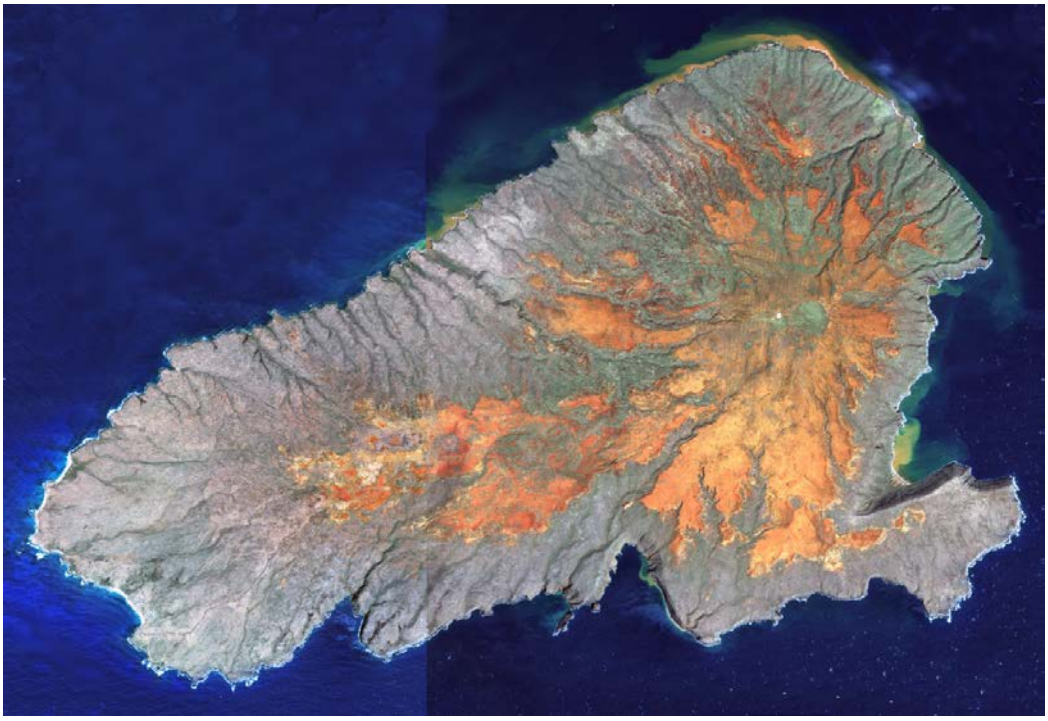
KAHO‘OLAWE ISLAND RESERVE BIOSECURITY IMPLEMENTATION PLAN



Fire Ant (*Wasmannia auropunctata*) G. Brilmyer

Ship Rat (*Rattus rattus*)

Prepared by
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VER. 7 FEBRUARY 2017

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CAPS - Cooperative Agricultural Pest Survey

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 – Hawaiʻi Department of Agriculture

HEAR - Hawaiʻi Ecosystems At Risk

HIOSH - Hawaii Occupational Safety and Health

HISC - Hawaiʻi Invasive Species Council.

HPWRA - Hawaiʻi Pacific Weed Risk Assessment

IAS - Invasive Alien Species

IPM – Integrated Pest Management

KIR - Kahoʻolawe Island Reserve.

KIRC - Kahoʻolawe Island Reserve Commission.

LFA - Little Fire Ant (*Wasmannia auropunctata*)

OSHA - Occupational Safety and Health Administration

PKO - Protect Kahoʻolawe Ohana

PPE - Personal Protective Equipment

RBP- Regional Biosecurity Plan for Micronesia and Hawaiʻi

RCRA - Resource Conservation and Recovery Act

U.S. DOA - United States Department of Agriculture

U.S. DOD - Unites States Department of Defense

U.S. DOI - United States Department of Interior

UXO – Unexploded ordnance

WPS - Worker Protection Standards

EXECUTIVE SUMMARY

Hawaiʻi receives annually 15 new introductions of non-native (alien) species on average, and certain species are considered "invasive" because they invade and establish populations in new areas. Hawaiʻi's invasive species problem is also the most severe of any State in the U.S. This Biosecurity Implementation Plan for the Kahoʻolawe Island Reserve (KIR) was written for a Hawaiʻi Invasive Species Council (HISC) grant entitled "Biosecurity Implementation Plan for the Island of Kahoʻolawe". A KIR Biosecurity Advisory Committee comprised of personnel from the Kahoʻolawe Island Reserve Commission (KIRC) and Protect Kahoʻolawe Ohana (PKO) guides this document and established protocols and ensures the goal and objectives are met. This Plan has one goal of keeping new Invasive Alien Species (IAS) from entering the KIR and 3 actions using a Prevention and Early Detection/Rapid Response (ED/RR) approach to obtain the goal: Three (3) actions 1.) Prevention, 2.) Detection and 3.) Response are crucial to a successful Biosecurity Plan and preventing new IAS from entering the KIR. Prevention is key and does not allow IAS to enter the KIR of which Education is an essential component. Detection consists of keen observations and monitoring from KIRC Staff and Volunteers PKO, and Passenger/Cargo Transport Companies. Response includes Quarantine and Eradication which occurs on site and is an immediate mitigation of IAS with the Rapid Response Kit

The island of Kahoʻolawe, the smallest of eight Main Hawaiian Islands, is under the jurisdiction of the State of Hawaiʻi and the Kahoʻolawe Island Reserve Commission (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 Hawaiʻi by the Navy in 1994, the 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 Kahoʻolawe. Results of floral and faunal (vertebrate and arthropod) surveys on Maui and Kahoʻolawe are included. Plant nursery protocols for IAS are established as well as methods for control and eradication. 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 Reserve.

This Biosecurity Plan is intended to identify necessary protocols, vectors and quarantine procedures, and will continue to develop with the assistance of the KIR Advisory Committee, field experts and personnel involved with controlling access into the KIR.

I. INTRODUCTION AND BACKGROUND

Hawaiʻi (Figure 1) receives an average of 15 new introductions of non-native (alien) species on an annual basis. Certain species are considered "invasive" because they invade and establish populations in new areas.

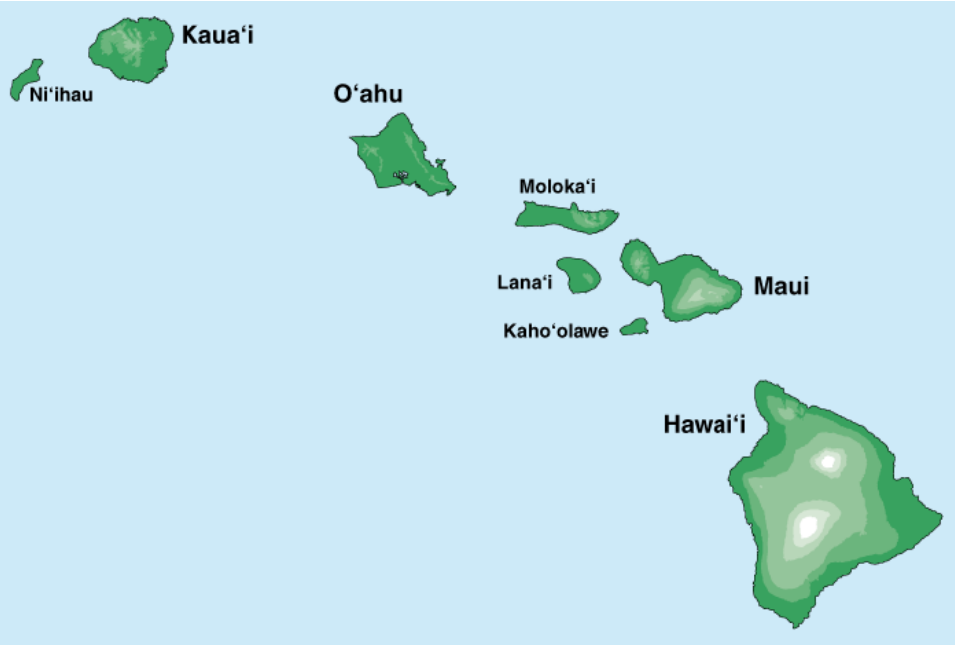

Figure 1. State of Hawaiʻi

Invading non-native species in the United States cause major environmental damage and losses adding up to more than $138 billion per year (Pimental et al., 1999). Hawaiʻi'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 invasive species 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). "Biosecurity" refers to measures that are taken to stop the spread or introduction of Invasive Alien Species (IAS) to animal and plant life, and is also the set of measures taken to manage the risk from invasive species to the economy, environment, and health and lifestyle of the people. An IAS is an organism (plant, fungus, bacteria or animal species) that is not native to a specific location, and which has a tendency to spread. Alien plants and animals can represent serious threats to the survival of native organisms and natural communities (KICC, 1992a). Possible vectors and locations with biosecurity risks are shown in Figure 2 and Table 1. This Biosecurity Plan was prepared by the Kahoʻolawe Island Reserve Commission (KIRC) for the Hawaiʻi Invasive Species Council (HISC) grant entitled "Biosecurity Implementation Plan for the Island of Kahoʻolawe" in FY16-17. It is intended to identify recommended protocols, vectors and quarantine procedures.

Hawaiʻi's Interagency Biosecurity Plan (HIBP) for 2017-2027 is a coordinated path forward to increase support for local agriculture, protection for our environment, and safeguards for the health and lifestyle of Hawaiʻi's people. The Biosecurity Vision for

Hawaiʻi's people, visitors, economy, agriculture, and natural environment to be protected from the impacts of invasive species. Achieving this will require hard work, policy development, and financial commitment (HIBP, 2016).

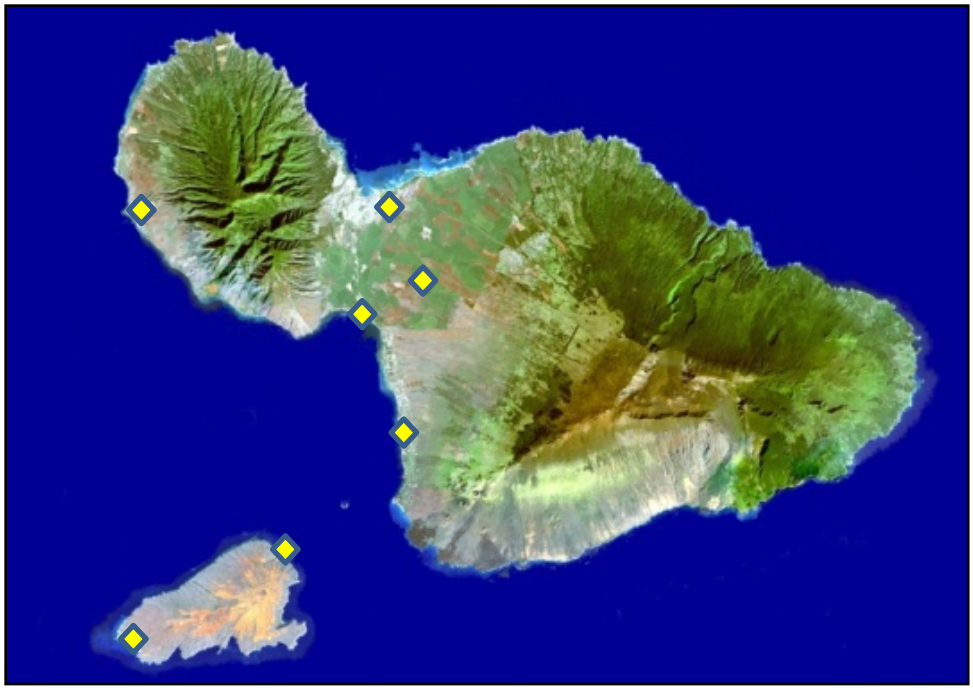

Figure 2. Types and locale of vectors for IAS to reach locations on Kahoʻolawe

Maui and the island of Kahoʻolawe including main ports of departure and entry with biosecurity risks (Table 1). Ports are located at boat harbors and also air fields.

