark an area (painted square) away from the walls in which all bins are to be loaded. This is to keep the bins as far from the walls as possible to keep IAS from moving across open ground.
2. Ensure the lids are placed on the bins whenever they are not attended.
3. Only fill the bins as close to the island access date as possible (such as the day before) and make sure to inspect every container (boxes and bags) thoroughly before loading into the bins.
4. Minimize the time between equipment and supplies arriving at the boathouse and transport to island, to reduce the opportunity for IAS to enter bins or cardboard boxes.
5. Place glue traps in each bin if they are to be left overnight in the boathouse and when they are closed for loading. The glue board can be checked prior to loading or unloading to see if ants are present.
6. Consider loading the bins onto 'Ōhua as soon as they are filled as this will present a lower risk of allowing IAS into the bin on the boat than in the Boathouse. Visually inspect 'Ōhua before the trip for IAS that may have gotten on board.
7. Consider using a secondary person to assist with the biosecurity protocols in the morning when loading the 'Ōhua. Also, this person can inspect the boathouse for IAS to quantify the risk associated with different pathways utilizing available resources.
8. Establishing a Biosecurity Area within the perimeter Boathouse fence will allow maintenance of a designated pest free zone. Everything coming into the Biosecurity area (Boathouse perimeter fence) should be inspected for IAS at the Biosecurity checkpoint (cement pad).

Kaho'olawe Island Reserve Biosecurity Plan

Use of Vessels

1. All vessels should be thoroughly visually inspected prior to loading, including checking of glue boards, bait stations and traps. This would be coordinated by the Captain of 'Ōhūa and the lead personnel for the other vessels. If seeds or IAS are found, the vessel should be washed down and re-checked. The occurrence of an IAS on board needs to be documented.
2. If available put glue boards, bait stations and traps on board at least the night before departure to detect the presence of IAS especially ants and rodents. These then need to be checked by the Captain of the vessel prior to loading and departure.
3. For 'Ōhūa, the Captain (and crew) will be responsible for biosecurity for consistency.

It is important that a specific position (e.g. Captain, crew) be made responsible and accountable for undertaking the required actions. Otherwise it is easy to assume that someone else is performing the protocols. This role needs to be clearly defined during the planning stages of the access so that everyone knows who it is. For other vessels, the Captain will be responsible.

It is also important to develop a collective responsibility and empower everyone that is looking for any biological risks and ways to eliminate and minimize them. This will be everyone's duty as the Biosecurity Officer will not be present for all stages of loading and unloading or even every access. Everyone involved needs to be monitoring for, identifying and reducing risks and feel empowered to raise any biosecurity issues they observe knowing they will be properly considered.

Follow Up CAPS

Follow up CAPS for ants need to be scheduled on Kaho'olawe and the Kihei Boathouse property to continue to monitor and compare the 2016 baseline species present in both areas with any new ant introductions. New surveys should be performed quarterly and any new ant taxa should be reported immediately.

Field Guides

To assist with the first objective of Prevention, field identification guide books will be developed for IAS flora and fauna and this Biosecurity Plan will be updated once the guide is complete. This will aid all logistical personnel responsible for early detection of IAS on board vessels.

Kanapou Bay Marine Debris Clean-up

Since 2003 the KIRC has removed 55 tons of marine debris from Kanapou Bay (Personal Communication, D. Tokishi). The personnel who assist will camp for several days and bring in gear for the trip. It is essential all equipment be inspected for IAS

Kaho'olawe Island Reserve Biosecurity Plan

before it is brought to the shores of Kanapou. Contractors must also take precaution with any equipment they bring in to use for the clean-up activities. Invasive foreign organisms may easily end up in Hawaiian waters just by riding along on marine debris that comes from all over the Pacific basin. An example of an invasive organism from the 2011 Japan tsunami debris is the Indo-Pacific green mussel (*Perna viridis*) that was observed in waters off of O'ahu.

Helicopter Operations

While in a generally good condition for a busy work area, the helicopter hangar needs improved biosecurity measures by decreasing the amount of gear on the floor to remove hiding places for IAS. Rodent stations and traps (if present) need to be verified. Cargo nets need to be inspected and kept free of contaminants such as seeds or invertebrates. Lifting a load of equipment directly from the back of a truck into a cargo net is preferable to lifting the material from the ground where it can pick up invertebrates or vegetative material including seeds. If the helicopter is to land on Kaho'olawe, the skids should be checked for plant material and the inside of the helicopter checked and cleaned.

VI. KNOWN GAPS/ DEFICIENCIES

Table 12 lists known gaps and biosecurity deficiencies in the departments of the State of Hawai'i.

	State Department	Gaps
1	Hawai'i Department of Agriculture (HDOA)	Lack of data management technology and inspection facilities, not fully equipped biocontrol lab and insufficient staff.
2	Department of Land and Natural Resources (DLNR)	Lack of authority to regulate invasive organisms attached to ship hulls and lack of capacity to detect and control invasive algae, weeds, and predators in our waters and forests.
3	Department of Health (DOH)	Operating at 60% of the capacity needed to fight disease such as dengue, Zika, and chikungunya.
4	University of Hawai'i (UH)	Lack of stable funding for agricultural and IAS programs.

Table 12 Known Gaps in the State of Hawai'i

On occasion, an IAS may utilize a vector which can bring it into the KIR. One main point of departure is the Kihei Boathouse, and the following section describes occurrences that have been detected so far.

Faunal IAS Observed at Kihei Boathouse

Table 13 list the faunal IAS that has been observed at the Kihei Boathouse property.

Kihei Boathouse	Common Name	Present on Kaho'olawe	
		Yes	No
<i>Achatina fulica</i>	Giant African Snail		X
<i>Felis catus</i>	Feral Cat	X	
<i>Gallus gallus domesticus</i>	Red Junglefowl		X
<i>Herpestes auropunctatus</i>	Mongoose		X
<i>Mus musculus</i>	House Mouse	X	
<i>Rattus norvegicus</i>	Norway rat		X
<i>Rattus rattus</i>	Roof rat		X

Table 13 Faunal IAS observed at the Kihei Boathouse Property

The giant African snail is considered one of the top 100 IAS in the world (Global Invasive Species, 2000). It can also carry the pathogens responsible for human meningitis. Feral cats on Kaho'olawe, possibly introduced during the Ranching Period, have tested positive for the parasitic amoeba, *Toxoplasma gondii*. Over 30 Red Junglefowl were removed from the Kihei Boathouse property in January, 2016 but continue to persist. Of the 8 main Hawaiian Islands only Kaho'olawe does not have Mongoose. The House mouse undergoes periodic population blooms on Kaho'olawe and has been documented to transmit Typhus (fleas) and leptospirosis. Also, while the presence of the Polynesian rat has been detected on Kaho'olawe, neither the roof rat nor the Norway rat have been observed to date. See Appendix P for Hawai'i Administrative Rules listing the regulations and statutes regarding management of pests in the State of Hawai'i.

Examples of IAS on Board the 'Ōhua

In December 2009, a Norway rat (*R. norvegicus*) was observed on board the 'Ōhua vessel at the Kihei Boathouse and was exterminated on board. The Norway rat (Figure 28) has been known to swim 800m interisland (Broome, 2007).



Figure 28 Norway rat (*R. norvegicus*)

In March 2015, Carpenter ants (*Camponotus variegatus*) in a large cardboard box holding a Rubbermaid container were placed on board 'Ōhua and delivered to Kaho'olawe. The large cardboard box had been sitting on the ground outside of the Kihei Boathouse for many months before transport to Kaho'olawe. In February 2016, a gold dust day gecko (*Phelsuma sp.*) was observed on board the 'Ōhua from ceremonial offerings in transit to Kaho'olawe, and was captured on board and then released at the Kihei Boathouse.

Table 14 lists the date of occurrence of inadvertent introduction and action taken.

Kaho'olawe Island Reserve Biosecurity Plan

	Date	Description	Action Taken
1	December 2, 2009	Norway Rat (<i>R. norvegicus</i>) on board 'Ōhua at Kihei Boathouse	Exterminated on board
2	March, 2015	Carpenter Ants (<i>C. variegatus</i>) in large cardboard box delivered to Kaho'olawe	None
3	February 16, 2016	Gold Dust Day Gecko (<i>Phelsuma</i> sp.) on 'Ōhua in transit to Kaho'olawe	Captured on board and released at Kihei Boathouse
4	November 7, 2017	Rosy Wolf Snail on Aki aki (<i>S. virginicus</i>) grass on board 'Ōhua	Rosy Wolf Snail collected on vessel and on Kaho'olawe at Honukanaeae while planting.

Table 14 Date of occurrence and action taken of IAS observed on 'Ōhua vessel

Personal property will not be stored at the Kihei Boathouse and abandoned vehicles should be removed from the premises. It was determined the rat probably accessed the boat from the front ramp which was in a lowered position. Protocols for leaving the ramp up were changed after this occurrence. Also, reduced clutter, use of metal trash bins, control of water supplies and properly discarded food will help eliminate resources for rodents. It should be realized exclusion of IAS from property and storage units is never permanent and must be maintained on a continual basis (Hoddenbach, 2005). The 'Ōhua should not have anything hanging off the side of the vessel such as lines or webbing. Ladders should not be stored leaning against the vessel in which rats or mongoose could crawl up and into the holds. Rats have been known to be able to jump 4 feet high.

It is imperative IAS detected at the Kihei Boathouse be quarantined, eradicated and kept out of the KIR. Also, IAS found at other locations that vessels originate from and bring personnel and materials to Kaho'olawe, should be inspected periodically for IAS and documented with a date and photographs if possible.

VII. CONCLUSIONS

This Biosecurity Plan is intended to identify necessary protocols, vectors, and quarantine procedures in the Kaho'olawe Island Reserve. The one objective of the Biosecurity Plan is to keep any new IAS from entering the KIR. Using an ED/RR approach, the three actions to achieve this objective are **Prevention, Detection, and Response**. Also, using the Pre-Border, Border and Post Border approach, IAS should be kept out of the KIR.

Prevention is key and linked to education and engagement of personnel, it will be crucial for a successful implementation of this Biosecurity Plan. Education and engagement will not only include personnel to achieve the objective of this Biosecurity Plan, but it will also establish a new mind set for those coming to Kaho'olawe. The main message is that IAS are detrimental to native ecosystems and Prevention is the most cost effective and efficient approach to control them. Early Detection will be important for new IAS, and a program for Rapid Response for Quarantine and Eradication. This will eliminate any impact the IAS would otherwise have on Kaho'olawe.

On February 24 2016, Rep. Tulsi Gabbard from Hawai'i (2nd District), in recognition of National Invasive Species week (February 22-26, 2016) presented the following arguments on the floor of the House of Representatives of the US Congress.

"Invasive species cost our local economy millions and threaten our unique ecosystems and water ways. Supporting Bill HR3893 - Area Wide Integrated Pest Management Act, would be a call for action that would bring local stake holders together with researchers and other key players, in order to find sustainable, cost effective and comprehensive solutions that will better help all to manage and prevent the spread of harmful pests and invasive species."

With due diligence, any IAS observations on Maui and Kaho'olawe, should quickly lead to the chain of action of Early Detection/Rapid Response and thorough mitigation. Involving all personnel that come to Kaho'olawe is vital to the execution of the Biosecurity concepts presented in this Biosecurity Plan. With the simple common objective of not allowing any new IAS from entering the Kaho'olawe Island Reserve, generations to come will be able to enjoy the island free of pest species that can potentially disrupt human activity, as well as the ecological balance maintained on Kaho'olawe today.

While biosecurity can always be improved, the existing processes are to a high standard (McClelland Environmental Services, 2017). Documentation is important to maximize consistency among staff. All biosecurity procedures must be readily accessible to show they are in place, allowing them to be audited, reviewed and revised as necessary.

In May 2017, a two year \$2.16 million budget was approved by the Hawai'i state legislature for 15 positions for the KIRC for FY18 and FY19. Due to the minimal number

Kaho'olawe Island Reserve Biosecurity Plan

of staff positions funded, the responsibility of each member of the KIRC is accentuated. Engagement, compliance and cooperation from each employee will be critical to carrying out the details of the Biosecurity Plan.

LITERATURE CITED

Abbott, Isabella, 2001. A Guidebook to Introduced Marine Species in Hawaii. Edited by L.G. Eldredge and C.M. Smith. Bishop Museum Technical Report 21.

Baker, T.C., S. E. Van Vorhis Key and L. K. Gaston, 1985. Bait-preference Tests for the Argentine Ant (Hymenoptera: Formicidae)

Broome, Keith, 2007. Island Biosecurity as a Pest Management Tactic in New Zealand. Managing Vertebrate Species: Proceedings of an International Symposium. USDA/APHIS/WS National Wildlife Research Center, Ft. Collins CO.

California Islands Biosecurity Program, 2013. Prepared by the California Islands Biosecurity Program Subcommittee, June 2013.

Chemiquay Amelia, M., Liliana M. Giussani, Maria A. Scataglini, Elizabeth A. Kellogg and Osvaldo, Morrone, 2010. Phylogenetic studies favor the unification of *Pennisetum*, *Cenchrus* and *Odontelytrum* (Poaceae): a combined nuclear, plastid and morphological analysis, and nomenclatural combination in *Cenchrus*. *Annals of Botany* 106:107-130, 2010.doi:10.1093/aob/mcq090.

CISR, 2016. Center for Invasive Species Research, University of California, Riverside, CA. http://cizr.ucr.edu/invasive_species_faqs.html

Conant, Patrick, Ronald A. Heu, Larry Nakahara, Bernarr Kumashiro and Meil Reimer, 2007. Little Fire Ant *Wasmannia auropunctata* (Roger) (Hymenoptera: Formicidae). New Pest Advisory No. 99-02. First Issued October 1999, Updated February 15, 2007. State of Hawaii, Department of Agriculture.

Corn, C.A., W. Char, G. Clarke and L. Cuddihy, 1980. Kaho'olawe Botanical Survey. Division of Forestry, Department of Land and Natural Resources.

Cowie Robert H., Kenneth A. Hayes, Chuong T. Tran and Wallace M. Meyer III, 2008. The horticultural industry as a vector of alien snails and slugs: widespread invasions in Hawaii. *International Journal of Pest Management* Vol. 54, No. 4, October–December 2008, 267–276.

Cromarty, P.L., Broome, K.G., Cox, A., Empson, R.A., Hutchinson, W.M., McFadden, I., 2002. Eradication planning for invasive alien animal species on islands—the approach developed by the New Zealand Department of Conservation. In: Veitch, C. R., Clout, M.N. (Eds.), *Turning the Tide: The Eradication of Invasive Species*, Proceeding of the International Conference of Eradication of Island Invasives. International Union for the Conservation of Nature, Gland, Switzerland, pp. 85–91.

Dames and Moore, 1997. Ola I Ke Kai o Kanaloa - Kaho'olawe Ocean Management Plan. Prepared for Kaho'olawe Island Reserve Commission in Association with Akala

Kaho'olawe Island Reserve Biosecurity Plan

Products Inc., Cultural Surveys Hawaii, Environmental Assessment Company, Mr. Robert Lu'uwai, Morgan and Associates and Native Hawaii Legal Corporation.

DLNR, 2017. Web site for Aquatic invasive Species. <http://dlnr.hawaii.gov/ais/ballastwaterbiofouling/biofouling/>

DLNR, 2013. Department of Land and Natural Resources, Early Detection and Rapid Response Plan for Myoporum Thrips (*Klambothrips myopori*) on Maui. Division of Forestry and Wildlife, Maui Invasive Species Council, Hawaii Department of Agriculture, Plant Pest Control. 19pp.

Global Invasive Species data base, 2000. Invasive Species Specialist Group, Species Survival Commission and International Union for Conservation of Nature. <http://www.iucngisd.org/gisd/>

Gon, Samuel M. III and G. Chun 1992. Biological database and Reconnaissance Survey of Kaho'olawe Island Including Rare Plant, Animals and Natural Communities. The Nature Conservancy of Hawai'i. Hawai'i Heritage Program. Prepared for the Kaho'olawe Island Conveyance Commission, Consultant Report No. 6 138pp.

Gulko, David, 1998. Hawaiian Coral Reef Ecology. Mutual Publishing, Honolulu Hawaii. 218pp, with Appendices.

Hathaway, Stacie A. and Robert N. Fisher, 2010. The Nature Conservancy Palmyra Program, Biosecurity Plan for Palmyra Atoll. Open File Report 2010-1097. US Department of the Interior, US Geological Survey. 81 pp.

HEAR, 2016. Hawaii Ecosystems at Risk (<http://www.hear.org/weedlists/usa/HI.htm>)

HIBP, 2016. Hawaii Interagency Biosecurity Plan 2017-2027, and Executive Summary. Department of Land and Natural Resources, State of Hawaii. 80pp plus appendices.

HISC, 2004. Hawai'i Invasive Species Council. Gaps in Hawai'i's Biosecurity System: Protecting Hawai'i from Invasive Species. Christy Martin, Public Information Officer. CGAPS Coordinating Group on Alien Pest Species.

HISC, 2015. Hawai'i Invasive Species Council Strategic Plan 2015 – 2020. 32pps

HISC, 2016. Hawaii Invasive Species Council FY 16 Summary Report of Hawaii Invasive Species Council Projects Supporting the Regional Biosecurity Plan for Micronesia and Hawaii. State of Hawaii Department of Land and Natural Resources.

Ikuma, Edmond K., Dean Sugano and Jean Kadooka Mardfin, 2002. Filling the gaps in the fight against invasive species. Honolulu, HI: Legislative Reference Bureau, January 2002.

Kaho'olawe Island Reserve Biosecurity Plan

Hoddenbach, Gerard, Jerry Johnson and Carol DiSalvo, 2005. National Park Service Rodent-Exclusion Manual, Mechanical Rodent-Proofing Techniques: A Training Guide for National Park Service Employees. Public Health Program, National Park Service. Available online at https://www.nps.gov/public_health/info/eh/vector/NPS_RP_Manual_v2.pdf

KICC, 1992a. Kaho'olawe Island Conveyance Commission. Biological Database and Reconnaissance Survey of Kaho'olawe Island including Rare Plants, Animals and Natural Communities. Gon, Samuel and Gail Chun, Joel Lau, Joan Yoshioka, Theresa Cabrera, Dwight Matsuwaki, Lucinana Honigman and Dan Zevin. By The Nature Conservancy of Hawai'i. Consultant Report No. 9. August, 1992.

KICC, 1992b. Kaho'olawe Island Conveyance Commission. Kaho'olawe Forest Reserve Period: 1910-1918. Hardy Spoehr. Consultant Report No. 19. 1992.

KICC, 1993. Kaho'olawe Island Conveyance Commission. Kaho'olawe Island: Restoring a Cultural Treasure. Final Report of the Kaho'olawe Island Conveyance Commission to the Congress of the United States. March 31, 1993.

KIRC, 1995. Kaho'olawe Island Reserve Commission, Kaho'olawe Use Plan. Prepared for the Kaho'olawe Island Reserve Commission, State of Hawaii by PBR Hawaii.

KIRC, 1998, Kaho'olawe Island Reserve Commission, Kaho'olawe Environmental Restoration Plan, Social Science Research Institute, University of Hawaii at Manoa 116pp.

KIRC, 2003. Kaho'olawe Island Reserve Commission, Health and Safety Plan. 811 Kolu St., Suite 201, Wailuku, HI 96793.

KIRC, 2015. Kaho'olawe Island Reserve Commission, Kaho'olawe Island Seabird Restoration Project. A Business Plan for Restoration of Hawaiian Bird Life and Native Ecosystems on Kaho'olawe. 119pp.

Koch, Katrin, Dave Algar and Klaus Schwenk, 2016. Feral Cat Globetrotters; genetic traces of historical human mediated dispersal. Ecology and Evolution, June 30 2016. DOI 10.1002/ece3.2261.

Krushelnycky, P. D., L. L. Loope & N. J. Reimer. 2005. The Ecology, Policy, and Management of Ants in Hawaii. Proceedings Hawaiian Entomology Society, 37:1-25.

Lilleeng-Rosenberger, Keri E., 2005. Growing Hawai'i's Native Plants. A simple step by step approach for every species. Melany H. Chapin, Consulting Editor, Mutual Publishing LLC, 416pp.

Magruder, W.H. and J.W. Hunt, 1979. Seaweeds of Hawaii. Oriental Publishing Company. Honolulu, Hawaii. 116p.

Kaho'olawe Island Reserve Biosecurity Plan

McClelland Environmental Services, 2017. Kaho'olawe Biosecurity Procedures Review, Prepared for Island Conservation and the Kaho'olawe Island Reserve Commission, 15 pp. Pete McClelland.

MDAR, 2010. Massachusetts Department of Agriculture Resources, Greenhouse BMP's; A handbook for the Greenhouse Industry in Massachusetts, UMASS Extension.

Moodley Desika, Sjirk Geerts, Tony Rebelo, David M. Richardson and John R.U. Wilson, 2014. Site Specific Conditions Influence Plant Naturalization: The case of alien Proteaceae in South Africa. *Acto Oecologica* 59 (2014) 62e71.

Noss, R.F. and R.L. Peters, 1995. *Endangered Ecosystems: A Status Report on Americas Vanishing Habitat and Wildlife*. Published by Defenders of Wildlife Washington D.C.

Parkes, John, 2009. Feasibility study on the management of invasive mammals on Kaho'olawe Island, Hawai'i. Invasive Species International. Landcare Research, New Zealand. Contract Report # LC0910/025

Pysek Petr, Vojtech Jarosik, Philip E. Hulme, Jan Pergle, Martin Hejden, Urs Schaffner and Montserat Vila, 2012. A global assessment of invasive plant impacts on resident species, communities and ecosystems: the interaction of impact measures, invading species' traits and environment. *Global Change Biology*. Vol 18, Issue 5 Pps 1725-1737.

Pimentel David, Lori Lach, Rodolfo Zuniga, and Doug Morrison, 1999. *Environmental And Economic Costs Associated With Non-Indigenous Species in the United States*. Cornell University, College of Agriculture and Life Sciences.

Stanley, Margaret C. and Wayne A. Robinson, 2007. Relative Attractiveness of Baits to *Paratrechina longicornis* (Hymenoptera: Formicidae) *J. Econ. Entomol.* 100(2): 509-516 (2007).

State of Hawaii, 2003. *Aquatic Invasive Species (AIS) Management Plan, Final Version*. Department of Land and Natural Resources, Division of Aquatic Resources. Prepared through Andrea D. Shluker, The Nature Conservancy of Hawai'i.

Stone, C. P., C. W. Smith, and J. T. Tunison (editors). 1992. *Alien plant invasions in native ecosystems of Hawaii: Management and Research*.

USDOA, 2010. United States Department of Agriculture, Final Environmental Assessment Predator Damage Management to Protect Avian Wildlife in Hawaii. Animal and Plant Health Inspection Service. In cooperation with Hawaii Dept of Land and Natural Resources, Hawaii Army National Guard. In coordination with US DOI Fish and Wildlife Service.

Kaho'olawe Island Reserve Biosecurity Plan

US Navy, 1979. Environmental Impact Statement Military Use of Kahoolawe Training Area, Hawaiian Archipelago. Prepared by: Environmental Impact Study Corp. Honolulu Hawaii September 1979, Department of the US Navy.

US NAVY, 2015. Regional Biosecurity Plan for Micronesia and Hawaii. Eds. University of Guam and the Secretariat of the Pacific Community. United States Department of the Navy.

Vanderwoude, C., 2008. Management of Pest Ants in Nurseries. Hawai'i Ant Lab Pacific Cooperative Studies Unit, University of Hawai'i. Funded by USDA Animal and Plant Health Inspection Service Section 10201, 2008 Farm Bill.

Vitousek, P.M., C.M. D'Antonio, L.L. Loope, M. Rejmanek, R. Westbrooks, 1997. Introduced Species: A Significant Component of Human Caused Global Change. New Zealand Journal of Ecology. 21:1-16.

Vitousek, P. M. 1988. Diversity and biological invasions of oceanic islands. In: Wilson, E. O. and Peter, F. M. (editors). Biodiversity, pp. 181- 189. Washington, D.C., National Academy Press.

Warren, Steven D., Stefanie Aschman and Darrel R. Herbst, 1994. The Plants of Kaho'olawe. US Army Corps of Engineers Construction Engineering Research Laboratories. Special Report EN-64/05. 35pp.

Internet Resources

Coordinating Groups on Alien Pests Species (CGAPS)

<https://www.invasivespeciesinfo.gov/docs/council/HISC%20Presentation.pdf>

US EPA Worker Protection Standard for Nurseries

<http://www.epa.gov/pesticide-worker-safety/agricultural-worker-protection-standard-wps>

Fountain Grass - (*Cenchrus setaceum*)

<http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2889798/pdf/mcq090.pdf>

<http://www.invasivespeciesinfo.gov/laws/hi.shtml>

Ants in Hawaii

<http://www.antweb.org/taxonomicPage.do?rank=species&project=hawaiians>

<http://idtools.org/id/ants/pia/>

Hawaii Ant Lab <http://www.littlefireants.com/>

DOI: <http://dx.doi.org/10.1093/jee/78.5.1083> 1083-1088 October, 1985.

http://entnemdept.ufl.edu/creatures/urban/ants/little_fire_ant.htm

Kaho'olawe Island Reserve Biosecurity Plan

Alien Aquatic Organisms

http://www.capitol.hawaii.gov/hrscurrent/Vol03_Ch0121-200D/HRS0187A/HRS_0187A-0006_0005.htm).

Resource Kit for Cat and Rat Eradication - Biosecurity

<http://rce.pacificinvasivesinitiative.org/intro/Biosecurity.html>

Hawaii Pacific Weed Risk Assessment - Regulatory Compliance

(HPWRP, 2016) <https://sites.google.com/site/weedriskassessment/home>
<http://www.agriculture.senate.gov/imo/media/doc/FIFRA.pdf>

APPENDIX A - Goats, Sheep and Cattle on Kaho'olawe

Year	Goats	Sheep	Cattle	Source	Goats Killed
1793	2			2	
1859		2,075		1	
1875	200	20,000		1	
1876		16,000		1	
1881	2,000	1,000		1	
1884	9,000	2,000	200	1	
1888		1,000	800	1	
1890	9,000	12,000	900	1,2,3	
1903		7,000		1	
1904		5,000	60	1	
1906	10,000	3,200		1	
1909	5,000	3,200	40	1	1,144
1910	1,500	1,500		1	550
1912	250	200		1	200
1913		300		1	
1915	300	75		1	
1916		150		1	
1917	900	10		1	
1918	13,000			3	13,000
1920			500	2	
1932	15	20	300	1	
1939	25	200	500	1	
1941	25		460	1	
1944	100	2,000		1	
1953	1,000	1,000		1	
1969	2,000	132		1	
1970	5,000			1	
1971	5,000	400		1	
1990	3			1	

Appendix A. Number of Goats, Sheep and Cattle on Kaho'olawe.
 Source ¹KICC, 1992b ²KICC, 1993 ³KIRC, 1998.

APPENDIX B - KIR Biosecurity Signs

KAHO'OLAWE ISLAND RESERVE BIOSECURITY AREA

PREVENTION ►► DETECTION ►► QUARANTINE ►► ERADICATION ►► EDUCATION

COQUI FROGS **LITTLE FIRE ANTS** **MONGOOSE** **NON-NATIVE PLANTS** **RATS & FIELD MICE** **OTHER REPTILES**

The Hawaiian archipelago accounts for only 0.2% of the U.S. land area but is home to nearly 75% of recorded extinctions, with invasive alien species (IAS) as the leading cause.

The KIRC prioritizes an IAS-free Kaho'olawe Island Reserve for the benefit of recovering Native Hawaiian species and revitalizing Native Hawaiian cultural practices. It is the kuleana of every person visiting or working on this property to protect the Reserve from the entry and spread of pests and diseases.

Please notify a member of the KIRC staff immediately if you identify any of the IAS shown on this notice within the vicinity.