Vector	**Locale**	**Kahoʻolawe**
Helicopter	Kahului Heliport, Puʻu Nene Airfield	LZ Base Camp, LZ Quail LZ-1
Boat	Kihei Boat Ramp, Maʻalaea, Lahaina, Kaunakakai, Kaneohe	Honokanaiʻa, Honokoʻa, Kuheʻeia, Hakioawa, Kanapou
Wind	Maui Nui (Maui, Molokaʻi, Lanaʻi)	Kahoʻolawe
People	All of the above	All of the above

Table 1 Types and locale of vectors for IAS to reach locations on Kahoʻolawe

Natural History

The island of Kahoʻolawe, 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. Kahoʻolawe is 17 km (10.6 mi.) long, 11 km (7 mi.) wide and 11,520 ha (28,800A) in size (45 mi^2). Its highest peak reaches 450 m (1477 ft). Kahoʻolawe 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 19ºC to 31ºC (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.

Kahoʻolawe 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, Band-rumped storm petrel and also is an important site for Hawaiian monk seal pupping.

Land Use and Land Owners

Kahoʻolawe is under the jurisdiction of the State of Hawaiʻi, 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 Hawaiʻi State Legislature in 1993 to manage the Kahoʻolawe 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 Protect Kahoʻolawe ʻOhana (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 ʻĀina, love of the land MISSION: To perpetuate Aloha ʻĀina throughout our islands through cultural, educational, and spiritual activities that heal and revitalize the cultural and natural resources on Kanaloa-Kahoʻolawe.

The majority of Kahoʻolawe 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 Kahoʻolawe 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 Hawaiʻi by the Navy in 1994, the Navy 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.

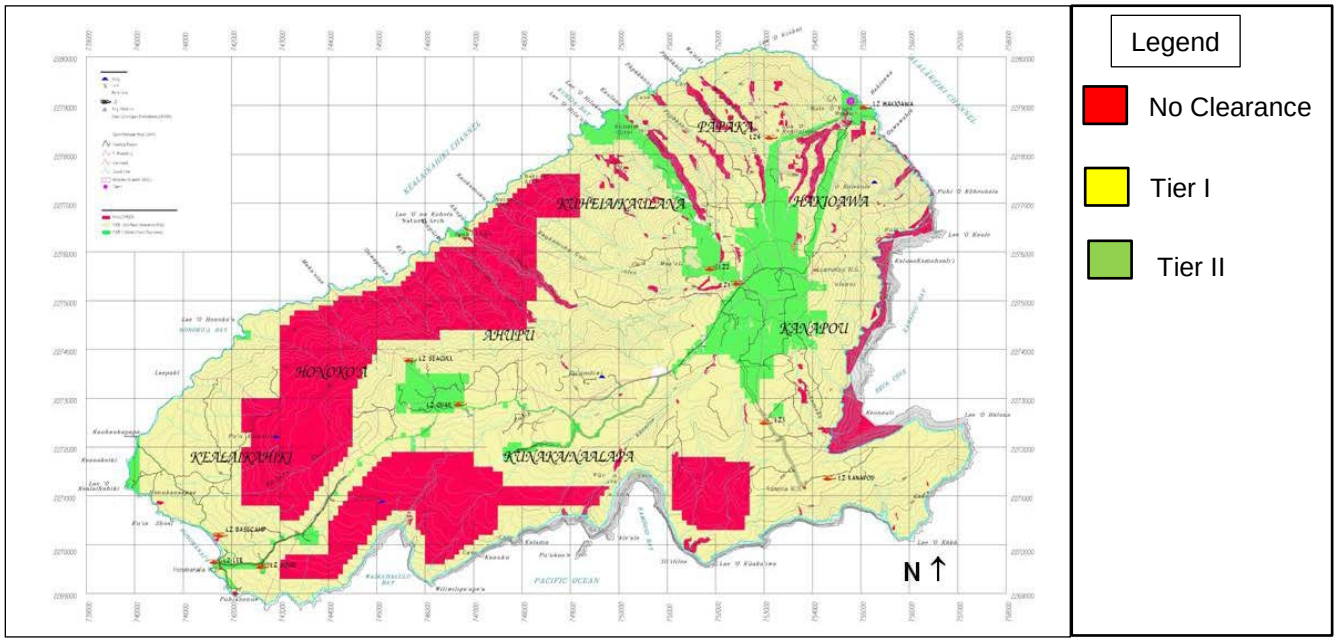

Figure 3. Final Clearance Map of Kahoʻolawe

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

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

Hawaiʻi Invasive Species Council (HISC)

Established in 2003 by the Hawaiʻi State Legislature, the Hawaiʻi 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 Hawaiʻi. Gaps were identified in invasive species management statewide, exposing the risks to Hawaiʻi'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*."

The HISC was authorized by Chapter 194, Hawaiʻi 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 invasive species 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 Hawaiʻi Department of Agriculture (HDOA) and includes the members from the University of Hawaiʻi (UH), the Hawaiian Department of Business and Economic Development and Tourism (DBEDT), the Hawaiʻi 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 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 U.S. Departments of the Interior (U.S. DOI), U.S. Department of Agriculture (U.S. DOA), and the U.S. Department of Defense (U.S. DOD). Hawaiʻi Ecosystems at Risk (HEAR, 2016) assists with identifying IAS for plants and animals in Hawaiʻi. 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 Hawaiʻi's biosecurity. The Vision statement from HISC's Strategic Plan for 2015-2020 protects Hawaiʻi's unique natural environment from the impact of IAS.

The HDOA which is the only agency with a mandated biosecurity program, and the DLNR, 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 (U.S.DOA) and the United State Fish and Wildlife Service (U.S.FWS), also play a role in Hawaiʻi's biosecurity.

Cultural Protocols and Ceremonial Offerings

Chapter 6K Hawaiʻi Revised Statutes [§6K-3] states that, "The Kahoʻolawe 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 Kahoʻolawe for the purpose of the traditional and cultural practices of the Hawaiian people (KICC 1993, KIRC 1995). Several cultural ceremonies are performed annually on Kahoʻolawe including Makahiki, the Rain Ceremony (Ka Holo i ka lani) and monthly volunteer trips by both the KIRC and the Protect Kahoʻolawe Ohana (PKO). It is imperative ceremonial offerings (hoʻokupu) in Figure 4, as well as individual field gear are thoroughly inspected by PKO access leaders and/or KIRC staff for IAS before they are brought to Kahoʻolawe. 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. 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.

Figure 4. Hoʻokupu on Kahoʻolawe

Kahoʻolawe Island Reserve (KIR) Biosecurity Advisory Committee

Managing IAS on Kahoʻolawe will involve prevention of pest establishment and controlling those already there (Broome, 2007). To establish protocols for the KIRC Biosecurity Implementation Plan, a KIR Biosecurity Advisory Committee will be formed to guide the document and established protocols, and ensure the Goal and Action Items are met. The members name, title, and affiliation are as follows (Table 2).

	KIR Biosecurity Advisory Committee			
	Member Name	**Title**	**Affiliation**	**Comments**
1	Mike Nahoʻopiʻi	Executive Director	KIRC	
2	Paul Higashino	Natural Resource Specialist V	KIRC	Program Manager
3	James Bruch	Natural Resources Specialist III	KIRC	Restoration
4	Lyman L. Abbott	Natural Resources Specialist III	KIRC	Restoration
5	Lopaka White	Natural Resources Specialist II	KIRC	Boat Captain
6	Dean Tokishi	Ocean Resource Specialist III	KIRC	Program Manager
7	Grant Thompson	Kahoʻolawe Island Reserve Specialist III	KIRC	Boat Captain/Kihei Boathouse
8	TBD	Access Leaders	PKO	
9	TBD	Access Leaders	PKO	

Table 2 Members of the KIR Biosecurity Advisory Committee

II. PROBLEM / NEED

Potential Harm from Invasive Alien Species (IAS)

IAS impact our economy, environment, human health and our quality of life. In Hawaiʻi, lost revenues due to pest infestations account for an estimated $300 million per year (Ikuma et al., 2002). Potential harm from IAS may threaten Biosecurity causing disease, predation, competition, habitat destruction, or hybridizing with local species (Table 3).

	Harm from Invasive Alien Species (IAS)
1	Disease
2	Predators
3	Competition
4	Habitat Destruction
5	Hybridization

Table 3 Potential Harm from IAS in Hawaiʻi

Examples of human health and disease from an IAS is the Dengue and Zika virus spread by the *Aedes* mosquito. Examples of predators on faunal life include rodents (rats and mice), mongoose and cats. Competition may be observed in the Barn Owl (*Tyto alba*) affecting the availability of food resources for the native Pueo (*Asio flammeus sandwicensis*). 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 (*Anas wyvilliana*) duck and introduced Mallard duck (*Anas platyrhynchos*). In addition to these introductions, if biosecurity efforts are not successful, Kahoʻolawe has the potential habitat for sustaining populations of high risk species.

There are six (6) different methods for accessing Kahoʻolawe.

1. **KIRC access vis ʻŌhua**
2. **KIRC Access vis a different vessel (NOAA, Charter)**
3. **PKO Access vis 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.**

Biosecurity Threats from IAS in Hawaiʻi to Kahoʻolawe

Since historical times Kahoʻolawe has been increasingly susceptible to IAS introductions. Although feral ungulates have been eradicated, invasive mammals include Polynesian rats (*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 invasive species such as feral cats (Koch, et al, 2016). Other examples

of IAS present in Hawaiʻi with the greatest potential to threaten the Biosecurity of Kahoʻolawe are listed in Table 4.