KHAKI WEED (*Alternanthera pungens*), also known as "pokey weed" seeds or burrs are dispersed largely by footwear, clothing, tires and animals. Please help us keep Kaho'olawe khaki-free: stay alert!

KAHO'OLAWE ISLAND RESERVE COMMISSION

WWW.KAHOOLAWE.HAWAII.GOV
811 KOLU STREET SUITE 201
WAILUKU, HI 96793
808.243.5020




/KircMaui @KircKahoolawe

APPENDIX B (Continued)
KIR Biosecurity Signs

KIR BIOSECURITY – E MAKA`ALA KĀKOU

Before Going to Kaho`olawe:




- Have you checked your gear for Invasive Alien Species? Animals, Insects, Weeds, Seeds and Soil.
- All dive gear must be clean of algae.
- Report any **IAS** you find to KIRC Staff for Quarantine.

Animals (rodents, lizards) Insects (esp. ants) Weeds, Seeds and Soil

GOAL - To Prevent Invasive Alien Species (IAS) from Entering the Kaho`olawe Island Reserve (KIR).

- PREVENTION
- DETECTION
- QUARANTINE
- ERADICATION
- EDUCATION

- Hawaii Invasive Species Council -
Kaho`olawe Island Reserve Commission

APPENDIX C - Biosecurity Quarantine Self Check Sheet

<p>Kaho'olawe Biosecurity Quarantine Self Check Sheet One Biosecurity quarantine form to be completed by every group/vessel traveling to island. Please bring this form with you. "E Maka'ala Kākou" (Lets be Vigilant)</p>			
Date:		Date inspected:	
Name:		Departure port / Destination port:	
<p>INSTRUCTIONS: <i>Prior</i> to arrival for quarantine check all clothing and equipment. Personal ukana must have been recently washed, dried and cleaned of any seeds, organic material and insects. Snorkel gear and footwear should be scrubbed in a weak (2%) bleach solution. <i>Pay particular attention to any velcro, inner pockets, socks, footwear, pant legs and bags for seeds, soil, organic material etc.</i> Any unclean items will <u>not</u> be permitted onto the island. Vessel Hulls must be free of Aquatic Alien Species e.g. algae biofouling. Contractors to provide KIRC with a manifest of all items going to Kaho'olawe at least 48 hours prior to launch.</p>			
	Tick if in compliance	Inspected by KIR Staff	Comments-
Boots			
Other footwear (Socks)			
Clothing including parka/coat			
Dive / snorkel equipment			
Tent/sleeping bag (if applicable)			
Field Research Equipment			
Tools/Construction Equipment			
Food stores (boxed/bagged)			
Cultural Materials			
<i>Vessel Operators Only</i> Date of Last Hull Biofouling Reduction Type? Dry dock/Water			
SIGNED: Group Leader/Vessel Captain		SIGNED: KIR Staff	

APPENDIX D - Invasive Alien Species (IAS) Encounter Form - Kaho'olawe

	Information		Comments
1	Name(s)		
2	Date		
3	Time		
4	Location		
5	IAS Common Name		
6	IAS Taxa		
7	Number of individuals		
8	Organism Type ¹		
9	Take Picture		
10	Other		

¹Please note if IAS is a Plant, Insect, Ant, or Animal



KIRC mainline (808) 243-5020. Or Please Call Hawaii Pest Hotline if needed at: 1 800 643-PEST. Or online; <http://reportapest.org> U.S. Department of Agriculture

IAS Rapid Response Kit Contents

1. Insecticide
2. Sticky Traps
3. Glass Jars/Vials
4. IAS Quarantine Forms

Please let KIRC Biosecurity personnel know if any items in the IAS Rapid Response Kit need to be replaced.

APPENDIX F - Amdro® Instructions for Control of Ants

Amdro® Kills Fire Ants Yard Treatment Bait

One of the most prevalent insects in the environment, ants are also leading household pests in the United States. Ants vary significantly in color and size, and have different food preferences, from proteins to fats and sweets. Ants treat this specially formulated bait as food, so they carry it back to the colony to share. Once the queen and other ants eat it, the whole mound dies. It kills 15 species of ants. "Ants are notoriously difficult to control around houses and other structures. Often the use of toxic sprays and dusts have little effect. While some workers (*ants*) will be killed the ant colonies recover very quickly and this often leads to a cycle of spraying to gain temporary relief". Ants consume liquids, not solids, and once bait granules are soggy they are no longer attractive to ants.

Amdro® is a trade name for a [hydramethylnon](#)-based [hydrazone insecticide](#). Be sure not to apply when ground is wet, if rain is expected within 24 hours or when temperatures are below 50°F. Application rate is 43 lbs/ac, max 3 times per year (usual rate is 2 lbs per acre).

Handling:

Avoid contact with eyes or clothing. Avoid breathing dust. Wash thoroughly with soap and water after handling. When engineering control is not feasible and employee exposure exceeds 1.4 mg/m,³ wear a NIOSH approved pesticide respirator. When there is risk of exposure to eyes, wear dust proof goggles, overalls, and gloves.

PPE:

If prolonged exposure is expected or adequate ventilation during formulation process cannot be maintained, it is recommended to wear a MSHA/NIOSH approved organic vapor/pesticide respirator, impervious gloves, chemical goggles or safety glasses with side shields.

Instructions:

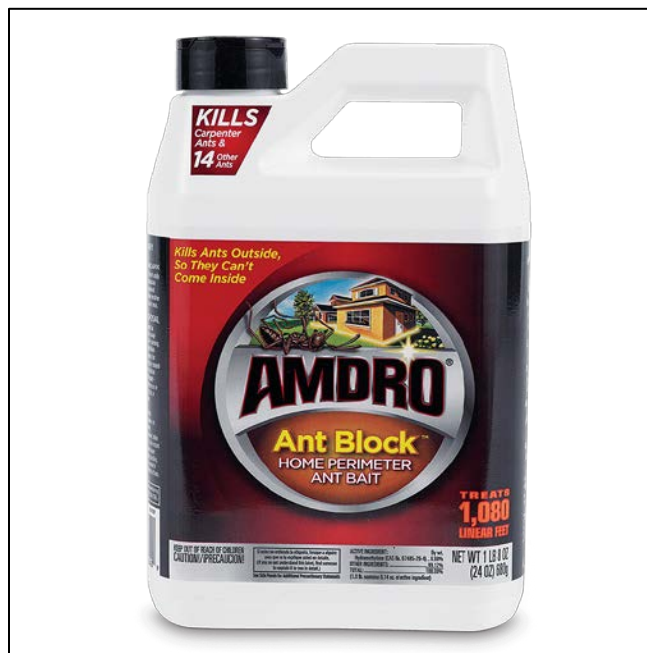
Obtain SDS Sheet for Amdro®

Read all instructions on Amdro® label.

Toxicological Information:

Avoid contact with skin, eyes and clothing. Wash hands thoroughly with soap and water after handling. Slightly irritating to the skin (based on technical active ingredient). If ingested, drink two glasses of water, induce vomiting if the person is conscious. Seek medical attention. If in eyes, hold eye open and rinse slowly and gently with water for 15-20 minutes. Remove contact lenses, if present, after the first 5 minutes, then continue rinsing eye. Call a poison control center or doctor for treatment advice.

Toxic to fish. Do not apply directly to water. Do not contaminate water when disposing of equipment wash waters. Do not apply when weather conditions favor drift from target areas.



Amdro® Ant Block Home Perimeter Ant Bait

Amdro Brand (granular bait)

Active: Hydramethylnon

Amdro is a large company and has many different pesticide products. Make sure to read the label to be sure that you're buying an ant bait.

- Amdro Fire Ant Bait Kills Fire Ants EPA Reg No.73342-1
- Amdro Ant Block Home Perimeter Ant Bait EPA Reg No.73342-2
- Amdro Pro EPA Reg No.241-322
-

Literature Cited

<http://www.amdro.com/all-products/ant-block-home-perimeter-ant-bait-granules>

<http://www.littlefireants.com/Amdro%20firestrike.pdf>

Other Ant Information

There are many products which claim to take care of fire ants. However, there are many different species of fire ants in the world (two species have made it to Hawai'i), and not all products will work on all species. Little Fire Ants do not build mounds, and they live in cooperative colonies which can span over large areas, in the trees, in rock walls, and in many small crevices and spaces. Their unique ecology requires a special approach to treatment that is based on their behavior and appetites. The Hawai'i Ant Lab has been studying Little Fire Ants in Hawai'i for more than a decade, and the University Cooperative Extension service has independently tested many ant products as well. Additional information for Little Fire Ant can be found at <http://www.littlefireants.com>.

Contact Pesticides

Substances like Raid, Sevin, and Orange Guard. These are made to kill a wide range of insects and bugs, which includes beneficial insects if they also come in contact with the spray. These pesticides are only a short term fix, and are mainly used for keeping ants out of a certain area. Using contact pesticides will not kill the colony, only the ants that come in contact with the spray. These are best used in the house where you just need to get rid of the few that are biting you.

If you have a potted plant that is infested with Little Fire Ant, then creating a drench using contact pesticides is a good way to get rid of the Little Fire Ant. Homeowners can use Sevin to create a drench. Create the Sevin mixture using the adequate amount of water as instructed on the label. Place the infested potted plant in your lawn or over a screen and bucket. Pour the mixture into the potting media until all of the potting media is completely soaked. The excess mixture will flow into the grass or into the bucket. Use the extra in the bucket to spray onto other plants in your yard to treat common garden pests.

Toxicant Baits:

These kinds of baits are meant to kill insects a short time after ingestion. Granular baits are normally made of corn grit that is infused with oil and the active ingredient. Worker ants suck the oil out of the corn grit and share the food with the queen and the rest of the colony. Normally worker ants die a few days after taking the bait. Toxicant baits that work on Little Fire Ant will contain one of these active ingredients: *hydramethylnon*, *indoxacarb*, and *metaflumizone*. They many come in a granular form, good for spreading on lawns or open areas, or they may come in a powder form that can be mixed into the protein gel bait, which can be used in areas of heavy vegetation. Please note while all of these products are safe for mammals and birds, they are not approved for use in all types of vegetation (for instance, some are not labeled for use in fruit trees, while others may be labeled for use in avocado or citrus trees only). Please read the label to ensure you have the right product for your landscape. Below are some examples of toxicant baits:

Siesta (granular bait)

Active: Metaflumizone

EPA Reg No.7969-232

Provaunt (powder, needs to be mixed into a bait)

Active: Indoxicarb

EPA Reg. No. 100-1487

MaxForce Complete (granular bait)

Active: Hydramethylnon

EPA Reg No.432-1255

Altrevin (granular bait)

Active: Metaflumizone

EPA Reg No.7969-270

-can be used for citrus and nut trees

Do not get granular baits wet, or they will lose attractiveness to the ants. Try to apply on a day when it appears you will have a few hours of dry weather. The product will decompose (break down) within a couple of days of application. Applications should be 5-6 weeks apart.

Insect Growth Regulators:

Unlike toxicants, IGRs don't kill the pests, but disrupt their life cycle. These products reduce or stop the egg production of queens, and prevent eggs and larvae from developing, thus weakening the colony. IGRs are not poison and will not kill adult workers (these are the ones that sting). Since IGRs have no impact on non-reproductive ants, the product will take some time to take effect: workers have a lifespan of about 3 months, and the impacts will be seen once the workers start to die off. IGRs contain the active ingredients *methoprene* or *pyriproxyfen*. However, only Tango (methoprene) has been approved to be mixed into the gel bait developed by HAL. The original recipe for the gel bait can be found on the Hawai'i Ant Lab website, <http://www.littlefireants.com/>. One gallon of bait will generally treat 1 acre (you may go up to 2 gal/acre for very heavy vegetation).

Barrier Treatments:

Barrier treatments can be used when you have infestations occurring on neighboring properties or stretches of land where control is not taking place. You may want to spray around the base of your house and all entryways to prevent ants from coming in to your house, while you are also baiting the ants outside in your yard to get rid of the colonies.

Do not apply a barrier treatment and bait at the same time in your yard! The barrier may prevent workers from reaching the bait or keep them from returning to the colony, which would be a waste of time and money for you. It's best to use a barrier treatment once your infestation is under control. If you are using a barrier around your house to prevent ants from coming inside, do not apply on the same day as you bait.

This is the type of product used by pest control companies who spray to prevent ants from entering or forming colonies inside your home. If you would prefer to apply these treatments yourself, know that they come as a granular or a liquid. Unlike bait products, these granulars must be mixed with water to be effective. Products may contain the active ingredients *bifenthrin*, *cyfluthrin*, and *cypermethrin*.

Kaho'olawe Island Reserve Biosecurity Plan

Examples of Barrier Treatments:

Talstar Brand

Active: Bifenthrin (and zeta-cypermethrin in some products)

- Talstar P (Talstar One) EPA Reg No.279-3206
- Talstar PL Granular EPA Reg No. 279-3168
- Talstar XTRA Granulars EPA Reg. No. 279-9552

Over N Out Advanced Fire Ant Killer

Active: Bifenthrin and zeta-cypermethrin
EPA Reg No.279-3344-71004

Ortho MAX Fire Ant Killer Broadcast Granules

Active: Bifenthrin
EPA Reg. No. 239-2681

Upstar Gold

Active: Bifenthrin
EPA Reg No. 70506-24

It is critical to have a supply of Response equipment on site including detection devices, traps for animals, sprays and spray gear for plants. Obtaining gear quickly from vendors will be important and a few are listed here:

BEI Hawaii

300 Pakana St. Wailuku, HI 96793 (808) 244-3761, Insecticides, Pesticides, Bait Boxes

Del's Feed and Farm Supply

326 Hanamanu St. Kahului, HI 96732 (808) 873-0101, Pest Traps

GoodNature

<http://www.goodnature.co.nz/products/>, A24 Traps

Simplot

400 Lehuakona St. Kahului, HI 96732 (808) 877-6636, Pesticides

APPENDIX G - List of Ants in Hawai'i and Kaho'olawe

As of 2003, all species of ants (Formicidae) intercepted at US Ports of entry and destined to or through the state of Hawai'i require quarantine action and are considered reportable if, they are not already established and widespread in Hawai'i and, life stages found in a shipment indicate the ability to reproduce.