	Common Name	**Taxa**	**Form**
1	Mongoose	*Herpestes auropunctatus*	Mammal
2	Rat	*Rattus spp.*	Mammal
3	Little Fire Ant (LFA)	*Wasmannia auropunctata*	Ant

Table 4 Examples of IAS present in Hawaiʻi with the greatest potential to threaten the Biosecurity of Kahoʻolawe

The introduction of any of these three organisms would be an enormous failure to the established Biosecurity protocols and would affect the ecological balance of Kahoʻolawe due to the nature of the animals and limitations of eradication tools currently available within the region. Vitousek (1988) states the accidental or intentional introduction of alien species is one of the most serious threats facing island ecosystems.

Mongoose (U.S. DOA, 2010) and rats (Hathaway and Fisher, 2010) are well known to have severe effects on ecosystems they invade. The LFA (*W. auropunctata*) was first observed in 1999 on Hawaiʻi Island and can cause blindness in pets and severely disrupt human activities (Hawaiʻi Ant Lab, 2016). Vanderwoude (2008) states knowingly moving material and equipment infested with LFA is an offense under Statute (HRS 150A) and Rule (HAR Chapter 4-72).

In March 1999, specimens of a Little Fire Ant (*W. auropunctata*) were first collected by a resident of Hawaiian Paradise Park in the Puna District of the Hawaiʻi Island and submitted to the Hawaiʻi Department of Agriculture (Conant et al. 2007). https://hdoa.hawaii.gov/pi/files/2013/01/npa99-02-lfireant.pdf.
http://www.biisc.org/types-of-products-to-control-lfa/

The transfer of invasive alien species (IAS) within Hawaiʻi is real, ongoing, and an increasing problem that must be addressed (RBP, 2014). Stone (1992) reports the problem of introduced (non-native) plants in Hawai'i's' natural areas is as critical now as it has ever been. Therefore one (1) Goal and three (3) actions in an Early Detection/Rapid Response (ED/RR) format have been developed to address this problem.

Goal of the KIR Biosecurity Implementation Plan

The Goal of the KIR Biosecurity Plan is to keep IAS from entering the KIR. There are three major actions of an effective Biosecurity Plan;

1. **Prevention** – stopping the IAS before it gets to island
2. **Detection** – locating and identifying if it gets there
3. **Response** – removing it quickly before it can establish and becomes impossible to remove or at least increasingly expensive to do so.

Three Actions of the KIR Biosecurity Implementation Plan

There are three (3) actions to accomplish the Goal of the KIR Biosecurity Implementation Plan (Table 5).

Number	Action	Description
1	**Prevention**	Do Not Allow IAS to enter the KIR.
		Education is also an essential component to Prevention.
2	**Detection**	Keen observations and monitoring of IAS from KIRC Staff and Volunteers PKO, and Passenger/Cargo Transport Companies. Occurs at ports of departure and also in the KIR.
3	**Response**	Eliminate threat by immediate mitigation of confirmed or suspected IAS through quarantine (capture and confinement).
	Quarantine	Capture and confine confirmed or suspected IAS.
	Eradication	Occurs on site with Rapid Response Kit.

Table 5 Three actions to achieve the Goal

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. Unlike plants which are often readily observable and identifiable, and there is time to remove them before they reproduce, IAS animals are often cryptic, hard to detect, relatively mobile and have the reproductive ability to reach unmanageable levels before they are detected.

With awareness and understanding is key to the importance of the Biosecurity Plan and has 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 Kahoʻolawe Island Reserve (KIR) by ocean vessel or air. (Pre and Post-launch check will be conducted using IAS Inspection Form and self-audit check sheet).

Education 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 Kahoʻolawe (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 channels of communication to report biosecurity risks.

Detection

Detection will perform real-time monitoring as a crucial method for an IAS at a vector location or in transit to the KIR. Document an IAS breach of Biosecurity measures. For example if a rat is observed on a boat, the vessel shall go back to Maui or its home island eg. Molokaʻi (California Islands Biosecurity Program, 2013). The IAS should be contained with the IAS rapid response kit.

Response

Quarantine the IAS according to specific protocols in the most efficient and expedient manner to mitigate the potential introduction. Eliminate an IAS threat immediately on site. Turning the vessel around and going back to Maui also prevents any other IAS on board from reaching the KIR. IAS control at ports of departure is also a critical aspect of this biosecurity plan. For example, the KIRC has identified priority target species at the Kihei Boathouse property (Figure 5) to be managed for eradication.

To achieve the Goal of keeping new IAS from entering the Kahoʻolawe Island Reserve, these three (3) actions in the ED/RR format need to be learned and performed by all personnel involved entering Kahoʻolawe and supporting logistical operations. Adequate time management needs to be considered in thoroughly performing these 3 actions.

Figure 5. Biosecurity signage and information to address the number one goal of Prevention

The concrete slab is a quarantine area to inspect outgoing materials to Kahoʻolawe.

Biosecurity Signs

Simplified 1 page KIR Biosecurity Signs (Appendix H) have been created to present a visual image in volunteer orientations, at the Kihei Boathouse where personnel congregate before the island access, and on Kahoʻolawe as reminder of Biosecurity principles. They were designed to be conspicuous, and to remind people how to inspect their equipment before going to Kahoʻolawe. It covers the one goal and three actions of the KIR Biosecurity Plan.

Biosecurity Plan Goals and Actions

Adapted from Pete McClelland Environmental Services 2017 review, and updated by the authors.

In order to be effective a Biosecurity Plan must be;

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

The Plan should be fully implemented with the available financial and personnel resources. It is not necessary that all actions stated in the Plan occur at one time, but any proposed phase-in must be appropriately audited and reviewed. 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. The 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.

Although the protocols and standards set in the Plan are clearly stated so they can be audited and maintained over time, the Plan could target only higher risk species or specific pathways if biosecurity measures are ineffective. The actions in the Plan need to remain logistically and financially achievable within the available resources and time frames.

As an added responsibility to visitors on access to Kahoʻolawe, the principles in the Plan should be acceptable to all users, and at least be easily explained and justified. If the requirements of the Plan are too arduous to comply with, and personnel do not accept the necessity of the protocols, visitors on access and staff will circumvent the biosecurity process.

Acceptance and support of the required actions by all 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, personnel responsible for the implementation of the Plan will also have the ability to perform random checks of personal gear, and vessels. Examples of non-compliance should be used as an educational tool for the group and future orientations.

The Plan should be kept as simple as possible while still covering all the required detail. Once biosecurity protocols becomes established as standard practice and part of the management, the requirements may become more stringent. However, if personnel believe the standards are impractical, too arduous, and hard to understand, they will not comply with what is required.

The Biosecurity Plan should have support and priority at all levels within the KIRC 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 feel 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 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 is 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 Kahoʻolawe 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.

If resources allow, all reasonable and manageable pathways wiil be covered by this Plan, and all pathways 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 X impact. 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 own rules. This 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 acceptance from all visitors.

III. CURRENT OPERATIONS

Volunteer Orientation and Biosecurity Protocols

The first step of anyone who accesses Kahoʻolawe is the mandatory volunteer orientation. For IAS Biosecurity this addresses **Prevention and Education**. It is crucial volunteers receive the biosecurity information expected of them at the time of the mandatory volunteer orientation. In case people cannot access the KIRC (and PKO) websites for biosecurity standards, a hard copy during the volunteer orientation could summarize the requirements. The information needs to be presented in a simple and concise format. It needs to stress the importance of protecting the Kahoʻolawe Island Reserve from IAS using the three principles of Prevention, Detection and Response. The PowerPoint presentation and Individual Biosecurity SOP is available on the KIRC Website on the Biosecurity page. Orientation and informational packets should include pictures of IAS as detrimental organisms that can severely impact the ecology of the island (Figure 6).

Figure 6. A slide from the KIRC volunteer orientation presentation on Biosecurity

KIRC and PKO Website

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;

Protocol for the Prevention of alien species introduction

*Control of introduced plants and animals and restoration of native plants and animals are principal goals of the KIRC to restore Kahoʻolawe. 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 Kahoʻolawe is crucial to preserving the native environment. These measures include: 1. Inspecting all clothing, gear, and equipment before coming to Kahoʻolawe. Field pests include weed, seeds, and insects. Thoroughly clean footwear, socks, pant legs, jackets, rain gear, tools, packs, and other containers. 2. Thoroughly wash and dry all swim clothes and gear. Dip snorkel and fins in a light bleach solution prior to your Kahoʻolawe access. Invasive algae is just as dangerous as terrestrial weeds. 3. Become acquainted with Hawaiʻi'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. 4. 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 Audit Checklist (Appendix N) 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.

The PKO website is listed here (http://www.protectkahoolaweohana.org/), also listing information on biosecurity and how to prevent the introductions of IAS.

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 Hoʻoulu Mea Kanu (Plant Nursery) and Kalamalama (Education center), in a "Building Bridges Between Kahoʻolawe and Kihei" Project granted through the Kūkulu Ola (*Build*

Life): Living Hawaiian Culture grant program from the Hawaiʻi Community Foundation and Hawaiʻi Tourism Authority, Atherton Family Foundation and Alu Like, Inc.'s Native Hawaiian Career and Technical Education Program. The plant nursery is under development and may be providing native flora to Kahoʻolawe. The Boathouse is the main point of departure and supports the operations of the current KIRC vessel ʻŌhua to transport materials and passengers to Kahoʻolawe. Figure 7 illustrates the approximate boundary of the 8.2 acre Kihei Boathouse property (and Nursery in Yellow) located at 2780 S. Kihei Rd., Kihei, HI 96753.

Figure 7. Eight acre Kihei Boathouse property and adjacent public boat ramp

Figure 8 illustrates the Kihei Boathouse and surrounding dry Kiawe (*P. pallida*) forest habitat. Landscape plants eg. 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 LFA (*W. auropunctata*) to arrive in the vicinity of the Kihei Boathouse.

Figure 8. Kihei Boathouse and surrounding urban habitat

Land Based Biosecurity and Standard Operating Protocols

Land Based Biosecurity will implement the ED/RR approach using the three actions to achieve the Goal. A self-audit checklist will be made available to the staff and volunteers to fill out before a trip (Appendix N) to island.

The transport of personnel and equipment to and from Kahoʻolawe is performed by the KIRC vessel ʻŌhua (Figure 9). It is a 39 foot ALMAR® with twin Cummins diesel engines.

Figure 9. KIRC vessel ʻŌhua at Kihei Boathouse

The ʻŌhua is a primary vessel and vector (carrier of IAS) to Kahoʻolawe, so it is imperative observant eyes **Prevention** of any IAS in cargo (Figure 10). 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 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 Kahoʻolawe. All stored lumber (in the fore ground in Figure 9) must be inspected for IAS before loading onto the vessel for transport to Kahoʻolawe. All cardboard and boxes sitting in or outside the Boathouse must be inspected for IAS before loading onto ʻŌhua. 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 ʻŌhua 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). With **Response** the date, time and location of the Quarantine event will be filled out on the IAS Quarantine Form located at the Boathouse. If possible a picture should be taken to eventually identify the IAS if unknown, and document its occurrence. If eradication of the IAS occurs on site, it will be accomplished with the IAS Rapid Response Kit which will be on site with insecticides, glass jar and plastic vials (Appendix D). Figure 10 illustrates an inspection of bananas.

Figure 10. An example of inspecting supplies for IAS before departure to Kahoʻolawe

Other vessels that transport personnel to and from Kahoʻolawe include PKO vessels, catamarans from Lahaina and Maʻalaea, and occasionally, double hulled canoes (Figure 11) escort fishing boats and outrigger canoes from local Canoe Clubs. Individual boat operators are responsible for implementing the biosecurity protocols.

Figure 11. On occasion, double-hulled canoes such as the Hokuleʻa will visit Honokanaiʻa bay for ceremony

IAS Rapid Response Kit and IAS Quarantine Form

The IAS Rapid Response Kits will be on the ʻŌhua, at the Kihei Boathouse, Base Camp at Honokanaiʻa, and provided to the PKO for accesses to Hakioawa. They should consist of insecticides, collection jars and vials (Figure 12) and other appropriate equipment (aspirator). This will ensure a “Rapid Response” to Quarantine the IAS threat. The IAS Rapid Response Kit and IAS Quarantine Form will be on site to document the ED\RR (including Quarantine and Eradication) steps taken for dispatch and identification of the IAS. The IAS Quarantine Form is available in Appendix D.

Figure 12. IAS Rapid Response Kit

Kihei Boathouse Rodent Control

The storage of pesticides is regulated under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) which governs the sale distribution and use of pesticides in the United States. Once they are disposed of, they are regulated under the Resource Conservation and Recovery Act (RCRA) which ensures responsible management of hazardous and non-hazardous waste. To control rodents at the Kihei Boathouse, Contrac® all-weather Blox® rodenticide is used (Figure 13) and recorded in the Rodent Control Log (Appendix M). 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*).

Figure 13. Contrac® Blox® bait

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. As an antidote to the poison, vitamin K is available to counteract the poison in the Contract® bait block. The Blox® is placed in a tamper resistant Protecta® Bait station (Figure 14) to keep non-target animals

such as dogs and cats from the bait. 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.

Figure 14. Protecta® Rodenticide Bait Station

To control for mice and rats permanent bait boxes are spaced out at roughly 25 meters apart including 2 inside the boathouse (Figure 15). Boxes are kept stocked with 8-16 oz. of fresh bait in accordance with the “Contrac® Specimen Label”. In addition, on Kaho’olawe bait boxes are located at the Honokanaiʻa and Hakioawa Base Camp to control seasonal rodent irruptions that impact sanitization of the base camps. Rodent stations are serviced in accordance with the “Contrac® Specimen Label” and recorded with a Rodent Control Log (Appendix M). If rodent activity is noted traps are also set out.

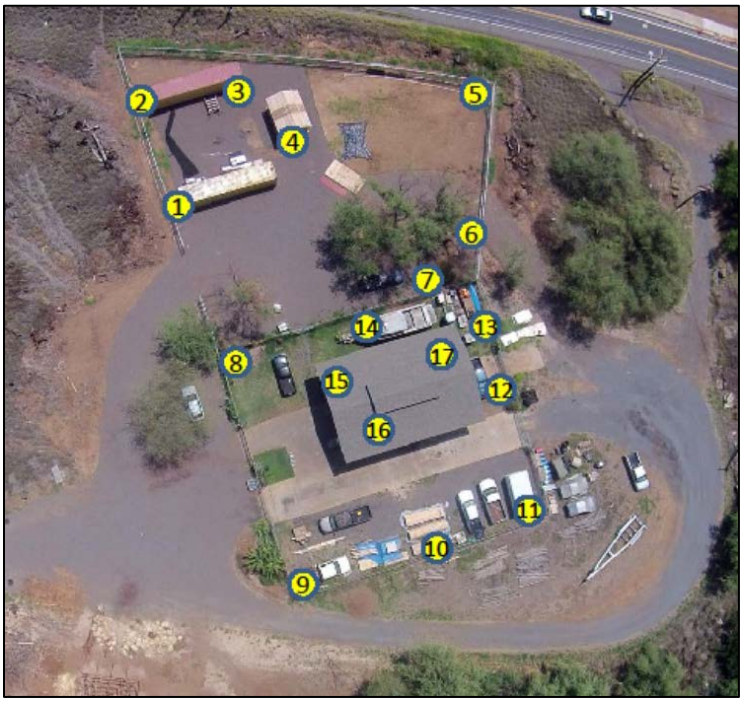

Figure 15. Location and numbers of labeled bait stations at Kihei Boathouse

Figure 16 illustrates a cluttered corner along the fence line where rodenticide bait has consistent uptake. This area is slated to be organized and clear of materials and vegetation where rodents can nest. The discovery of Giant African Snails also demonstrates that there is abundant cover and moisture in this area providing habitat for additional IAS. Additional recommendations are presented at the end of this section.

Figure 16. Cluttered corner along the Boathouse fence line

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 Kahoʻolawe (Parkes, 2009). Due diligence from all parties is required to maintain a significant biosecurity barrier from rodents reaching Kahoʻolawe. Only though a strong **Educational** component in 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/Nursery Ant and IAS 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). 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 comprehensive and adaptive strategy of using the 5 objectives will achieve the one Goal to keep IAS from entering the KIR. Additional information can be found at http://www.littlefireants.com. Many insecticide products that treat ants also can treat other pest insects e.g. pyrethroids and are recommended for both Kihei Nursery and Boathouse.

Ant control

There are many products which claim to take care of fire ants. Remember, however, that there are many different species of fire ants in the world (two species have made it to Hawaiʻi), and not all products will work on all species. Little fire ants (*Wasmannia auropunctata*) 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 Hawaiʻi Ant Lab has been studying LFA in Hawaiʻi for more than a decade, and the University Cooperative Extension service has independently tested many ant products as well.

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 LFA, then creating a drench using contact pesticides is a good way to get rid of the LFA. 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.

Baits

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 LFA products: *toxicant* and *growth regulation*.

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 LFA 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:

Amdro Brand (granular bait)

Active: Hydramethylnon
Amdro is a big company and has many different kinds of pesticides. Make sure to read the label to make 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

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.

<u>Insect Growth Regulators:</u>

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 Hawaiʻi 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 form 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*.

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

Ant Bait Treatments for the Kihei Boathouse

Several ant bait treatment products are available and have been tested by the Hawaiʻi Ant Group (Table 6) with the Pacific Cooperative Studies Unit of the University of Hawaiʻi.

	Name	**Description**	**Comment**
1	[1]Amdro®	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

Table 6 Types of Ant Baits

[1] Recommended Use at Kihei Boathouse.

The Hawaiʻi Ant Group was formed to develop a better understanding of ants and their impacts in Hawaiʻi as well as facilitate and exchange of information, monitor and report new introductions and increase public awareness. Amdro®, MaxForce Complete® and Tango® may all be used at the Kihei Boathouse. Appendix I lists the proper techniques of mixing the Tango® 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 Hawaiʻi and Kahoʻolawe are listed in Appendix O.

Ant 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. 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. 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 17 illustrates the area in the Kihei nursery and boathouse for ant and other insect pests barrier protection using 1% Talstar P in water. Usage is recorded in the Pesticide Use Log (Appendix L).

Figure 17. Ant barrier treatment (blue) and granular bait treatment (orange) at Kihei Boathouse and Nursery

Co-operative Agricultural Pest Survey (CAPS)

The Little Fire Ant (*W. auropunctata*) 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 LFA) at Hawaiian Points of Entry are as follows;

Targets are, LFA (*W. auropunctata*) and Red Imported Fire Ants (*Solenopsis invicta*) not yet in Hawaiʻi, 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.

When planning the survey, work out the area you want to cover and obtain a map or aerial image of the site. Plan to do the survey 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 up around 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. Common ant habitats are listed in Table 7 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	
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	

	Potential Habitat for Ants	
	Location	**Comments**
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 7 Potential habitat for ants for CAPS

Ant Taxa Observed at Kihei Boathouse

Table 8 lists the eight (8) ant taxa found during four, 2016 surveys at the Kihei Boathouse in accordance with CAPS protocols. Also listed is whether or not it has been observed on Kahoʻolawe and the Pacific Invasive Ant (PIA) Risk Assessment. The Carpenter ant (*C. variegatus*) was not initially observed although it was present on the property (observed April 15, 2016, collected April 22, 2016) and may be due to the nocturnal behavior of this particular ant species.

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

Table 8 Ant taxa found at Kihei Boathouse during 4 surveys in 2016

Figure 18 illustrates the locations of the sweet and protein baits during the CAPS surveys.

Figure 18. Co-operative Agricultural Pest Survey (CAPS) stations (Protein & Sweet Baits). Surveys conducted in January, June, September and December 2016

IAS Plant Control at the Kihei Boathouse Property

Table 9 lists the fifty (50) botanical species observed at or near the Kihei Boathouse in January, 2016. Priority Target Species for eradication highlighted in yellow.

	Taxa		**Taxa**
1	*Abutilon incanum*	26	*Ipomoea pes-caprae ssp brasiliensis*
2	*Abutilon menziesii (E)*	27	*Jacquemontia ovalifolia*
3	*Alocasia sp.*	28	*Leucaena leucocephala*
4	*Aloe vera*	29	*Macroptilium lathyroides*
5	*Alternanthera pungens*	30	*Malvastrum coromandelianum*
6	*Amaranthus spinosus*	31	*Merremia aegyptia*
7	*Bonamia menziesii (E)*	32	*Musa x paradisiaca*
8	*Bothriochloa pertusa*	33	*Panandus tectorius*
9	*Cenchrus ciliaris*	34	*Panicum maximum (Megathyrsus maximus)*
10	*Chloris barbata*	35	*Paspalum conjugatum*
11	*Cordyline fruticosa*	36	*Pluchea indica*
12	*Cynodon dacytlon*	37	*Prosopis pallida*
13	*Cyperus sp.*	38	*Ricinus communis*

	Taxa		**Taxa**
14	*Desmanthus pernambucanus*	39	*Samanea saman*
15	*Digitaria insularis*	40	*Schefflera actinophylla*
16	*Dodonaea viscosa*	41	*Sida fallax*
17	*Eluesine indica*	42	*Sporobolus africanus*
18	*Erigeron bonariensis*	43	*Synedrella nodifolia*
19	*Euphorbia hirta*	44	*Tribulus terrestris*
20	*Ficus sp.*	45	*Tridax procumbens*
21	*Gossypium tomentosum*	46	*Trifolium sp.*
22	*Heliotropium curvassavicum*	47	*Verbesina encelioides*
23	*Hibiscus clayii*	48	*Vitex rotundifolia*
24	*Indigofera spicata*	49	*Waltheria indica*
25	*Indigofera suffruticosa*	50	*Washingtonia robusta*

Table 9 Botanical Survey of Kihei Boathouse, January 2016

E = Federally Endangered

Since 2015, Puncture vine (*Tribulus terrestris*) and Khaki weed (*Alternanthera pungens*) have been manually removed from the Boathouse area 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 Kahoʻolawe. Puncture vine (*T. terrestris*) became a pest problem at the Boathouse area in the first half of 2016 (Figure 19). It 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 KIRC Biosecurity Advisory Committee on an annual basis.