This ant assemblage is unique in that nearly all of the species qualify with habits and life histories that make them efficient at moving about in conjunction with human activity (tramp species). Among them are a majority of the world's most successful, and damaging IAS. Although highly invasive species such as Argentine Ant (*Linepithema humile*), Big Headed Ant (*Pheidole megacephala*) and the Yellow Crazy Ant (*Anoplolepis gracilipes*) may dominate, a fairly diverse array of other ants with differing habits and ecological strategies are also successful in the Hawaiian Islands. These include highly active and common species (*Paratrechina longicornis*, *Nylanderia* spp. and *Technomyrmex* spp.), others that form small and inconspicuous colonies (*Hypoponera* spp. and *Cardiocondyla* spp.), as well as some highly specialized species (*Strumigenys* spp.). (<https://www.antweb.org/adm1.do?name=Hawaii&country=United%20States>).

“Ants represent a wholly introduced component of Hawaiian ecosystems. The establishment of roughly 45 ant species over the past two centuries has wide ranging implications for agriculture, other sectors of the economy, and the conservation of native biodiversity. Although ants have received considerable attention in Hawaii, many questions regarding the factors that determine their distributions and influence patterns of species co-occurrence remain largely unexplored. More focus has been directed at their ecological effects in natural areas, where they can directly threaten native invertebrates and vertebrates and indirectly impact native plants. Increased awareness of the negative repercussions of ant introductions in Hawaii has led to improvements in preventative quarantine policy in the last decade, however agencies responsible for ant and other invasive species interdiction remain severely understaffed. Efforts to control or eradicate ant infestations for conservation purposes in Hawaii represent a recent development, and have so far met with variable success. The threat of other destructive ant species, such as the red imported fire ant, arriving in Hawaii underscores the importance of an early detection network and an established infrastructure ready for rapid response” (Krushelnycky et al., 2005).

Cardiocondyla tramp species ([C. wroughtonii](#), [C. obscurior](#), [C. emeryi](#) and [C. minutior](#)) are known to be polygynous (http://www.antwiki.org/wiki/Cardiocondyla_nuda).

Kaho'olawe Island Reserve Biosecurity Plan

This table lists the ants that are present in Hawai'i, and the yellow highlighted rows are ants that have been found on Kaho'olawe (N=18).

Ants In Hawai'i		
Number	Taxa	Common Name
1	<i>Anoplolepis gracilipes</i>	Yellow Crazy Ant
2	<i>Bannapone zwaluwenburgi</i>	
3	<i>Brachymyrmex obscurior</i>	
4	<i>Camponotus variegatus</i>	Carpenter Ant
5	<i>Cardiocondyla emeryi</i>	<i>Cardiocondyla. sp on Kaho'olawe</i>
6	<i>Cardiocondyla kagutsuchi</i>	"
7	<i>Cardiocondyla minutior</i>	"
8	<i>Cardiocondyla obscurior</i>	"
9	<i>Cardiocondyla venustula</i>	"
10	<i>Cardiocondyla wroughtonii</i>	"
11	<i>Cerapachys biroi</i>	
12	<i>Hypoponera ergatandria</i>	
13	<i>Hypoponera hi01</i>	
14	<i>Hypoponera opaciceps</i>	
15	<i>Hypoponera opacolor</i>	
16	<i>Hypoponera punctatissima</i>	
17	<i>Hypoponera ragusai</i>	
18	<i>Hypoponera zwaluwenburgi</i>	
19	<i>Lepisiota hi01</i>	
20	<i>Leptogenys falcigera</i>	
21	<i>Linepithema humile</i>	Argentine Ant
22	<i>Monomorium destructor</i>	Singapore Ant
23	<i>Monomorium floricola</i>	
24	<i>Monomorium indicum</i>	
25	<i>Monomorium liliuokalanii</i>	Lili'uokalani Ant
26	<i>Monomorium pharaonis</i>	Pharoah Ant
27	<i>Nylanderia bourbonica</i>	
28	<i>Nylanderia sharpii</i>	
29	<i>Nylanderia vaga</i>	
30	<i>Ochetellus glaber</i>	
31	<i>Paratrechina longicornis</i>	Black Crazy Ant
32	<i>Pheidole fervens</i>	
33	<i>Pheidole megacephala</i>	Big Headed Ant
34	<i>Pheidole navigans (P. moerens)</i>	
35	<i>Plagiolepis alluaudi</i>	Little Yellow Ant
36	<i>Ponera swezeyi</i>	
37	<i>Pseudomyrmex gracilis</i>	Elongate Twig Ant
38	<i>Solenopsis geminata</i>	Tropical Fire Ant

Kaho'olawe Island Reserve Biosecurity Plan

Ants In Hawai'i		
Number	Taxa	Common Name
39	<i>Solenopsis globularia</i>	
40	<i>Solenopsis hi01</i>	
41	<i>Solenopsis papuana</i>	
42	<i>Strumigenys emmae</i>	
43	<i>Strumigenys godeffroyi</i>	
44	<i>Strumigenys lewisi</i>	
45	<i>Strumigenys membranifera</i>	
46	<i>Strumigenys rogeri</i>	
47	<i>Sylophopsis sechellensis</i>	
48	<i>Tapinoma melanocephalum</i>	
49	<i>Tapinoma sessile</i>	
50	<i>Technomyrmex albipes</i>	White Footed Ant
51	<i>Technomyrmex difficilis</i>	
52	<i>Technomyrmex pallipes</i>	
53	<i>Technomyrmex vitiensis</i>	
54	<i>Tetramorium bicarinatum</i>	Guinea Ant
55	<i>Tetramorium caldarium</i>	
56	<i>Tetramorium insolens</i>	
57	<i>Tetramorium lanuginosum</i>	
58	<i>Tetramorium simillimum</i>	
59	<i>Tetramorium tonganum</i>	
60	<i>Trichomyrmex destructor</i>	
61	<i>Wasmannia auropunctata</i> ¹	Little Fire Ant

Ants found in Hawai'i

¹By law, Little Fire Ant is a regulated species (HRS 150A and HAR Chapter 4-72).

In feeding tests, Argentine ant, (*L. humile*) workers chose 25% honey water or sucrose water over granulated brown sugar or other solid foods with high protein content such as tuna meal (Baker et al., 1985). Stanley and Robinson (2007) report that of several baits available, tuna fish and Xstinguish® were the most preferred by the Black Crazy ant, (*P. longicornus*) foragers followed by sugar water and sugar water and boric acid (H₃BO₃). Bait preferences for ant taxa is listed in the following Table.

	Taxa	Bait Preference	Source
1	<i>Linepithia humile</i>	Honey Water	Baker et al., 1985
2	<i>Paratrechina longicornis</i>	Sugar Water and Boric Acid	Stanley and Robinson, 2007

Bait preference for ant taxa

Note: Both ant taxa found on Kaho'olawe.

APPENDIX H - Pesticide Use Log

Kihei Nursery Pesticide Use Log									
Entry	Date	Time	Name	Pesticide Used	Concentration (%)	Carrier	Total Quantity	Area Sprayed	Comments
1									
2									
3									
4									
5									
6									
7									
8									
9									
10									
11									
12									
13									
14									
15									
16									
17									
18									
19									
20									

APPENDIX I - KIRC Plant Specifications

KIRC 11/15/01



Standards and Specifications for Native Plant Suppliers

Plant Specifications

- All plants (species determined by the Kaho'olawe Island Reserve Commission) will be grown on either raised benches, weed cloth-covered ground, plastic-covered ground, cement slab or in a certified nursery.
- Seeds and/or cuttings for plants will come from dryland habitats from the islands of Maui, Lana'i and Moloka'i or will be supplied by the KIRC from Kaho'olawe seed source depending on the species requested by the KIRC.

Kaho'olawe seed provided by the KIRC to the Contractor shall not be grown out as seed stock for additional seed supply in any nursery without explicit permission from the KIRC. This is to prevent cross-pollination of small but unique gene pools of native species on Kaho'olawe with same species from other sites.

- Plant containers will be either dibble tube or containers, as specified.
- Plants will be grown in a sterile medium. Plants will be free of nematodes.
- No compost will be used that contains sewage sludge.
- Height requirements and/or plant length for out-plantings will be at least 21cm (8in) and not more than 31.5cm (12in) for all plants.
- Root structure development will be well established, but without being root-bound within containers.
- Plants will show overall vigor in leaf, stem and root structure.

APPENDIX I
KIRC Plant Specifications

KIRC 11/15/01

Delivery Specifications

- Plants and specified quantities will be delivered to Pacific Helicopter Tours at the Pu'unene heliport, Island of Maui on specified dates to be determined by contract.
- Upon delivery, all plants will be free of alien plants, free of nematodes, free of fungal or other diseases, free of ants, and/or any type of alien organism that may be harmful to the restoration efforts on the Island of Kaho'olawe.
- Shipping boxes and containers in which plants come in will be free of unwanted alien organisms. Containers will be no bigger than 17in x 13in x 13in (1.5cu.ft.) and weigh no more than 50lbs per container.
- *All plants will be inspected at the heliport for alien organisms by the KIRC prior to shipment to the island of Kaho'olawe. If the shipment does not meet agreed standards, the plants will be rejected. It is the responsibility of the vendor to remove the plants from the heliport facilities by the end of that workday, 5:00 pm.*

The Kaho'olawe Island Reserve Commission, Department of Land and Natural Resources, State of Hawai'i is the entity which regulates all access and activities within the Kaho'olawe Island Reserve. The Commission will be the entity purchasing the plants.

Written quotes should be provided in writing to:
Restoration Manager
Kaho'olawe Island Reserve Commission
811 Kolu St.
Wailuku, Hawai'i 96793

For questions and additional growing and shipping requirements, call:
(808) 243-5890 or 243-5031.

APPENDIX J – FIFRA and US EPA Worker Protection Standards

Federal Insecticide, Fungicide and Rodenticide Act (FIFRA)

The storage of pesticides is regulated under FIFRA which governs the sale distribution and use of pesticides in the United States. The Act provides for federal regulation of pesticide distribution, sale, and use. All pesticides distributed or sold in the United States must be registered (licensed) by EPA. Before EPA may register a pesticide under FIFRA, the applicant must show, among other things, that using the pesticide according to specifications *"will not generally cause unreasonable adverse effects on the environment."* FIFRA defines the term *"unreasonable adverse effects on the environment"* to mean: " (1) any unreasonable risk to man or the environment, taking into account the economic, social, and environmental costs and benefits of the use of any pesticide, or (2) a human dietary risk from residues that result from a use of a pesticide in or on any food inconsistent with the standard under section 408 of the Federal Food, Drug, and Cosmetic Act." (<http://www.agriculture.senate.gov/imo/media/doc/FIFRA.pdf>).

The storage of pesticides is regulated under FIFRA which governs the sale, distribution and use of pesticides in the United States, pesticides are regulated under FIFRA until they are disposed. Then they are regulated by Resource Conservation and Recovery Act (RCRA) which ensures the responsible management of hazardous and non-hazardous waste. An Emergency Response Plan will be in place in case of an accident or Pesticide spill. Contact names and phone numbers to the KIRC and Hawai'i Poison Control Center emergency response personnel will be available on site. The list of pesticides should be readily available for emergency responders. Please use Proper Personnel Protective Equipment (PPE) and immediately report all spills and accidents to KIRC personnel. Follow guidelines on pesticide labels and document quantity of pesticide used.

US EPA Worker Protection Standard:

The Worker Protection Standard (40 CFR Part 170) from the US EPA are regulations reducing the risk of pesticide poisonings and injuries among pesticide handlers. The standard contains requirements for pesticide safety training, notification of pesticide applications, personnel protective equipment (PPE), restricted entry intervals following pesticide application, decontamination supplies and emergency medical assistance. To protect the health and safety of workers and handlers, employers are responsible for training them in the safe use of pesticides. The training manual for the Worker Protection Standard for Agricultural Pesticides (<http://www.epa.gov/oecaagct.htc.html>) provides detailed information on who is covered and how to meet regulatory requirements. The WPS requires that owners and employers on agricultural establishments provide protections to workers and handlers from potential pesticide exposure and provide mitigations in case exposures may occur (MDAR, 2010). The Occupational Safety and Health Administration (OSHA) "Right to Know" Act will be clearly displayed in the Kihei Nursery area for workers and information on chemical hazards.

Kaho'olawe Island Reserve Biosecurity Plan

USDA Animal and Plant Health Inspection Service (APHIS):

APHIS is a multi-faceted Agency with a mission that includes protecting and promoting US agricultural health, regulating genetically engineered organisms, administering the Animal Welfare Act and carrying out wildlife damage management activities. These efforts support the overall mission of USDA, which is to protect and promote food, agriculture, and natural resources. (<https://www.aphis.usda.gov/aphis/banner/aboutaphis>)

Safety Data Sheets (SDS):

Safety Data Sheets (SDS) sheets will be readily available on site for safety concerns and proper use of Pesticides. All chemicals used at the Kihei Nursery and in this Biosecurity Plan will have a SDS on file to provide safety information and the correct application for the personnel using them. Also, the KIRC Health and Safety Plan (KIRC, 2003) complies with Title 29 of the Code of Federal Regulations Part 191 of the US Department of Labor Occupational Safety and Health Administration (OSHA), the Hawai'i Occupational Health and Safety Division (HIOSH) and US EPA regulations.

Emergency Eyewash

Eyewash meeting the requirements of the ANSI standard Z358.1-1990 should be utilized at the work sites for hands free irrigation for both eyes for at least 15 minutes at a flow rate of at least 0.4 gallons / minute.