Figure 19. Seed (nutlet) and flower of Puncture Vine (*T. terrestris*)

Standard Operating Protocols for the Transportation of Plants to Kahoʻolawe

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 Kahoʻolawe. 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 in a timely manner.

All plants will be inspected at the Boathouse for IAS by the KIRC prior to shipment to island. Once plants are cleared they will signed off with a date and time, 24 or less before vessel leaves for Kahoʻolawe. Plants in containers will be checked again just before loading onto vessel.

Nurseries and Farms supplying plants to the Kihei Nursery site need to be a registered facility with the KIRC and acknowledge they will deliver IAS free material in agreement with the Biosecurity protocols in this 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.

Hoʻolawa Farms in Haiku specializes in Hawaiʻi'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 Kahoʻolawe. 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 these plant deliveries.

KIRC Kihei Nursery

Construction began on the KIRC 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 Nursery protocol information is presented here. The full plan is available on the KIRC website at kahoolawe.hawaii.gov/biosecurity.shtml. The Nursery (Figure 20) is currently being used for propagation of plants around the Kihei Boathouse property and for training staff, interns and volunteers until Firm SOP's are in place. More about the Kihei Nursery is listed in Section IV, Future Efforts.

Figure 20. Work Area and Tables at KIRC Kihei Nursery in 2017

Ocean Based Biosecurity

Ocean Based Biosecurity will implement the three actions to achieve the goal.

Kahoʻolawe 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 the Kahoʻolawe Island Reserve (KIR) in Figure 21.

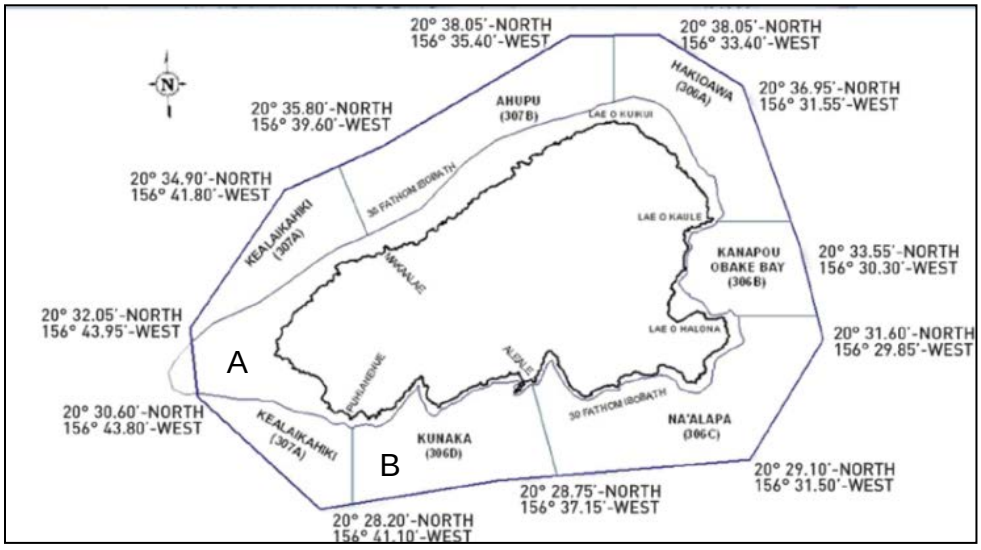

Figure 21. Boundaries of Zone A and B in the KIR

The Kahoʻolawe Island Reserve (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 Kahoʻolawe and all the submerged lands and waters between the shoreline of Kahoʻolawe and the 30-fathom (180 ft.) depth which surrounds Kahoʻolawe (HAR13-261). Unauthorized entry into Zone A is prohibited at all times except in case of emergency.

Zone B: All waters and submerged lands between the 30-fathom (180 ft.) depth surrounding Kahoʻolawe 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 as listed above or in case of emergency. Trollers must remain underway, making way at all times while in Zone B.

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.*

Table 10 lists the algal taxa that is present in the KIR. This list is compiled from the KIRC Ocean Management Plan (Dames and Moore, 1997).

	Algae in the Kahoʻolawe Island Reserve		
No	**Taxa**	**Hawaiian Name**	**Color**
1	*Codium reediae*	ʻaʻalaʻula (wawaeʻiole)	Green
2	*Ahnfeltia concinna*	ʻakiʻaki	Red
3	*Dictyota sp.*	alani	Brown
4	*Grateloupia filicina*	huluhuluwaena	Red
5	*Sargassum echinocarpum*	limu kala	Brown
6	*Laurencia succisa*	lipeʻepeʻe	Red
7	*Dictyopteris plagiogramma*	lipoa	Brown
8	*Gracilaria coronopifolia*	manauea	Red
9	*Laurencia nidifica*	maneʻoneʻo	
10	*Porphyra sp.*	paheʻe	Green
11	*Ulva fasciata*	palahalaha	Green
12	*Codium edule*	wawaeʻiole	Green

Table 10 Algal taxa in the KIR

Table 11 lists the algal taxa not observed in the KIR. “Cryptogenic” is unclear whether the species is native or introduced.

	IAS Algae not in the Kahoʻolawe Island Reserve		
No	**Taxa**	**Common Name**	**Comment**
1	*Acanthophora spicifera*	Prickly Seaweed	
2	*Avrainvillea amadelpha*	Leather Mudweed	Cryptogenic[1]
3	*Cladophora sericea*[2]	Green Slime Weed	

	IAS Algae not in the Kahoʻolawe Island Reserve		
No	**Taxa**	**Common Name**	**Comment**
4	*Dappaphycus spp.*	Smothering Seaweed	
5	*Dictyosphaeria cavernosa*[2]	Green Bubble Algae	
6	*Gracilaria salicornia*	Gorilla Seaweed	Cryptogenic[1]
7	*Hypnea musciformis*	Hookweed	
8	*Nemacystus decipiens*		Cryptogenic[1]
9	*Wrangalia bicuspidata*		Cryptogenic[1]

Table 11 IAS Algal taxa not observed in the KIR

[1]DAR, 2003.
[2]Personal Communication, D. Tokishi, Ocean Resources Specialist, KIRC

Also, *Eucheuma sp., Kappaphycus sp.* and *Ulva reticulata* are introduced seaweeds in Hawaiʻi (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 22 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 22. DAR sign posted at Kihei Boat Ramp February, 2016

Alien Aquatic Organisms

Alien aquatic organisms are species that pose a serious problem in Hawaiʻi, and are a significant threat to people as well as to native ecosystems (State of Hawaiʻi, 2003). Invasive species 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 12 lists the three invasive fish species found in the KIR that prey on native fish species.

	Taxa	**Common Hawaiian Name**
1	*Lutjanus kasmira*	Taʻape
2	*Lutjanus fulvas*	Toʻau
3	*Cephalophalus argus*	Roi

Table 12 Three invasive fish found in the KIR

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

Dive Gear

All skin diving and scuba gear needs to be inspected and disinfected before using in Kahoʻolawe 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 Honokanaiʻa during large surf. Wipes with ammonium chloride (Clorox® or Lysol®) should be used to clean and remove any organic matter and all dear 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.

Virkron® for Hull Fouling and Anchors

Virkron® 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 23 illustrates personnel from NOAA pressure washing the hull of their vessel (Kohola).

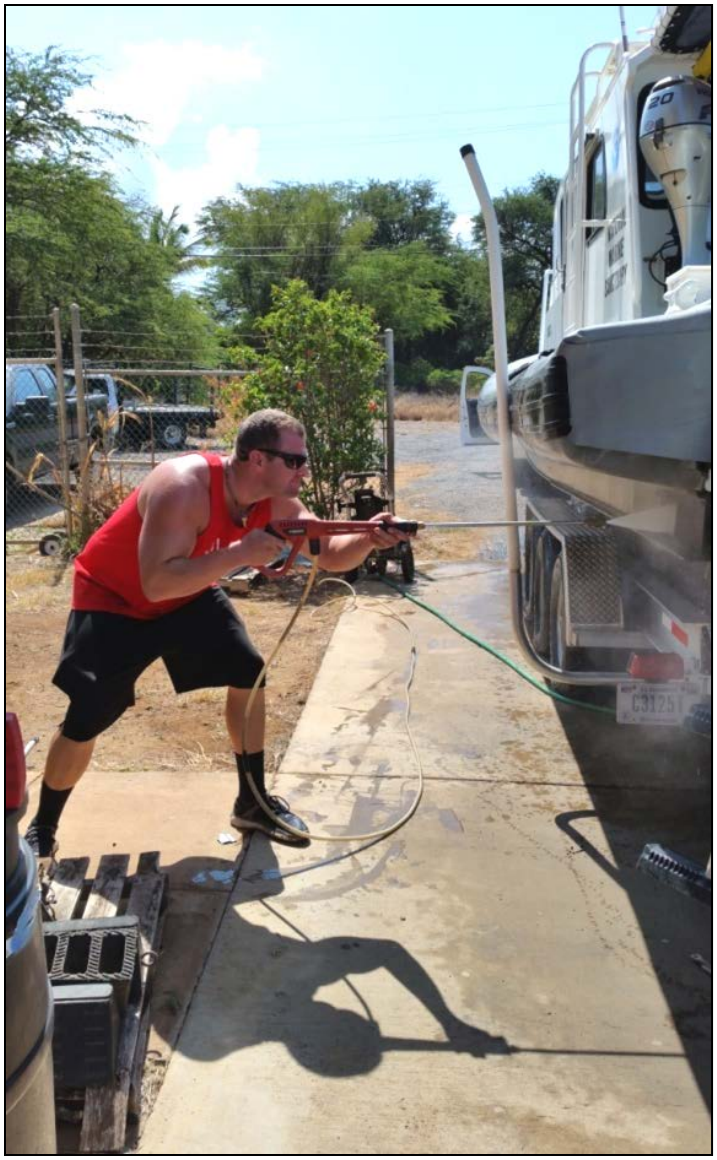

Figure 23. Pressure washing hull of NOAA vessel

Additional Recommendations

Recommendations in 2017 for the KIR Biosecurity Implementation Plan (Pete McClelland Environmental Services, 2017) and updated by the authors;

Kihei Boathouse

1. Remove (or at least organize) the clutter outside the boathouse as it provides major refugia for rodents.
2. Organize the inside of the boathouse by getting everything up off the floor. Shelves should be at least 6 inches above the floor to reduce refugia for rodents, geckos and invertebrates.
3. 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.
4. 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.
5. 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.
6. Remove invasive trees from the boathouse, nursery and storage areas which may drop seeds into vessels. The detection of unwanted seeds is more difficult with seeds from other plant species even if already on Kahoʻolawe.

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 ʻŌhua 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 Ohua 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 ʻŌhua. Also, this person can inspect the boathouse for IAS to quantify the risk associated with different pathways utilizing available resources.

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 ʻŌhua 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 ʻŌhua, the Captain will be responsible for biosecurity for consistency.

It is important that a specific position (e.g. Captain) 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.

Transportation of Plants and Vegetation

KIRC and PKO landings present one of the greatest biosecurity risks identified. The transport of plant material, including banana stumps (with soil), ti leaves, fern and forest materials for lei to Kahoʻolawe for ceremonial purposes has the high potential to introduce everything from seeds and invertebrates to geckos and rodents. It is important to establish a process that will reduce this risk to an acceptable level. 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 should come from an approved nursery. KIRC biosecurity standards for approved nurseries are listed in Appendix K. An audit of these standards should be performed annually at each nursery by KIRC

personnel. If needed, plants can be re-potted with a sterile soil moisture at the boathouse nursery prior to their transport 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. All plants should be visually inspected before they are loaded onto the vessels.

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 Kahoʻolawe. A self-audit checklist is available as Appendix N.

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 ʻŌhua) 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 Kahoʻolawe.

Management Support

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

Contractor Specific Biosecurity

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.

Types of Rodent and Plant Species

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 Kahoʻolawe, any Black Rat (*R. rattus*) would likely have a greater impact as they are good climbers and so are more likely to affect tree nesting birds. Norway rat (*R. norvegicus*) are much larger and can have a greater impact on ground nesting birds. Also the seeds of many plants are difficult to differentiate, so while most seeds on a vessel may be of a species already established in Hawaiʻi and on Kahoʻolawe, there is a risk that in with them, will be a highly invasive plant species. Therefore, it is important to aim to stop all unplanned transfers of species to island rather than try and differentiate between species.

Protect Kahoʻolawe Ohana (PKO)

A crucial partner in implementing any effective biosecurity for Kahoʻolawe 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 Plan
- Audit on the ground practices in this Plan
- Alter the practices and/or Plan so that they are consistent
- Share Knowledge and Experience through KIR Biosecurity Advisory Committee

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 plan for this CIP project, all personnel should be well briefed on the Biosecurity protocols expected to be implemented during this CIP project on Kahoʻolawe.

Ala Loa Construction

The Ala Loa is a coastal trail that will eventually circumnavigate the entire shoreline area of Kahoʻolawe for cultural practices. Since 2003, several miles have been built from

Honukanaenae to Lae o Paki and from Hakioawa to Kuheʻeia. 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 Kahoʻolawe to work on the Ala Loa. If not addressed, seeds from IAS can remain imbedded in the equipment, and become established on Kahoʻolawe from a different island. Biosecurity protocols also apply to the other supplies that accompany cultural visitors. The field gear brought by all individuals also needs to be thoroughly inspected.

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 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 Kahoʻolawe, the skids should be checked for plant material and the inside of the helicopter checked and cleaned.

IV: SITE SPECIFIC IAS PRESENT ON KAHOʻOLAWE

Kahoʻolawe Botanical Surveys and Results

Several botanical surveys have occurred in the past on Kahoʻolawe (U.S. 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 Kahoʻolawe in December, 2015 to update previous inventory and are listed in Appendix B. HPWRA scores will serve as baseline data for future IAS introductions, not only in these four primary points of entry, but also potentially for all of Kahoʻolawe.

Moodley et al., (2014) state the outcome of alien plant introductions is often considered invasive or non-invasive. Table 13 lists twenty three (23) site specific IAS present on Kahoʻolawe with Hawaiʻi 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	*Lantana camara*	Lantana (wild type)	32	High
2	Poaceae	[1]*Cenchrus setaceum*	Fountain grass	26	High
3	Poaceae	*Cynodon dactylon*	Bermuda grass	22	High
4	Asteraceae	*Verbesina encelioides*	Golden crown-beard	21	High
5	Poaceae	*Digitaria insularis*	Sour grass	20	High
6	Poaceae	*Chloris barbata*	Swollen fingergrass	20	High
7	Poaceae	*Cenchrus ciliaris*	Buffelgrass, Laredo buffelgrass	19	High
8	Fabaceae	*Prosopis sp.*	Mesquite (Kiawe)	19	High
9	Poaceae	*Panicum maximum*	Guinea grass	17	High
10	Fabaceae	*Neonotonia wightii*	Glycine, perennial soybean	16	High
11	Fabaceae	*Acacia mearnsii*	Black wattle	15	High
12	Fabaceae	*Leucaena leucocephala*	Leucaena (Koa Haole)	15	High
13	Solanaceae	*Nicotiana glauca*	Tree tobacco	15	High
14	Fabaceae	*Vachellia farnesiana*	Sweet acacia, Klu	14	High
15	Asteraceae	*Heterotheca grandiflora*	Telegraph weed	14	High
16	Poaceae	*Tragus berteronianus*	African bur grass, small carrot seed grass	13	High
17	Amaranthaceae	*Atriplex semibaccata*	Australian saltbush	13	High
18	Asparagaceae	*Agave americana*	American century plant	12	High
19	Fabaceae	*Acacia confusa*	Formosan koa	10	High
20	Bataceae	*Batis maritima*	Pickleweed, saltwort	9	High
21	Asteraceae	*Zinnia peruviana*	Field zinnia, wild zinnia	5	Evaluate
22	Proteaceae	*Grevillea robusta*	Silk oak	5	Evaluate
23	Myrtaceae	*Eucalyptus robusta*	Swamp mahogany	3	Low

Table 13 Site Specific IAS present on Kahoʻolawe

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

IAS Flora Observed on the Four Botanical Surveys

Using the HPWRA scoring order in Table 13, 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 C.

Since the removal of goats (*C. hirca*) in 1993, a 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 and should be replaced with a native plant if it is removed from an area.

Initially observed at Lua ʻO Kealialalo in 1996, it is possible fountain grass (*C. setaceum*) 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 ʻO Kealialalo from October, 2015 through December 2016, including 207 mature plants (Figure 24).

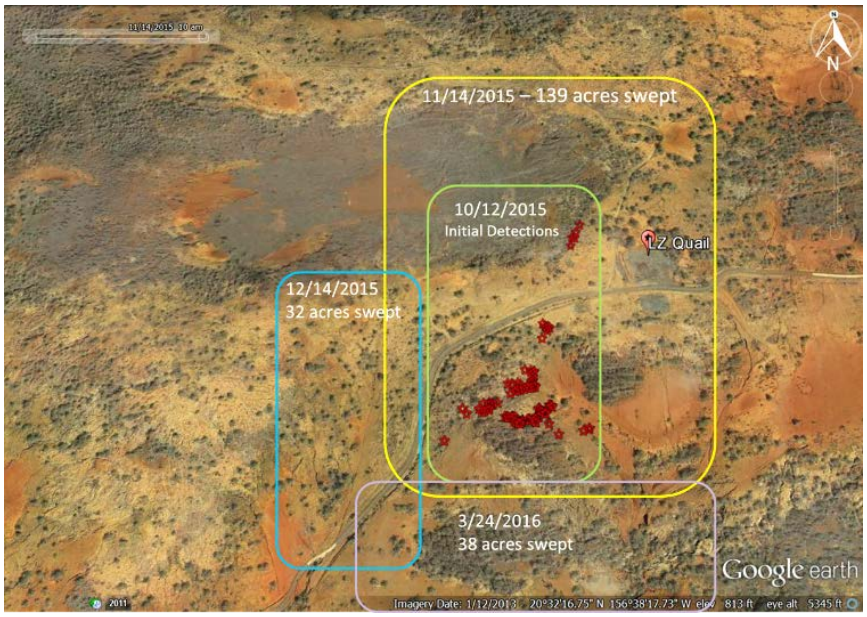

Figure 24. Location of recent Fountain grass control at Lua ʻO Kealialalo

Fountain grass surveys should be performed quarterly to keep this priority IAS in check. There are other IAS of concern from Table 13 e.g. Koa haole (*Leucaena leucocephala*). While occurring in specific locations on the island, IAS plant species have the potential to spread and increase its range on Kahoʻolawe. Inadvertently transporting seeds by vehicle is a potential vector which must be avoided. There is also risk of spreading IAS from Kahoʻolawe to other islands. Volunteers should be aware of this as they return to their home islands.

Additional Recommendations for Site Specific IAS on Kahoʻolawe

Recommendations in 2017 for the KIR Biosecurity Implementation Plan (McClelland Environmental Services, 2017) and updated by the authors;

Island-wide Eradication of Invasive Mammals

For the proposed eradication of rodents and feral cats on Kahoʻolawe 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 Kahoʻolawe 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.

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

Detection on Kahoʻolawe

Regular annual checks of the main access sites, Hakioawa and Honokanaiʻa 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 Kahoʻolawe methods as the purpose of this plan is to Prevent IAS from getting to Kahoʻolawe rather than trying to detect and eradicate them once they are present.

Early Detection and Rapid Response on Kahoʻolawe

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 response and eradication should be anticipated.

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, Traps

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

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

Response to IAS on Island and Preventing Re-introductions

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 Kahoʻolawe. This requires an appropriate standard of biosecurity to prevent re-invasions.

Kahoʻolawe Base Camp

Located in Honokanaiʻa on the South western side of Kahoʻolawe, the KIRC field base has a significant amount of infrastructure (buildings, vehicles) and is usually serviced using the KIRC vessel ʻŌhua which is a landing craft.

Native Fauna on Kahoʻolawe

Appendix E lists the native fauna on Kahoʻolawe.

Non-native Fauna on Kahoʻolawe

Appendix F lists the non-native fauna (and IAS status) observed on Kahoʻolawe (KIRC 1998, KIRC 2015).

List of Arthropods on Kahoʻolawe

Appendix G lists the arthropods on Kahoʻolawe.

V. FUTURE EFFORTS

KIRC Nursery

The KIRC Kihei Nursery is a State of Hawaiʻi run facility and therefore needs to be managed according to State of Hawaiʻi and U.S. Federal regulations. The U.S. EPA Workers Protection Standard is covered as well as the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA). Pesticide storage is discussed along with ant bait and barrier protocols and proper use. Strict biosecurity will be implemented according to this KIRC Biosecurity Plan and the Nursery facility manager will keep it on site for all personnel working at the Kihei Nursery to read.

Potted Plants Ant Control

Vanderwoude (2008) identifies three ways ants can enter the 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 were PPE and also be sure other personnel are kept away from the sprayed plants until they are dry.