Emergency Eye Wash

APPENDIX K - Four Botanical Surveys performed on Kaho'olawe in 2015

APPENDIX K - Four Botanical Surveys performed on Kaho'olawe in 2015					
	Taxa	Base Camp	LZ Quail	LZ One	Hakioawa
1	<i>Abutilon grandifolium</i>	1			1
2	<i>Abutilon incanum</i>	1			1
3	<i>Ageratum conyzoides</i>				1
4	<i>Alternanthera caracasana</i>				1
5	<i>Alternanthera pungens</i>	1			
6	<i>Asclepias physocarpa</i>			1	1
7	<i>Atriplex semibaccata</i>		1	1	1
8	<i>Batis maritima</i>				1
9	<i>Boerhavia coccinea</i>	1	1		
10	<i>Bothriochloa pertusa</i>	1		1	1
11	<i>Broussonetia papyrifera</i>				1
12	<i>Calyptocarpus vialis</i>				1
13	<i>Cenchrus ciliaris</i>	1	1	1	1
14	<i>Chamaecrista nictitans var. glabrata</i>			1	1
15	<i>Chenopodium murale</i>				1
16	<i>Chenopodium oahuense</i>				1
17	<i>Chloris barbata</i>				1
18	<i>Chloris virgata</i>	1			1
19	<i>Conyza bonariensis</i>		1	1	
20	<i>Cordia subcordata</i>				1
21	<i>Cyanthillium cinereum</i>				1
22	<i>Dactyloctenium aegyptium</i>				1
23	<i>Desmanthus pernambucanus</i>	1		1	
24	<i>Desmodium triflorum</i>		1	1	
25	<i>Digitaria insularis</i>			1	1
26	<i>Dodonaea viscosa</i>	1			1
27	<i>Eclipta prostrata</i>				1
28	<i>Emilia fosbergii</i>	1	1	1	1
29	<i>Eragrostis amabilis</i>	1			
30	<i>Erythrina sandwicensis</i>				1
31	<i>Euphorbia hirta</i>	1			1
32	<i>Euphorbia hyssopifolia</i>				1
33	<i>Gossypium tomentosum</i>	1			1
34	<i>Heteropogon contortus</i>	1	1	1	1
35	<i>Heterotheca grandiflora</i>		1		

Kaho'olawe Island Reserve Biosecurity Plan

APPENDIX K - Four Botanical Surveys performed on Kaho'olawe in 2015					
	Taxa	Base Camp	LZ Quail	LZ One	Hakioawa
36	<i>Indigofera spicata</i>	1			
37	<i>Ipomoea pes-caprae</i>				1
38	<i>Jacquemontia sandwicensis</i>				1
39	<i>Lantana camara</i>			1	1
40	<i>Leonotis nepetifolia</i>				1
41	<i>Leucaena leucocephala</i>	1	1	1	1
42	<i>Macroptilium atropurpureum</i>		1	1	1
43	<i>Macroptilium lathyroides</i>	1	1	1	1
44	<i>Malvastrum coromandelianum</i> subsp. <i>coromandelianum</i>				1
45	<i>Melinis repens</i>		1	1	
46	<i>Merremia aegyptia</i>	1			
47	<i>Myoporum sandwicense</i>				1
48	<i>Neonotonia wightii</i>			1	
49	<i>Nicotiana glauca</i>			1	1
50	<i>Ocimum gratissimum</i>				1
51	<i>Pennisetum polystachion</i>	1	1		
52	<i>Pluchea carolinensis (odorata)</i>		1	1	1
53	<i>Pluchea indica</i>				1
54	<i>Pluchea x fosbergii</i>			1	
55	<i>Portulaca oleracea</i>	1			
56	<i>Portulaca pilosa</i>				1
57	<i>Prosopis pallida</i>	1	1		1
58	<i>Psilotum nudum</i>		1		
59	<i>Salsola tragus</i>		1		
60	<i>Scaevola taccada</i>				1
61	<i>Senecio madagascariensis</i>		1	1	1
62	<i>Sesuvium portulacastrum</i>				1
63	<i>Setaria verticillata</i>				1
64	<i>Sida ciliaris</i>				1
65	<i>Sida fallax</i>	1		1	1
66	<i>Sonchus oleraceus</i>			1	1
67	<i>Sporobolus africanus</i>	1			
68	<i>Sporobolus virginicus</i>				1
69	<i>Stachytarpheta jamaicensis</i>			1	
70	<i>Stapelia gigantea</i>				1
71	<i>Synedrella nodiflora</i>				1
72	<i>Tamarix aphylla</i>			1	

Kaho'olawe Island Reserve Biosecurity Plan

APPENDIX K - Four Botanical Surveys performed on Kaho'olawe in 2015					
	Taxa	Base Camp	LZ Quail	LZ One	Hakioawa
73	<i>Thespesia populnea</i>				1
74	<i>Tragus berteronianus</i>	1			
75	<i>Tribulus Sp. (cistoides?)</i>	1			
76	<i>Tridax procumbens</i>	1		1	
77	<i>Urochloa maxima (Megathyrsus maximus)</i>		1	1	1
78	<i>Vachellia farnesiana</i>	1			1
79	<i>Verbena litoralis</i>			1	
80	<i>Vitex rotundifolia</i>				1
81	<i>Waltheria indica</i>	1	1	1	1
82	<i>Xanthium strumarium var. canadense</i>				1
	Sum	28	20	29	59

Appendix K. Four Botanical Surveys on Kaho'olawe in 2015

APPENDIX L - Flora Survey of Kaho'olawe

Appendix L – Flora Survey of Kaho'olawe			
No.	Family	Species	Species
1	Malvaceae	<i>Abutilon grandifolium</i>	hairy abutilon
2	Malvaceae	<i>Abutilon incanum</i>	hoary abutilon
3	Fabaceae	<i>Acacia confusa</i>	Formosa koa
4	Fabaceae	<i>Acacia mearnsii</i>	black wattle
5	Asteraceae	<i>Acanthospermum australe</i>	spiny-bur
6	Pteridaceae	<i>Adiantum hispidulum</i>	rough maidenhair fern
7	Asparagaceae	<i>Agave sisalana</i>	sisal, sisal hemp, century plant
8	Asteraceae	<i>Ageratum conyzoides</i>	maile honohono
9	Amaranthaceae	<i>Alternanthera caracasana</i>	mat chaff flower
10	Amaranthaceae	<i>Alternanthera pungens</i>	khaki weed
11	Apocynaceae	<i>Alyxia stellata</i>	maile
12	Amaranthaceae	<i>Amaranthus spinosus</i>	spiny amaranth
13	Amaranthaceae	<i>Amaranthus viridis</i>	slender amaranth
14	Primulaceae	<i>Anagalis arvensis</i>	Scarlet pimpernel
15	Plantaginaceae	<i>Antirrhinum orontium</i>	lesser snapdragon
16	Papaveraceae	<i>Argemone glauca var. glauca</i>	pua kala
17	Asteraceae	<i>Artemisia australis</i>	hinahina
18	Apocynaceae	<i>Asclepias curassavica</i>	butterfly weed
19	Apocynaceae	<i>Asclepias physocarpa</i>	balloon plant
20	Amaranthaceae	<i>Atriplex semibaccata</i>	Australian saltbush
21	Bataceae	<i>Batis maritima</i>	Pickleweed
22	Asteraceae	<i>Bidens alba var. radiata</i>	Spanish needle
23	Asteraceae	<i>Bidens mauiensis</i>	kookoolau
24	Asteraceae	<i>Bidens pilosa</i>	Spanish needle
25	Nyctaginaceae	<i>Boerhavia acutifolia</i>	alena
26	Nyctaginaceae	<i>Boerhavia coccinea</i>	boerhavia
27	Nyctaginaceae	<i>Boerhavia herbstii</i>	alena
28	Nyctaginaceae	<i>Boerhavia repens</i>	alena
29	Poaceae	<i>Bothriochloa bladhii</i>	bluestem
30	Poaceae	<i>Bothriochloa pertusa</i>	pitted beardgrass
31	Moraceae	<i>Broussonetia papyrifera</i>	wauke, paper mulberry
32	Asteraceae	<i>Calyptocarpus vialis</i>	straggler daisy
33	Capparaceae	<i>Capparis sandwichiana</i>	maiapilo
34	Cyperaceae	<i>Carex meyenii</i>	carex
35	Casuarinaceae	<i>Casuarina equisetifolia</i>	common ironwood
36	Casuarinaceae	<i>Casuarina glauca</i>	longleaf ironwood
37	Apocynaceae	<i>Catharanthus roseus</i>	Madagascar periwinkle
38	Poaceae	<i>Cenchrus ciliaris</i>	buffelgrass
39	Poaceae	<i>Cenchrus echinatus</i>	sandbur
40	Poaceae	<i>Cenchrus purpureus</i>	cane grass
41	Poaceae	<i>Cenchrus setaceus</i>	fountain grass
42	Poaceae	<i>Cenchrus tribuloides</i>	sandbur
43	Asteraceae	<i>Centaurea melitensis</i>	yellow star thistle
44	Gentianaceae	<i>Centaurium erythraea subsp. erythraea</i>	bitter herb
45	Fabaceae	<i>Chamaecrista nictitans var. glabrata</i>	partridge pea
46	Euphorbiaceae	<i>Chamaesyce prostrata</i>	prostrate spurge
47	Chenopodiaceae	<i>Chenopodium carianatum</i>	chenopodium
48	Chenopodiaceae	<i>Chenopodium murale</i>	goosefoot, lamb's

Kaho'olawe Island Reserve Biosecurity Plan

Appendix L – Flora Survey of Kaho'olawe			
No.	Family	Species	Species
			quarters
49	Chenopodiaceae	<i>Chenopodium oahuense</i>	aweoweo
50	Poaceae	<i>Chloris barbata</i>	swollen fingergrass
51	Poaceae	<i>Chloris divaricata</i> var. <i>divaricata</i>	stargrass
52	Poaceae	<i>Chloris truncata</i>	fingergrass
53	Poaceae	<i>Chloris virgata</i>	feather fingergrass
54	Asteraceae	<i>Cirsium vulgare</i>	bull thistle, pua kala
55	Arecaceae	<i>Cocos nucifera</i>	niu, coconut
56	Rubiaceae	<i>Coffea arabica</i>	Arabian coffee
57	Asteraceae	<i>Conyza bonariensis</i>	hairy horseweed
58	Asteraceae	<i>Conyza canadensis</i>	horseweed
59	Boraginaceae	<i>Cordia subcordata</i>	kou
60	Hymenophyllaceae	<i>Crepidomanes minutum</i>	filmy fern
61	Convolvulaceae	<i>Cressa truxillensis</i>	cressa
62	Fabaceae	<i>Crotalaria incana</i>	fuzzy rattlepod
63	Cucurbitaceae	<i>Cucumis dipsaceus</i>	teasel gourd
64	Asteraceae	<i>Cyanthillium cinereum</i>	little ironweed
65	Poaceae	<i>Cynodon dactylon</i>	Bermuda grass
66	Cyperaceae	<i>Cyperus gracilis</i>	McCoy grass
67	Cyperaceae	<i>Cyperus phleoides</i> var. <i>phleoides</i>	Cyperus
68	Poaceae	<i>Dactyloctenium aegyptium</i>	beach wiregrass
69	Fabaceae	<i>Desmanthus pernambucanus</i>	slender mimosa
70	Fabaceae	<i>Desmodium sandwicense</i>	Spanish clover
71	Fabaceae	<i>Desmodium tortuosum</i>	Florida beggarweed
72	Fabaceae	<i>Desmodium triflorum</i>	tick clover
73	Poaceae	<i>Dichanthium aristatum</i>	Wilder grass
74	Poaceae	<i>Dichanthium sericeum</i>	Australian bluestem
75	Poaceae	<i>Digitaria ciliaris</i>	Henry's crabgrass
76	Poaceae	<i>Digitaria insularis</i>	sourgrass
77	Sapindaceae	<i>Dodonaea viscosa</i>	'A'ali'i
78	Pteridaceae	<i>Doryopteris decipiens</i>	iwaiwa
79	Pteridaceae	<i>Doryopteris decora</i>	iwaiwa
80	Amaranthaceae	<i>Dysphania carinata</i>	goosefoot, lamb's quarters
81	Asteraceae	<i>Dyssodia tenuiloba</i>	dogweed, Dahlberg daisy
82	Poaceae	<i>Echinochloa colona</i>	jungle-rice
83	Asteraceae	<i>Eclipta prostrata</i>	false daisy
84	Poaceae	<i>Ehrharta stipoides</i>	meadow ricegrass
85	Cyperaceae	<i>Eleocharis calva</i>	kohekohe, pipiwai, spikerush
86	Asteraceae	<i>Emilia fosbergii</i>	pualele
87	Poaceae	<i>Eragrostis amabilis</i>	lovegrass
88	Poaceae	<i>Eragrostis cilianensis</i>	stinkgrass
89	Poaceae	<i>Eragrostis curvula</i>	lovegrass
90	Poaceae	<i>Eragrostis grandis</i>	lovegrass
91	Poaceae	<i>Eragrostis leptophylla</i>	lovegrass
92	Poaceae	<i>Eragrostis pectinacea</i>	Carolina lovegrass
93	Poaceae	<i>Eragrostis variabilis</i>	kawelu, emoloa, kalamalo
94	Asteraceae	<i>Erechtites valerianifolia</i>	fireweed
95	Fabaceae	<i>Erythrina sandwicensis</i>	wiliwili
96	Myrtaceae	<i>Eucalyptus</i> spp.	Eucalyptus

Kaho'olawe Island Reserve Biosecurity Plan

Appendix L – Flora Survey of Kaho'olawe			
No.	Family	Species	Species
97	Euphorbiaceae	<i>Euphorbia celastroides</i> var. <i>amplectens</i>	akoko
98	Euphorbiaceae	<i>Euphorbia celastroides</i> var. <i>stokesii</i>	akoko
99	Euphorbiaceae	<i>Euphorbia heterophylla</i>	spurge
100	Euphorbiaceae	<i>Euphorbia hirta</i>	hairy spurge
101	Euphorbiaceae	<i>Euphorbia hyssopifolia</i>	hyssopleaf sandmat
102	Euphorbiaceae	<i>Euphorbia prostrata</i>	prostrate spurge
103	Euphorbiaceae	<i>Euphorbia skottsbergii</i> var. <i>vaccinioides</i>	akoko
104	Santalaceae	<i>Exocarpos gaudichaudii</i>	hulumoa
105	Moraceae	<i>Ficus microcarpa</i>	Chinese banyan
106	Asteraceae	<i>Flaveria trinervia</i>	flaveria
107	Asparagaceae	<i>Furcreae foetida</i>	Mauritius hemp
108	Asteraceae	<i>Galinsoga parviflora</i>	gallant soldier
109	Asteraceae	<i>Gamochaeta pensylvanica</i>	purple cudweed
110	Malvaceae	<i>Gossypium tomentosum</i>	mao, Hawaiian cotton
111	Rhamnaceae	<i>Gouania hillebrandii</i>	gouania
112	Proteaceae	<i>Grevillea robusta</i>	silk oak
113	Boraginaceae	<i>Heliotropium curassavicum</i>	nena, seaside heliotrope
114	Poaceae	<i>Heteropogon contortus</i>	pili
115	Asteraceae	<i>Heterotheca grandiflora</i>	telegraph weed
116	Cactaceae	<i>Hylocereus undatus</i>	night-blooming cereus
117	Asteraceae	<i>Hypochoeris glabra</i>	smooth cat's-ear
118	Asteraceae	<i>Hypochoeris radicata</i>	hairy cat's-ear, gosmore
119	Fabaceae	<i>Indigofera suffruticosa</i>	indigo
120	Convolvulaceae	<i>Ipomoea cairica</i>	ivy-leaved morning glory, koali ai
121	Convolvulaceae	<i>Ipomoea indica</i>	morning glory, koali awa
122	Convolvulaceae	<i>Ipomoea pes-caprae</i>	pohuehue, beach morning glory
123	Convolvulaceae	<i>Ipomoea tuboides</i>	Hawaiian moon flower
124	Convolvulaceae	<i>Jacquemontia sandwicensis</i>	pau o Hi'iaka
125	Fabaceae	<i>Kanaloa kahoolawensis</i>	kanaloa
126	Poaceae	<i>Lachnagrostis filiformis</i>	heupueo
127	Asteraceae	<i>Lactuca sativa</i>	prickly lettuce
128	Verbenaceae	<i>Lantana camara</i>	lantana
129	Lamiaceae	<i>Leonotis nepetifolia</i>	lion's ear, lion's tail
130	Brassicaceae	<i>Lepidium didymum</i>	swinecress
131	Brassicaceae	<i>Lepidium oblongum</i>	pepperwort, peppergrass
132	Fabaceae	<i>Leucaena leucocephala</i>	koa haole, ekoa, lilikoa
133	Asteraceae	<i>Lipochaeta rockii</i>	nehe
134	Asteraceae	<i>Lipochaeta succulenta</i>	nehe
135	Solanaceae	<i>Lycium sandwicense</i>	ohelo kai
136	Primulaceae	<i>Lysimachia arvensis</i>	scarlet pimpernel
137	Fabaceae	<i>Macroptilium atropurpureum</i>	twining cow pea
138	Fabaceae	<i>Macroptilium lathyroides</i>	erect cow pea
139	Malvaceae	<i>Malva parviflora</i>	cheese weed
140	Malvaceae	<i>Malvastrum coromandelianum</i> subsp. <i>coromandelianum</i>	mallow
141	Anacardiaceae	<i>Mangifera indica</i>	mango
142	Asteraceae	<i>Melanthera bryanii</i>	nehe
143	Asteraceae	<i>Melanthera integrifolia</i>	nehe
144	Asteraceae	<i>Melanthera lavarum</i>	nehe
145	Poaceae	<i>Melinis minutiflora</i>	molasses grass

Kaho'olawe Island Reserve Biosecurity Plan

Appendix L – Flora Survey of Kaho'olawe			
No.	Family	Species	Species
146	Poaceae	<i>Melinis repens</i>	Natal redtop
147	Convolvulaceae	<i>Merremia aegyptia</i>	hairy merremia
148	Cucurbitaceae	<i>Momordica charantia</i>	bitter melon
149	Myoporaceae	<i>Myoporum sandwicense</i>	naio, false sandalwood
150	Fabaceae	<i>Neonotonia wightii</i>	glycine
151	Lomariopsidaceae	<i>Nephrolepis brownii</i>	sword fern
152	Urticaceae	<i>Neraudia sericea</i>	neraudia
153	Solanaceae	<i>Nicotiana glauca</i>	tree tobacco
154	Solanaceae	<i>Nicotiana tabacum</i>	tobacco
155	Amaranthaceae	<i>Nototrichium sandwicense</i>	kului
156	Lamiaceae	<i>Ocimum gratissimum</i>	wild basil
157	Rubiaceae	<i>Oldenlandia corymbosa</i>	Old World diamond flower
158	Ophioglossaceae	<i>Ophioglossum polyphyllum</i>	pololei, adder's tongue
159	Cactaceae	<i>Opuntia ficus-indica</i>	panini
160	Oxalidaceae	<i>Oxalis corniculata</i>	yellow wood sorrel
161	Poaceae	<i>Panicum fauriei</i> var. <i>fauriei</i>	panicum
162	Poaceae	<i>Panicum fauriei</i> var. <i>latius</i>	panicum
163	Poaceae	<i>Panicum ramosius</i>	panicum
164	Poaceae	<i>Panicum torridum</i>	kakonakona
165	Asteraceae	<i>Perityle emoryi</i>	rock daisy
166	Pteridaceae	<i>Pityrogramma austroamericana</i>	goldfern
167	Pteridaceae	<i>Pityrogramma calomelanos</i>	silverfern
168	Asteraceae	<i>Pluchea carolinensis</i>	sourbush, marsh fleabane
169	Asteraceae	<i>Pluchea indica</i>	Indian fleabane
170	Asteraceae	<i>Pluchea x fosbergii</i>	marsh fleabane
171	Plumbaginaceae	<i>Plumbago zeylanica</i>	iliee
172	Caryophyllaceae	<i>Polycarpon tetraphyllum</i>	four-leaved allseed
173	Portulacaceae	<i>Portulaca molokiniensis</i>	ihi
174	Portulacaceae	<i>Portulaca oleracea</i>	pigweed
175	Portulacaceae	<i>Portulaca pilosa</i>	pigweed
176	Portulacaceae	<i>Portulaca villosa</i>	ihi
177	Fabaceae	<i>Prosopis pallida</i>	kiawe
178	Psilotaceae	<i>Psilotum nudum</i>	moa
179	Brassicaceae	<i>Raphanus sativus</i>	wild radish
180	Euphorbiaceae	<i>Ricinus communis</i>	castor bean
181	Amaranthaceae	<i>Salsola tragus</i>	Russian thistle, tumbleweed
182	Santalaceae	<i>Santalum ellipticum</i>	iliahialoe, coast sandalwood
183	Goodeniaceae	<i>Scaevola taccada</i>	naupaka kahakai
184	Asteraceae	<i>Senecio madagascariensis</i>	fireweed
185	Fabaceae	<i>Senna gaudichaudii</i>	kolomona
186	Fabaceae	<i>Sesbania tomentosa</i>	ohai
187	Aizoaceae	<i>Sesuvium portulacastrum</i>	akulikuli, sea purslane
188	Poaceae	<i>Setaria verticillata</i>	bristly foxtail
189	Cucurbitaceae	<i>Sicyos pachycarpus</i>	anunu
190	Malvaceae	<i>Sida ciliaris</i>	red sida
191	Malvaceae	<i>Sida fallax</i>	ilima
192	Malvaceae	<i>Sida rhombifolia</i>	sida
193	Asteraceae	<i>Sigesbeckia orientalis</i>	small yellow crown-beard

Kaho'olawe Island Reserve Biosecurity Plan

Appendix L – Flora Survey of Kaho'olawe			
No.	Family	Species	Species
194	Brassicaceae	<i>Sisymbrium altissimum</i>	tumble mustard
195	Solanaceae	<i>Solanum americanum</i>	glossy nightshade, popolo
196	Solanaceae	<i>Solanum linnaeanum</i>	apple of Sodom
197	Solanaceae	<i>Solanum lycopersicum</i>	tomato
198	Asteraceae	<i>Sonchus oleraceus</i>	sow thistle, pualele
199	Asteraceae	<i>Sphagneticola trilobata</i>	Wedelia
200	Poaceae	<i>Sporobolus africanus</i>	rattail grass
201	Poaceae	<i>Sporobolus pyramidatus</i>	dropseed
202	Poaceae	<i>Sporobolus virginicus</i>	akiaki
203	Verbenaceae	<i>Stachytarpheta jamaicensis</i>	Jamaica vervain
204	Apocynaceae	<i>Stapelia gigantea</i>	zulu giant
205	Asteraceae	<i>Synedrella nodiflora</i>	nodeweed
206	Tamaraceae	<i>Tamarix aphylla</i>	tamarix
207	Fabaceae	<i>Tephrosia purpurea var. purpurea</i>	auhuhu, ahuhu
208	Malvaceae	<i>Thespesia populnea</i>	milo
209	Asteraceae	<i>Thymophylla tenuiloba</i>	dog fennel
210	Poaceae	<i>Tragus berteronianus</i>	bur grass
211	Zygophyllaceae	<i>Tribulus cistoides</i>	nohu
212	Aiaoaaceaea	<i>Trianthema portulacastrum</i>	Giant Pigweed - New island record (12/2017)
213	Asteraceae	<i>Tridax procumbens</i>	coat buttons
214	Poaceae	<i>Urochloa decumbens</i>	signal grass
215	Poaceae	<i>Urochloa maxima</i>	Guinea grass
216	Fabaceae	<i>Vachellia farnesiana</i>	klu
217	Verbenaceae	<i>Verbena litoralis</i>	vervain, oi
218	Asteraceae	<i>Verbesina encelioides</i>	golden crown-beard
219	Fabaceae	<i>Vigna o-wahuensis</i>	vigna
220	Lamiaceae	<i>Vitex rotundifolia</i>	pohinahina
221	Malvaceae	<i>Waltheria indica</i>	uhaloa
222	Asteraceae	<i>Xanthium strumarium var. canadense</i>	cocklebur
223	Asteraceae	<i>Zinnia peruviana</i>	pua pihi

Appendix L. Flora Survey of Kaho'olawe

Non-native flora from Starr Environmental, Bishop Museum Plant database for Kaho'olawe. (<http://www2.bishopmuseum.org/HBS/checklist/query.asp?grp=Plant>) Also, Corn et al., 1980.

APPENDIX M - Native Fauna Recorded on Kaho'olawe

	Taxa	Common Name	Hawaiian Name
1	<i>Anous minutus</i>	Black Noddy	Noio ('Eki'eki)
2	<i>Arenaria interpres</i>	Ruddy Turnstone	'Akekeke
3	<i>Asio flammeus sandwichensis</i>	Short Eared Owl	Pueo
4	<i>Bulweria bulwerii</i>	Bulwer`s Petrel	'Ou
5	<i>Calidris alba</i>	Sanderling	Hunakai
6	<i>Chelonia mydas</i>	Green Turtle	Honu
7	<i>Fregata minor palmerstoni</i>	Frigate Bird	'Iwa
8	<i>Halocaridina rubra</i>	Anchialine Pool Shrimp	Opae ula
9	<i>Heteroscelus incanus</i>	Wandering Tattler	'Ulili
10	<i>Lasiurus cinereus semotus</i> (E)	Hawaiian Hoary Bat	'Ōpe'a pe'a
11	<i>Larus sp.</i>	Migratory gulls	
12	<i>Manduca blackburni</i> (E)	Blackburn's Sphinx Moth	
13	<i>Neomonachus schauinslandi</i> (E)	Hawaiian Monk Seal	Ilio holo i ka uua
14	<i>Numenis tahitiensis</i>	Bristle thighed curlew	Kioea
15	<i>Nycticorax nycticorax</i>	Black Crowned Night Heron	'Auku'u
16	<i>Oceanodroma castro</i> (E)	Band rumped storm petrel	'Ake'ake
17	<i>Oceanodroma tristrami</i>	Tristans Storm Petrel	
18	<i>Phaethon lepturus</i>	White Tail Tropic Bird – Sea Cliffs	Koa'e Kea
19	<i>Phaethon rubricauda</i>	Red Tail Tropic Bird – Sea Cliffs	Koa'e Ula
20	<i>Phoebastria immutabilis</i>	Laysan Albatross	Moli
21	<i>Pterodroma sandwichensis</i> (E)	Hawaiian Petrel	Ua'u
22	<i>Pluvialis squatarola</i>	Black-bellied Plover	
23	<i>Pluvialis fulva</i>	Pacific Golden Plover	Kolea
24	<i>Puffinus pacificus</i>	Wedge-tailed Shearwater	'Ua'u kani
25	<i>Sterna fuscata</i>	Sooty Tern	'Ewa'ewa
26	<i>Sula dactylatra</i>	Masked Booby	'A
27	<i>Sula leucogaster</i>	Brown Booby	'A
28	<i>Sula sula</i>	Red footed Booby	'A
29	<i>Triops longicaudata</i>	Dinosaur Shrimp	

Appendix M. Native Fauna Recorded on Kaho'olawe. (E) = Federally Endangered

APPENDIX N - Non Native Fauna Recorded on Kaho'olawe

	Taxa	Common Name	IAS
1	<i>Acridotheres tristis</i>	Common Myna	
2	<i>Alectoris chukar</i>	Chukar	
3	<i>Alauda arvensis</i>	Eurasian Skylark	
4	<i>Anas sp.</i>	Unidentified Duck	
5	<i>Callipepla gambelii</i>	Gambel's Quail	
6	<i>Cardinalis cardinalis</i>	Northern Cardinal	
7	<i>Carpodacus mexicanus</i>	House Finch	
8	<i>Cettia diphone</i>	Japanese Bush-warbler	
9	<i>Columba livia</i>	Rock Dove	
10	<i>Cryptoblepharus boutoni poecilopleurus</i>	Snake-eyed Skink	
11	<i>Emoia cyanura</i>	Azur-tailed Skink	
12	<i>Felis catus</i>	Feral Cat	*
13	<i>Gehyro mutilata</i>	Stump-toed Gecko	
14	<i>Geopelia striata</i>	Zebra Dove	
15	<i>Hemidactylus frenatus</i>	House gecko	
16	<i>Hemidactylus garnoti</i>	Indo-Pacific Gecko (Fox gecko)	
17	<i>Hemiphylodactylus typus typus</i>	Tree Gecko	
18	<i>Leiopisma metallicum</i>	Metallic Skink	
19	<i>Lepidodactylus lugubris</i>	Mourning Gecko	
20	<i>Ligia sp.</i>		
21	<i>Lipinia noctua noctua</i>	Moth Skink	
22	<i>Lonchura malabarica</i>	Warbling Silverbill	
23	<i>Lonchura punctulata</i>	Nutmeg Mannikin	
24	<i>Mimus polyglottos</i>	Northern Mockingbird	
25	<i>Mus musculus</i>	House Mouse	*
26	<i>Paroaria coronata</i>	Red-crested Cardinal	
27	<i>Passer domesticus</i>	House Sparrow	
28	<i>Rattus exulans</i>	Polynesian Rat	*
29	<i>Streptopelia chinensis</i>	Spotted Dove	
30	<i>Tyto alba</i>	Barn Owl	*
31	<i>Zosterops japonicus</i>	Japanese White-eye	