FIFRA Compliance

The Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) 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 U.S. 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 Hawaiʻi 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.

U.S. EPA Worker Protection Standard

The Worker Protection Standard (40 CFR Part 170) from the U.S. 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 Nursery area for workers and information on chemical hazards.

The USDA Animal and Plant Health Inspection Service (APHIS) is a multi-faceted Agency with a mission that includes protecting and promoting U.S. 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 U.S. Department of Labor Occupational Safety and Health Administration (OSHA), the Hawaiʻi Occupational Health and Safety Division (HIOSH) and U.S. EPA regulations.

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.

"*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).

The Black Gold Potting Mix (bottom right) attracts ants and will be placed into the grey bin and sealed with a lid and ratchet straps. Management of pest ants in the KIRC Kihei nursery will reference Vanderwoude (2008) when they are observed. Weed cloth will be laid down beneath the plant tables (Figure 25) and potted plants moved up and off the ground. Hoses should not be left lying on the bare soil.

Figure 25. Weed cloth beneath coarse gravel under Kihei nursery tables

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 (Figure 26).

Figure 26. Emergency Eye Wash

Field Guides

To assist with the first objective of Prevention, field identification guide books will be developed for IAS flora and fauna and this 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 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 ʻOahu.

VI. KNOWN GAPS/ DEFICIENCIES

Table 14 lists known gaps and biosecurity deficiencies in the departments of the State of Hawaiʻi.

	State Department	Gaps
1	Hawaiʻi 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 Hawaiʻi (UH)	Lack of stable funding for agricultural and invasive species programs.

Table 14 Known Gaps in the State of Hawaiʻi

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

Kihei Boathouse		**Present on Kahoʻolawe**	
IAS Taxa	**Common Name**	**Yes**	**No**
Achatina fulica	Giant African Snail		X
Felis catus	Feral Cat	X	
Gallus gallus domesticus	Red Junglefowl		X
Herpestes auropunctatus	Mongoose		X
Mus musculus	House Mouse	X	
Rattus norvegicus	Norway rat		X
Rattus rattus	Roof rat		X

Table 15 Faunal IAS observed at the Kihei Boathouse Property

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

Examples of IAS on Board the ʻŌhua

In December 2009, a Norway rat (*Rattus norvegicus*) was observed on board the ʻŌhua vessel at the Kihei Boathouse and was exterminated on board. The Norway rat (*R. norvegicus*) (Figure 27) has been known to swim 800m interisland (Broome, 2007).

Figure 27. Norway Rat (*R. norvegicus*)

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

Table 16 lists the date of occurrence of inadvertent introduction and action taken.

	Date	Description	Action Taken
1	December 2, 2009	Norway Rat (*R. norvegicus)* on board ʻŌhua at Kihei Boathouse	Exterminated on board
2	March, 2015	Carpenter Ants (*C. variegatus*) in large cardboard box delivered to Kahoʻolawe	None
3	February 16, 2016	Gold Dust Day Gecko (*Phelsuma sp.*) on ʻŌhua in transit to Kahoʻolawe	Captured on board and released at Kihei Boathouse

Table 16 Date of occurrence and action taken of IAS observed on ʻŌhua 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 ʻŌhua 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.

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 Kahoʻolawe 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 Kahoʻolawe 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.

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 Kahoʻolawe, should be inspected periodically for IAS and documented with a date and photographs if possible.

VII. NEXT STEPS

Conclusions

This Biosecurity Plan is intended to identify necessary protocols, vectors, and quarantine procedures in the Kahoʻolawe Island Reserve. The one goal of the Plan is to keep any new IAS from entering the KIR. Using an Early Detection/Rapid Response (ED/RR) approach, the three actions to achieve this goal are of Prevention, Detection, and Response.

Prevention is key and linked to Education, and will be crucial for a successful implementation of this Biosecurity Plan. Education will not only inform personnel of the goal of this Biosecurity Plan, but it will also establish a new mind set for those coming to Kahoʻolawe. The main Educational message is that IAS are detrimental to native ecosystems and Prevention is the most cost effective and efficient approach to control them. It will important for new IAS to be Detected Early and have a program for rapid response for Quarantine and Eradication. This will eliminate any impact the IAS would otherwise have on Kahoʻolawe.

On February 24 2016, Rep. Tulsi Gabbard from Hawaiʻi (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 U.S. 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 Kahoʻolawe, should quickly lead to the chain of action of Early Detection/Rapid Response and thorough mitigation. Involving all personnel that come to Kahoʻolawe is vital to the execution of the Biosecurity concepts presented in this Biosecurity Plan. With the simple common goal of not allowing any new IAS from entering the Kahoʻolawe 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 Kahoʻolawe 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.

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Internet Resources

Coordinating Groups on Alien Pests Species (CGAPS)
https://www.invasivespeciesinfo.gov/docs/council/HISC%20Presentation.pdf

U.S. 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.
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Alien Aquatic Organisms
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Resource Kit for Cat and Rat Eradication - Biosecurity
http://rce.pacificinvasivesinitiative.org/intro/Biosecurity.html

Hawaii Pacific Weed Risk Assessment - Regulatory Compliance
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http://www.agriculture.senate.gov/imo/media/doc/FIFRA.pdf

APPENDIX A - Goats, Sheep and Cattle on Kahoʻolawe

Table of Goats Sheep and Cattle on Kahoʻolawe						
	Year	**Goats**	**Sheep**	**Cattle**	**Source**	**Goats Killed**
1	1793	2			2	
2	1859		2,075		1	
3	1875	200	20,000		1	
4	1876		16,000		1	
5	1881	2,000	1,000		1	
6	1884	9,000	2,000	200	1	
7	1888		1,000	800	1	
8	1890	9,000	12,000	900	1,2,3	
9	1903		7,000		1	
10	1904		5,000	60	1	
11	1906	10,000	3,200		1	
12	1909	5,000	3,200	40	1	1,144
13	1910	1,500	1,500		1	550
14	1912	250	200		1	200
15	1913		300		1	
16	1915	300	75		1	
17	1916		150		1	
18	1917	900	10		1	
19	1918	13,000			3	13,000
20	1920			500	2	
21	1932	15	20	300	1	
22	1939	25	200	500	1	
23	1941	25		460	1	
24	1944	100	2,000		1	
25	1953	1,000	1,000		1	
26	1969	2,000	132		1	
27	1970	5,000			1	
28	1971	5,000	400		1	
29	1990	3			1	

Appendix A. Number of Goats, Sheep and Cattle on Kahoʻolawe.
Source [1]KICC, 1992b [2] KICC, 1993 [3] KIRC, 1998.

APPENDIX B - Four Botanical Surveys performed on Kahoʻolawe in 2015.

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

	Taxa	Base Camp	LZ Quail	LZ One	Hakioawa
38	*Jacquemontia sandwicensis*				1
39	*Lantana camara*			1	1
40	*Leonotis nepetifolia*				1
41	*Leucaena leucocephala*	1	1	1	1
42	*Macroptilium atropurpureum*		1	1	1
43	*Macroptilium lathyroides*	1	1	1	1
44	*Malvastrum coromandelianum subsp. coromandelianum*				1
45	*Melinis repens*		1	1	
46	*Merremia aegyptia*	1			
47	*Myoporum sandwicense*				1
48	*Neonotonia wightii*			1	
49	*Nicotiana glauca*			1	1
50	*Ocimum gratissimum*				1
51	*Pennisetum polystachion*	1	1		
52	*Pluchea carolinensis (odorata)*		1	1	1
53	*Pluchea indica*				1
54	*Pluchea x fosbergii*			1	
55	*Portulaca oleracea*	1			
56	*Portulaca pilosa*				1
57	*Prosopis pallida*	1	1		1
58	*Psilotum nudum*		1		
59	*Salsola tragus*		1		
60	*Scaevola taccada*				1
61	*Senecio madagascariensis*		1	1	1
62	*Sesuvium portulacastrum*				1
63	*Setaria verticilliata*				1
64	*Sida ciliaris*				1
65	*Sida fallax*	1		1	1
66	*Sonchus oleraceus*			1	1
67	*Sporobolus africanus*	1			
68	*Sporobolus virginicus*				1
69	*Stachytarpheta jamaicensis*			1	
70	*Stapelia gigantea*				1
71	*Synedrella nodiflora*				1
72	*Tamarix aphylla*			1	
73	*Thespesia populnea*				1
74	*Tragus berteronianus*	1			

	Taxa	Base Camp	LZ Quail	LZ One	Hakioawa
75	*Tribulus Sp. (cistoides?)*	1			
76	*Tridax procumbens*	1		1	
77	*Urochloa maxima (Megathyrsus maximus)*		1	1	1
78	*Vachellia farnesiana*	1			1
79	*Verbena litoralis*			1	
80	*Vitex rotundifolia*				1
81	*Waltheria indica*	1	1	1	1
82	*Xanthium strumarium var. canadense*				1
	Sum	28	20	29	59

Appendix B. Four Botanical Surveys on Kahoʻolawe in 2015

APPENDIX C - Flora Survey of Kahoʻolawe

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

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

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

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

No.	Family	Species	Species
198	Asteraceae	*Sonchus oleraceus*	sow thistle, pualele
199	Asteraceae	*Sphagneticola trilobata*	Wedelia
200	Poaceae	*Sporobolus africanus*	rattail grass
201	Poaceae	*Sporobolus pyramidatus*	dropseed
202	Poaceae	*Sporobolus virginicus*	akiaki
203	Verbenaceae	*Stachytarpheta jamaicensis*	Jamaica vervain
204	Apocynaceae	*Stapelia gigantea*	zulu giant
205	Asteraceae	*Synedrella nodiflora*	nodeweed
206	Tamaraceae	*Tamarix aphylla*	tamarix
207	Fabaceae	*Tephrosia purpurea var. purpurea*	auhuhu, ahuhu
208	Malvaceae	*Thespesia populnea*	milo
209	Asteraceae	*Thymophylla tenuiloba*	dog fennel
210	Poaceae	*Tragus berteronianus*	bur grass
211	Zygophyllaceae	*Tribulus cistoides*	nohu
212	Asteraceae	*Tridax procumbens*	coat buttons
213	Poaceae	*Urochloa decumbens*	signal grass
214	Poaceae	*Urochloa maxima*	Guinea grass
215	Fabaceae	*Vachellia farnesiana*	klu
216	Verbenaceae	*Verbena litoralis*	vervain, oi
217	Asteraceae	*Verbesina encelioides*	golden crown-beard
218	Fabaceae	*Vigna o-wahuensis*	vigna
219	Lamiaceae	*Vitex rotundifolia*	pohinahina
220	Malvaceae	*Waltheria indica*	uhaloa
221	Asteraceae	*Xanthium strumarium var. canadense*	cocklebur
222	Asteraceae	*Zinnia peruviana*	pua pihi

Appendix C. Flora of Kahoʻolawe

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 D - Invasive Alien Species (IAS) Quarantine Form - Kahoʻolawe