Appendix N. Non Native Fauna Recorded on Kaho'olawe

* = IAS

APPENDIX O - Arthropods Recorded on Kaho'olawe

Appendix O - Arthropods Recorded on Kaho'olawe		
Number	Taxa	Common Name
1	<i>Acanthoscelides obtectus</i> (?)	Bean Weevil
2	<i>Achaea janata</i>	Castor Semi Looper
3	<i>Acrosticha apicalis</i>	
4	<i>Aedes albopictus</i>	
5	<i>Afrolistophorus musculus</i>	Fur Mite
6	<i>Algarobius bottimeri</i>	Kiawe Bean Weevil
7	<i>Allograpta exotica</i>	Syrphid Fly
8	<i>Allograpta obliqua</i>	Hover fly
9	<i>Alydus pilosus</i>	Broad Headed bug
10	<i>Amastra morticina</i>	Amastrid Land Snail
11	<i>Amastra</i> sp.	Amastrid Land Snail
12	<i>Amorbia (emigratella?)</i>	Mexican Leaf Roller
13	<i>Amphicerus cornutus</i>	Powderpost Bostrichid
14	<i>Ampulex compressa</i>	Emerald Cockroach Wasp
15	<i>Anacamptodes fragilaria</i>	Koa Haole Moth, Citrus Looper
16	<i>Anax junius</i>	Green Darner Dragonfly
17	<i>Androlaelaps hermaphrodita</i>	
18	<i>Anoplolepis gracilipes</i>	Yellow Crazy Ant
19	<i>Anthicus vexator</i>	
20	<i>Aphelacarus</i> sp.	
21	<i>Aphis nerii</i>	
22	<i>Apis mellifera</i>	European Honey Bee
23	<i>Aracerus levipennis</i>	
24	<i>Archytas cirphis</i>	Mexican Cutworm Tachinid
25	<i>Argiope appensa</i>	Garden Spider
26	<i>Argius cingulata</i>	Sweet Potato Hornworm
27	<i>Ascalapha odorata</i>	Black Witch
28	<i>Asynonychus godmanii</i>	Fuller Rose weevil
29	<i>Atropacarus singularis</i>	
30	<i>Bactrocera dorsalis</i>	Oriental Fruit Fly
31	<i>Barichneumon californicus</i>	
32	<i>Blaesoxipha plinthopyga</i>	
33	<i>Borborillus sordidus</i>	
34	<i>Brachydeutera hebes</i>	
35	<i>Brachydeutera ibari</i>	
36	<i>Brachystomella? contorta?</i>	
37	<i>Bradybaena similis</i>	Succineid Snail
38	<i>Bradysia nr. hoyti</i>	(bishopi?)
39	<i>Bradysia radicum</i>	

Kaho'olawe Island Reserve Biosecurity Plan

Appendix O - Arthropods Recorded on Kaho'olawe		
Number	Taxa	Common Name
40	<i>Bradysia spatitergum</i>	
41	<i>Bradysia tritici</i>	
42	<i>Brephidium exilis</i>	Western Pigmy Blue
43	<i>Brumoides saturalis</i>	
44	<i>Bryania bipunctata</i>	
45	<i>Caconemobius howarthi?</i>	
46	<i>Cadrema pallida</i>	
47	<i>Camponotus variegatus</i>	Carpenter Ant
48	<i>Canaceoides angulatus</i>	
49	<i>Carabidae sp.</i>	Carabid Beetle
50	<i>Cardiocondyla sp.</i>	Ant
51	<i>Ceratina arizonensis</i>	Small Carpenter Bee (native)
52	<i>Ceropsilopa coquilletti</i>	
53	<i>Chaetogaedia monticola</i>	
54	<i>Cheiracanthium diversum?</i>	Pale Leaf Spider
55	<i>Cheiracanthium mordax</i>	
56	<i>Chelonus blackburni</i>	
57	<i>Chrysodeixis erisoma</i>	Green Garden Looper
58	<i>Chrysomya megacephala</i>	Oriental Blow Fly
59	<i>Chrysosoma globiferum</i>	
60	<i>Chrysosoma sp.</i>	
61	<i>Clasiopella uncinata</i>	
62	<i>Clogmia albipunctata?</i>	
63	<i>Coccinella septempunctata</i>	Seven Spotted Ladybird
64	<i>Coelophora inequalis</i>	
65	<i>Collembola</i>	Springtail
66	<i>Copromyza equina</i>	
67	<i>Corythuca morrilli</i>	Morrill Lace Bug
68	<i>Cosymbia serrulata</i>	Geometrid caterpillar/Kiawe Flower Looper
69	<i>Cremastobombycia lantanelle</i>	Lantana Leaf Miner
70	<i>Cryptolaemus montrouzieri</i>	Mealy Bug Destroyer
71	<i>Cryptotermes brevis</i>	Drywood Termite
72	<i>Ctenolepisma sp.</i>	Bristletail
73	<i>Cubaris murina</i>	
74	<i>Curinus coeruleus</i>	Metallic Blue Ladybird Beetle
75	<i>Cyclophora nanaria</i>	Dwarf Tawny Wave
76	<i>Danaus plexippus</i>	Monarch butterfly
77	<i>Delta campaniforme ssp. Esuiens</i>	Yellow and Black Potter Wasp
78	<i>Delta campniforme</i>	Yellow Potter Wasp
79	<i>Diachus auratus</i>	Bronze Leaf Beetle

Kaho'olawe Island Reserve Biosecurity Plan

Appendix O - Arthropods Recorded on Kaho'olawe		
Number	Taxa	Common Name
80	<i>Diomus notescens</i>	Minute Two Spotted Ladybird
81	<i>Dioxya sorocula</i>	
82	<i>Diploptera punctata</i>	Cypress Cockroach
83	<i>Diptera sp.</i>	Aquatic Fly
84	<i>Dolichurus stantoni</i>	Black Cockroach Wasp
85	<i>Draeculacephala minerva</i>	
86	<i>Drosophila melanogaster</i>	
87	<i>Drosophila sulfurigaster bilimbata</i>	
88	<i>Ectemnius distinctus</i>	Sphecid wasp
89	<i>Ectemnius mandibularis</i>	Sphecid wasp
90	<i>Ectomyelois ceratoniae</i>	Carob Moth
91	<i>Eidoleon wilsoni</i> , <i>E. perjurus</i>	Hawaiian Ant Lion
92	<i>Elaphria nucicolora</i>	
93	<i>Entomobrya atrocincta</i>	
94	<i>Entomobrya multifasciata</i>	
96	<i>Epitrix hirtipennis</i>	Flea Beetle
95	<i>Eristalinus arvorum</i>	Syrphid Fly
97	<i>Ethirothrips brevis</i>	
98	<i>Ethonia nigroapicella</i>	Kou Leaf Worm
99	<i>Eublemma accedens</i>	Uhaloa Moth
100	<i>Euborellia annulipes</i>	Earwig
101	<i>Euborellia eteronoma</i>	Earwig
102	<i>Eucelatoria armigera</i>	
103	<i>Euchromius ocellus</i>	Grass veneer moth
104	<i>Eupodes hawaiiensis</i>	
105	<i>Euryomma? peregrina</i>	
106	<i>Euthyrrhapha pacifica</i>	Pacific cockroach
107	<i>Evania appendigaster</i>	Larger ensign wasp
108	<i>Eysarcoris ventralis</i>	Small Stinkbug
109	<i>Folsomides? parvulus?</i>	
110	<i>Galumna flabellifera</i>	
111	<i>Gasteracantha mammosa</i>	Asian spiny backed spider
112	<i>Gastrocopta servillis</i>	Pupillid Land Snail
113	<i>Gnathaphanus picipes</i>	
114	<i>Gonocephalum adpressiforme</i>	
115	<i>Graptostetus manillensis</i>	
116	<i>Gryllodes sigillatus</i>	Flightless Field Cricket
117	<i>Gymnochiromyia hawaiiensis</i>	
118	<i>Halobates sericeus</i>	Pelagic water strider
119	<i>Haplothrips gowdeyi</i>	Black Flower Thrips
120	<i>Hecamede granifera</i>	

Kaho'olawe Island Reserve Biosecurity Plan

Appendix O - Arthropods Recorded on Kaho'olawe		
Number	Taxa	Common Name
121	<i>Helcinia sp.</i>	Helicinid Land Snail
122	<i>Hemicheyletia bakeri</i>	
123	<i>Herpetogramma licarsisalis</i>	Grass webworm
124	<i>Heterospilus prosopidus</i>	
125	<i>Hierodula patellifera</i>	Giant Asian Mantis
126	<i>Hoplophorella singularis</i>	
127	<i>Hydrellia tritici</i>	
125	<i>Hylaeus anthracinus</i> (E)	Yellow-faced Bee
124	<i>Hylaeus assimilans</i> (E)	Yellow-faced Bee
128	<i>Hylaeus connectans</i>	Yellow Faced Bee
129	<i>Hyles lineata</i>	White-lined Sphinx
130	<i>Hypena strigata</i>	Lantana Biocontrol Moth
131	<i>Hyposmocoma sp</i>	
132	<i>Hypozetes laysanensis</i>	
133	<i>Ischnura ramburii</i>	Ramburs forktail
134	<i>Isometrus maculatus</i>	Scorpion
135	<i>Kilauella debilis?</i>	
136	<i>Lamellina gracilis</i>	Achatinellid Land Snail
137	<i>Lampides boeticus</i>	Bean Butterfly
138	<i>Lasioglossum spp.</i>	Halticid Sweat Bee
139	<i>Latrodectus geometricus</i>	Brown Widow Spider
140	<i>Latrodectus hesperus?</i>	
141	<i>Lepidocyrtus sp.</i>	
142	<i>Leptachatina sp.</i>	Amastrid Land Snail
143	<i>Leptachatina subcylindricea</i>	Amastrid Land Snail
144	<i>Leptobrysa decora</i>	Lace Bug
145	<i>Leptogenys falcigera</i>	Ant
146	<i>Lespesia archippivora</i>	Lesser Army Worm Parasite Fly
147	<i>Leucopis albipuncta</i>	
148	<i>Linepithema humilis</i>	Argentine Ant
149	<i>Lispe metatarsalis</i>	
150	<i>Lumbricadae</i>	Earthworm
151	<i>Lycophotia porphyrea</i>	
152	<i>Lygaeidae sp.</i>	Lygaeid Seed Bug
153	<i>Lyropupa kahoolavensis</i>	Pupillid Land Snail
154	<i>Lyropupa sp.</i>	Pupillid Land Snail
155	<i>Macaria abydata</i>	Koa haole Moth, Dot Lined Angle
156	<i>Manduca blackburni</i> (E)	Blackburn's Sphinx Moth
157	<i>Mantidae spp.</i>	Praying Mantid
158	<i>Megalographa biloba</i>	Bilobed Looper
159	<i>Megalorhipida leucodactyla</i>	

Kaho'olawe Island Reserve Biosecurity Plan

Appendix O - Arthropods Recorded on Kaho'olawe		
Number	Taxa	Common Name
160	<i>Melipotis indomita</i>	Monkeypod-Kiawe Caterpillar, Indomitable Melipotus
161	<i>Melophagus ovinus</i>	Sheep Ked
162	<i>Melormenis basilis</i>	West Indian Flatid Planthopper
163	<i>Micraspis lineola</i>	Ladybird Beetle
164	<i>Mimosestes nubigens</i>	
165	<i>Miridae spp.</i>	Mirid Plant bug
166	<i>Monomorium bicolor complex</i>	Ant
167	<i>Monomorium destructor</i>	Destructive Trailing Ant
168	<i>Monomorium floricola</i>	Bicolored Trailing Ant
169	<i>Monomorium pharaonius</i>	Pharaoh Ant
170	<i>Multioppia wilsoni</i>	
171	<i>Myobia musculi</i>	Fur Mite
172	<i>Myocoptes musculinus</i>	Fur Mite
173	<i>Mythimna (loreyimima?)</i>	Sugar Cane Armyworm
174	<i>Mythimna (scottii?)</i>	
175	<i>Neacoryphus bicrucis</i>	Whitecrossed Seed Bug
176	<i>Neoscona oaxacensis</i>	Western Spotted Orb Weaver
177	<i>Neoseiulus oahuensis</i>	
178	<i>Neostylopyga rhombifolia</i>	Harlequin Cockroach
179	<i>Nesoclimacias lanaiensis?</i>	
180	<i>Nesopupa dispersa</i>	Pupillid Land Snail
181	<i>Nesopupa newcombi interrupts</i>	Pupillid Land Snail
182	<i>Nesopupa sp.</i>	Pupillid Land Snail
183	<i>Nezara viridula</i>	Southern Green Stinkbug
184	<i>Notobia purpurascens</i>	
185	<i>Nylanderia bourbonica</i>	Ant
186	<i>Nysius coenosulus</i>	
187	<i>Nysius kinbergi</i>	
188	<i>Nysius sp.</i>	Seed Bug
189	<i>Nysius terrestris</i>	
190	<i>Ochetellus glaber</i>	Ant
191	<i>Ochthera circularis?</i>	
192	<i>Odonata spp.</i>	Dragonfly
193	<i>Oechalia pacifica</i>	Native Stinkbug
194	<i>Oestrus ovis</i>	Sheep Bot Fly
195	<i>Oligotoma saundersii</i>	
196	<i>Ollan v-nigrum</i>	Ladybird Beetle
197	<i>Omiodes blackburnii</i>	Coconut Leaf roller
198	<i>Omiodes continuatalis</i>	Grass Leaf roller
199	<i>Omiodes demaratalis</i>	Grass Leaf Roller

Kaho'olawe Island Reserve Biosecurity Plan

Appendix O - Arthropods Recorded on Kaho'olawe		
Number	Taxa	Common Name
200	<i>Opeas clavulinum hawaiiense</i>	Subulinid Land Snail
201	<i>Opeas javanicum</i>	Subulinid Land Snail
202	<i>Oppia sp.</i>	
203	<i>Ornithonyssus bacoti</i>	Tropical Rat Mite
204	<i>Orobatidae spp.</i>	Orobatid Mite
205	<i>Orthemis ferruginea</i>	Libellulid Dragonfly
206	<i>Orthomecyna keoniae</i>	
207	<i>Orthomecyna sp.</i>	Orthomecyna Crambid Moth
208	<i>Otobius megnini</i>	Ear Tick
209	<i>Oxydema longulum</i>	
210	<i>Pachodynerus nasidens</i>	
211	<i>Pachodynerus spp.</i>	Ichneumonid Wasp
212	<i>Pagiopalus atomarius</i>	Cane Hunting Spider
213	<i>Pantala flavescens</i>	Globe Skimmer
214	<i>Paratrechina longicornis</i>	Black Crazy Ant
215	<i>Paurocephala sp.</i>	
216	<i>Pelypedilum nubiferum</i>	Chronomid Midge Spotted Wing
217	<i>Periplaneta americana</i>	American Cockroach
218	<i>Phanerotoma hawaiiensis</i>	
219	<i>Pheidole megacephala</i>	Big-headed Ant
220	<i>Phidippus? audax</i>	
221	<i>Philonesia guavarum</i>	Helicarionid Land Snail
222	<i>Philonesia sp.</i>	Helicarionid Land Snail
223	<i>Pigrita uuku</i>	
224	<i>Pigritia sp</i>	
225	<i>Placopsidella grandis</i>	
226	<i>Placosternus crinicornis</i>	Kiawe Round Headed Borer
227	<i>Planiocephalus flavicosta</i>	Leafhopper
228	<i>Platosciara adrostylata</i>	
229	<i>Platosciara pernicioso</i>	
230	<i>Platyzosteria soror</i>	White Margined Cockroach
231	<i>Plautia stali</i>	
232	<i>Polistes aurifer</i>	
233	<i>Polistes exclamens</i>	Common Paper Wasp
234	<i>Polistes spp.</i>	Ichneumonid Wasp
235	<i>Porcellio laevis</i>	Isopod
236	<i>Proisotoma centralis</i>	
237	<i>Proprioseiopsis ovatus</i>	
238	<i>Protaetia fusca</i>	Mango Flower Beetle
239	<i>Pseudopterocheilus congruus</i>	Vespid Wasp
240	<i>Psoroptes ovis</i>	Sheep Scab Mite

Kaho'olawe Island Reserve Biosecurity Plan

Appendix O - Arthropods Recorded on Kaho'olawe		
Number	Taxa	Common Name
241	<i>Pseudopterocheilus spp.</i>	Wasp
242	<i>Pseudomyrmex gracilis</i>	Elongate Twig Ant
243	<i>Psychoda nr. alternata</i>	
244	<i>Ptycta sp.1</i>	
245	<i>Ptycta sp.2</i>	
246	<i>Pycnoscelus indicus</i>	Suriname Cockroach
247	<i>Radfordia affinis</i>	Fur Mite
248	<i>Rodiola cardinalis</i>	
249	<i>Sarcophaga africa</i>	
250	<i>Scapheremaeus sinuosus</i>	
251	<i>Scaptomyza (Bunostoma) sp.</i>	
252	<i>Scatella bryani</i>	
253	<i>Scatella hawaiiensis</i>	
254	<i>Sceliphron caementarium</i>	
255	<i>Schelorbates elegans</i>	
256	<i>Schistocerca nitens</i>	Gray Bird Grasshopper
257	<i>Scolopendra subspinipes</i>	Centipede
258	<i>Scopula personata</i>	
259	<i>Scymnodes lividigaster</i>	Yellow Shouldered Lady Beetle
260	<i>Scymnus loewii</i>	
261	<i>Seira terrestris</i>	
262	<i>Simosyrphus grandicornis</i>	
263	<i>Sinoxylon conigerum</i>	
264	<i>Sminthurides biniserratus</i>	
265	<i>Sminthurides lolelua</i>	Sminthurid Springtail
266	<i>Sminthurinus kaha</i>	
267	<i>Solenopsis geminata</i>	Tropical Fire Ant
268	<i>Spanagonicus albofasciatus</i>	Whitemarked Fleahopper
269	<i>Spathius prusius</i>	
270	<i>Specularis impressithorax</i>	Wiliwili Bruchid
271	<i>Sphaerochthonius suzukii</i>	
272	<i>Spinibdella bioculata</i>	
273	<i>Spoladea recurvalis</i>	Hawaiian Beet Webworm
274	<i>Stator limbatus</i>	Bean Weevil
275	<i>Stator pruininus</i>	Bean Weevil
276	<i>Stenocorse bruchivorus</i>	
277	<i>Stoeberhinus testaceus</i>	Potato Moth
278	<i>Striatura sp. OR Hawaiia sp.</i>	Zonitid Land Snail
279	<i>Strymon bazochi</i>	Lantana Scrub Hairstreak
280	<i>Styrgomyia didyma</i>	
281	<i>Succinea sp.</i>	Succineid Land Snail

Kaho'olawe Island Reserve Biosecurity Plan

Appendix O - Arthropods Recorded on Kaho'olawe		
Number	Taxa	Common Name
282	<i>Sybra alternans</i>	Longhorned Beetle
283	<i>Symploce capitata</i>	
284	<i>Syntormon flexibilis</i>	
285	<i>Tachinidae spp.</i>	Tachinid Fly
286	<i>Tamisca kawikae? (sp.)</i>	
287	<i>Tamisca sp.</i>	
288	<i>Tapinoma melanocephalum</i>	Ant
289	<i>Technomyrmex albipes</i>	White Footed Ant
290	<i>Tectocephus sarekensis</i>	
291	<i>Tenodera aridifolia sinensis</i>	Praying Mantis
292	<i>Tethina variseta</i>	
293	<i>Tethina willistoni</i>	
294	<i>Tetramorium bicarinatum</i>	Guinea Ant
295	<i>Tetramorium caldarium</i>	Ant
296	<i>Tetramorium simillmium</i>	Ant
297	<i>Thaumatodon sp.</i>	Endodontid Land Snail
298	<i>Thyanta custator (?)</i>	Red shoulder stink bug
299	<i>Thyrocopa epicapna</i>	
300	<i>Thyrocopa kanaloa</i>	
301	<i>Tornatellides kahoolavensis (E)</i>	Achatinellid Land Snail
302	<i>Tornatellides spp.</i>	Achatinellid Land Snail
303	<i>Tortanellina baldwini</i>	Achatinellid Land Snail
304	<i>Toxomerus marginatus</i>	
305	<i>Tramea lacerata</i>	Black saddlebags, ragedy skimmer
306	<i>Trichocorixa reticulata</i>	Water Boatman
307	<i>Trichorhina tomentosa</i>	
308	<i>Trupanea crassipes</i>	
309	<i>Udara blackburnii</i>	Hawaiian Blue Butterfly
310	Unidentified sp.	Thiarid Land Snail
311	Unidentified sp.	Water Boatmen
312	<i>Unknown sp.</i>	Water Boatman (?)
313	<i>Urophorus humeralis</i>	Sap Beetle
314	<i>Uroplata girardi</i>	Leaf mining Lantana beetle
315	<i>Urosigalphus bruchi</i>	
316	<i>Vanduzea segmentata</i>	Vanduzea Treehopper
317	<i>Vepracarus sp.</i>	
318	<i>Xenopsylla cheopis</i>	Oriental Rat Flea
319	<i>Xenylla yucatana</i>	
320	<i>Xylocopa sonorina</i>	Carpenter bee
321	<i>Xylopsocus casanoptera</i>	

Kaho'olawe Island Reserve Biosecurity Plan

Appendix O - Arthropods Recorded on Kaho'olawe		
Number	Taxa	Common Name
322	<i>Xystrologa sp.</i>	
323	<i>Zelus renardii</i>	Leaf Hopper Assassin Bug

Appendix O. Arthropods recorded on Kaho'olawe. (Ants N=18)

Literature Cited for Arthropods recorded on Kaho'olawe (Appendix O)

Beardsley, J.W. & W.D. Perreira. 2000. New distribution records for non-endemic Hymenoptera (Insecta) in Hawai'i. Bishop Mus. Occas. Pap. 63(1): 21-30.

Eijzenga, H. & K. Wood. 2008. Offshore Islet Survey.

Foote, D. 1997. Database of arthropods recorded from Kahoolawe.

Evenhuis, N.L. 2000. New Hawaiian Diptera records, with special reference to the Diptera of Kaho'olawe. Bishop Mus. Occas. Pap. 64(2): 22-27.

Gon, Samuel III and Gail Chun, 1992. Biological Database and Reconnaissance Survey of Kaho'olawe Island. Including Rare Plants, Animals, and Natural Communities. Prepared for Kaho'olawe Island Conveyance Commission. Prepared by Hawai'i Natural Heritage Program, The Nature Conservancy of Hawai'i. Kaho'olawe Biological Reconnaissance Report August 1992.

Medeiros, M. 2008. Checklist of moths collected on Kahoolawe in Oct. 2008.

Medeiros, M. 2009. A revision of the endemic Hawaiian genus *Thyrocopa* (Lepidoptera: Crambidae & Coleophridae) Zootaxa 2201 1-47.

Medeiros, Matthew, and David Adamski, 2012. Three New Species of Hawaiian Moths from Kaho'olawe Island (Lepidoptera: Crambidae & Coleophridae) Zootaxa 3341:p59-63.

Miller, S.E. 1996. Range expansions and name changes for moths (Lepidoptera) in the Hawaiian Islands. Bishop Mus. Occas. Pap. 46(2): 28-31.

Nishida, G.M. 1994. Hawaiian Terrestrial Arthropod Checklist. 2nd ed. Bishop Museum Technical Report No. 4, Bishop Museum, Honolulu, HI.

Nishida, G.M. 2002. Online Searchable Hawaiian Arthropod Checklist Database. Bishop Museum, Honolulu, HI.

Shelley, R.M. 1991. Deletion of the centipede *Theatops spinicaudus* (Wood) from the Hawaiian fauna (Scolopendromorpha: Cryptopidae). Bishop Mus. Occas. Pap. 31: 182-84.

Literature Cited for Arthropods recorded on Kaho'olawe (Appendix O)

Samuelson, A. 2003 in press. Bishop Museum Occasional Papers.

Starr, F., K. Starr, and L. Loope. 2004. New Arthropod Records from Kaho'olawe. Bishop Mus. Occas. Pap. 79:50-54.

Starr, F., K. Starr, and L. Loope. 2006. New Arthropod Records from Kaho'olawe. Bishop Mus. Occas. Pap. 88:47-53.

Starr, F., K. Starr, and L. Loope. 2008 In Press. New Arthropod Records from Kaho'olawe. Bishop Mus. Occas. Pap.

Starr, F. & K. Starr. 2010 in press. New Ant (Hymenoptera: Formicidae) Records from Maui Nui.

Starr, F. & K. Starr. December, 2015 in Press. 10 new insects from Kaho'olawe.

Taiti, S. & F.G. Howarth. 1996. Terrestrial isopods from the Hawaiian Islands (Isopoda: Oniscidea). Bishop Mus. Occas. Pap. 45(1): 59-71.

Vorsino, Adam E., Cynthia B. King, William P. Haines, Daniel Rubinoff, 2013. Modeling the Habitat Retreat of the rediscovered Endemic Hawaiian Moth *Omiodes continualis* Wallengren (Lepidoptera: Crambidae). PLOS One January 2013 Vol. 8 Issue 1, e51885 11pp.

APPENDIX P- Hawai'i Administrative Rules - State Regulations

- **Department of Agriculture** (Title 4)
 - Division of Plant Industry (Subtitle 6)
 - Seed Rules (Chapter 67)
 - Noxious Weed Rules (68)
 - Pests for Control or Eradication (69A)
 - Plant and Non-Domestic Animal Quarantine Plant Import Rules (70)
 - Plant and Non-Domestic Animal Quarantine Non- Domestic Animal Quarantine Import Rules (71)
 - Plant and Non-Domestic Animal Quarantine Microorganism Import Rules (71A)
 - Plant and Non- Domestic Animal Quarantine Plant Intrastate Rules (Amended 72)
 - Plant and Non-Domestic Quarantine Plant Export Rules (73)

- **Department of Land and Natural Resources** (Title 13)
 - Fisheries (Subtitle 4)
 - Fisheries Resource Management (Part IV)
 - Non- Indigenous Aquatic Species
 - Protected Freshwater Fisheries Resources (Part VI)
 - Introduced Fresh Water Fishes (Chapter 99)
 -

Hawai'i Revised Statutes

- Agriculture and Animals (Title 11)
 - Noxious Weed Control (Chapter 152)
 - Prohibited Acts (152-3)
 - Noxious Weed Control and Eradication (152-6)
- Conservation and Resources (Title 12)
 - Aquatic Resources (Chapter 187A)
 - Release and Confiscation of Harmful Aquatic Life (187A-6.5)
 - Alien Aquatic Organisms (187A-32)
 - Invasive Species Council (Chapter 194)
 - General Provision Relating to Aquatic Resources and Wildlife (Chapter 197)
 - Introduction of aquatic life and wildlife (197-3)
- Property (Title 28)
 - Landowners liability for access to control invasive species (Chapter 520)

End of KIR Biosecurity Implementation Plan