	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		

[1]Please 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. Glass Jars/Vials
3. IAS Quarantine Forms

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

APPENDIX E - Native Fauna on Kahoʻolawe

	Taxa	Common Name	Hawaiian Name
1	*Arenaria interpres*	Ruddy Turnstone	Akekeke
2	*Asio flammeus sandwicensis*	Short Eared Owl	Pueo
3	*Bulweria bulwerii*	Bulwer`s Petrel	ʻOu
4	*Calidris alba*	Sanderling	Hunakai
5	*Fregata minor palmerstoni*	Frigate Bird	ʻIwa
6	*Heteroscelus incanus*	Wandering Tattler	ʻUlili
7	*Lasiurus cinerus semotus*	Hawaiian Hoary Bat	ʻŌpeʻa peʻa
8	*Manduca blackburni* (E)	Blackburn's Sphinx Moth	
9	*Neomonachus schauinslandi* (E)	Hawaiian Monk Seal	Ilio holo i ka uaua
10	*Numenis tahitiensis*	Bristle thighed curlew	Kioea
11	*Oceanodroma castro*	Band rumped storm petrel	ʻAkeʻake
12	*Oceanodroma tristrami*	Tristans Storm Petrel	
13	*Phaethon lepturus*	White Tail Tropic Bird – Sea Cliffs	Koaʻe Kea
14	*Phaethon rubricauda*	Red Tail Tropic Bird – Sea Cliffs	Koaʻe Ula
15	*Phoebastria immutabilis*	Laysan Albatross	Moli
16	*Phoebastria nigripes*	Blackfooted Albatross	Kaʻupu
17	*Pterodroma sandwichensis* (E)	Hawaiian Petrel - Unconfirmed Sighting	Ua'u
18	*Pluvialis fulva*	Pacific Golden Plover	Kolea
19	*Puffinus auricularis newelii*	Newell's shearwater	ʻAʻo
20	*Sula dactylatra*	Masked Booby	'A
21	*Sula leucogaster*	Brown Booby	'A
22	*Sula sula*	Red footed Booby	'A
23	*Triops longicaudata*	Dinosaur Shrimp	

Appendix E. Native Fauna on Kahoʻolawe. E = Federally Endangered

APPENDIX F - Non Native Fauna on Kahoʻolawe

	Taxa	Common Name	IAS Status
1	*Callipepala gambelii*	Gambel's Quail	
2	*Cardinalis cardinalis*	Northern Cardinal	
3	*Carpodacus mexicanus*	House Finch	
4	*Cettia diphone*	Japanese Bush-warbler	
5	*Felis catus*	Feral Cat	*
6	*Geopelia striata*	Zebra Dove	
7	*Lonchura malabarica*	Warbling Silverbill	
8	*Lonchura punctulata*	Nutmeg Mannikin	
9	*Mimus polyglottus*	Northern Mockingbird	
10	*Mus musculus*	House Mouse	*
11	*Paroaria coronata*	Red-crested Cardinal	
12	*Passer domesticus*	House Sparrow	
13	*Rattus exulans*	Polynesian Rat	*
14	*Streptopelia chinesis*	Spotted Dove	
15	*Tyto alba*	Barn Owl	*
16	*Zosterops japonicus*	Japanese White-eye	

Appendix F. Non Native Fauna on Kahoʻolawe

APPENDIX G - Arthropods on Kahoʻolawe

Number	Taxa	Common Name
1	*Acanthoscelides obtectus*	
2	*Achaea janata*	Castor semi looper
3	*Acrosticha apicalis*	
4	*Aedes albopictus*	
5	*Afrolistrophorus musculus*	Fur Mite
6	*Algarobius bottimeri*	Kiawe Bean Weevil
7	*Allograpta obliqua*	Hover fly
8	*Alydus pilosus*	Broad Headed bug
9	*Amorbia (emigratella?)*	
10	*Amphicerus cornutus*	
11	*Ampulex compressa*	Emerald Cockroach Wasp
12	*Anacamptodes fragilaria*	Koa Haole moth, Citrus looper
13	*Anax junius*	Green Darner Dragonfly
14	*Androlaelaps hermaphrodita*	
15	*Anoplolepis gracilipes*	Yellow crazy ant
16	*Anthicus vexator*	
17	*Aphelacarus sp.*	
18	*Aphis nerii*	
19	*Apis mellifera*	European honey bee
20	*Archytas cirphis*	Mexican Cutworm Tachinid
21	*Argiope appensa*	
22	*Ascalapha odorata*	Black Witch
23	*Asynonychus godmanii*	Fuller rose beetle
24	*Atropacarus singularis*	
25	*Bactrocera dorsalis*	Oriental Fruit Fly
26	*Barichneumon californicus*	
27	*Blaesoxipha plinthopyga*	
28	*Borborillus sordidus*	
29	*Brachydeutera hebes*	
30	*Brachydeutera ibari*	
31	*Brachystomella? contorta?*	
32	*Bradybaena similaris*	Succineid Snail
33	*Bradysia nr. hoyti*	(bishopi?)
34	*Bradysia radicum*	
35	*Bradysia spatitergum*	
36	*Bradysia tritici*	
37	*Brephidium exilis*	
38	*Bryania bipunctata*	
39	*Caconemobius howarthi?*	
40	*Cadrema pallida*	

Number	Taxa	Common Name
41	*Camponotus variegatus*	Carpenter ant
42	*Canaceoides angulatus*	
43	*Carabidae sp.*	Carabid Beetle
44	*Cardiocondyla sp.*	Ant
45	*Ceratina sp. nr. Dentipes*	Small carpenter bee (native)
46	*Ceropsilopa coquilletti*	
47	*Chaetogaedia monticola*	
48	*Cheiracanthium diversum?*	pale leaf spider
49	*Cheiracanthium mordax*	
50	*Chelonus blackburni*	
51	*Chrysodeixis erisoma*	Green garden looper
52	*Chrysomya megacephala*	Oriental Blow Fly
53	*Chrysosoma globiferum*	
54	*Chrysosoma sp.*	
55	*Clasiopella uncinata*	
56	*Clogmia albipunctata?*	
57	*Coccinella septempunctata*	
58	*Collembola*	Springtail
59	*Copromyza equina*	
60	*Cosymbia serrulata*	Geometrid caterpillar
61	*Cremastobombycia lantanella*	Lantana Leaf Miner
62	*Cryptolaemus montrouzieri*	Mealy bug destroyer
63	*Cubaris murina*	
64	*Cyclophora nanaria*	
65	*Danaus plexippus*	Monarch butterfly
66	*Delta campaniforme ssp. Esuiens*	Yellow and black potter wasp
67	*Delta campniforme*	Yellow Potter Wasp
68	*Dioxyna sorocula*	
69	*Diptera sp.*	Aquatic fly
70	*Distoleon wilsoni, D. perjurus*	Hawaiian Ant Lion
71	*Dolichurus stantoni*	Black cockroach wasp
72	*Draeculacephala minerva*	
73	*Drosophila melanogaster*	
74	*Drosophila sulfurigaster bilimbata*	
75	*Ectemnius distinctus*	Sphecid wasp
76	*Ectemnius mandibularis*	Sphecid wasp
77	*Ectomyelois ceratoniae*	
78	*Elaphria nucicolora*	
79	*Entomobrya atrocincta*	
80	*Entomobrya multifasciata*	
81	*Eristalinus arvorum*	
82	*Ethirothrips brevis*	

Number	Taxa	Common Name
83	*Ethonia nigroapicella*	Kou leaf worm
84	*Eucelatoria armigera*	
85	*Euchromius ocelleus*	
86	*Eupodes hawaiiensis*	
87	*Euryomma? peregrina*	
88	*Euthyrrhapha pacifica*	Pacific cockroach
89	*Evania appendigaster*	Larger ensign wasp
90	*Eysarcoris ventralis*	
91	*Folsomides? parvulus?*	
92	*Galumna flabellifera*	
93	*Gasteracantha mammosa*	Asian spiny backed spider
94	*Gnathaphanus picipes*	
95	*Gonocephalum adpressiforme*	
96	*Gryllodes sigillatus*	Flightless Field Cricket
97	*Gymnochiromyia hawaiiensis*	
98	*Halobates sericeus*	Pelagic water strider
99	*Haplothrips gowdeyi*	Black Flower Thrips
100	*Hecamede granifera*	
101	*Hemicheyletia bakeri*	
102	*Herpetogramma licarsisalis*	
103	*Heterospilus prosopidus*	
104	*Hierodula patellifera*	Giant Asian Mantis
105	*Hoplophorella singularis*	
106	*Hydrellia tritici*	
107	*Hylaeus anthracinus*	Yellow-faced Bee
108	*Hylaeus assimilans*	Yellow-faced Bee
109	*Hylaeus connectans*	Yellow Faced Bee
110	*Hyles lineata*	White-lined Sphinx
111	*Hypena strigata*	
112	*Hyposmocoma sp*	
113	*Hypozetes laysanensis*	
114	*Ischnura ramburii*	
115	*Isometrus maculates*	
116	*Kilauella debilis?*	
117	*Lasioglossum spp.*	Halticid sweat bee
118	*Latrodectus geometricus*	Brown widow spider
119	*Latrodectus hesperus?*	
120	*Lepidocyrtus sp.*	
121	*Leptobrysa decora*	Lace bug
122	*Leptogenys falcigera*	Ant
123	*Lespesia archippivora*	Lesser army worm
124	*Leucopis albipuncta*	

Number	Taxa	Common Name
125	*Linepithema humile*	Argentine ant
126	*Lispe metatarsalis*	
127	*Lumbricadae*	Earthworm
128	*Lycophotia porphyrea*	
129	*Lygaeidae sp.*	Lygaeid Seed Bug
130	*Macaria abydata*	Koa haole moth, dot lined angle
131	*Manduca blackburni*	Blackburn's Sphinx moth E
132	*Mantidae spp.*	Praying Mantid
133	*Megalographa biloba*	
134	*Megalorrhipida leucodactyla*	
135	*Melipotis indomita*	Monkeypod-Kiawe Caterpillar
136	*Melophagus ovinus*	Sheep Ked
137	*Melormenis basilis*	West Indian Flatid Planthopper
138	*Miridae spp.*	Mirid Plant bug
139	*Monomorium bicolor complex*	Ant
140	*Monomorium floricola*	Bicolored trailing ant
141	*Monomorium pharaonius*	Pharaoh ant
142	*Multioppia wilsoni*	
143	*Myobia musculi*	Fur Mite
144	*Myocoptes musculinus*	Fur Mite
145	*Mythimna (loreyimima?)*	
146	*Mythimna (scottii?)*	
147	*Neoseiulus oahuensis*	
148	*Neostylopyga rhombifolia*	Harlequin Cockroach
149	*Nesoclimacias lanaiensis?*	
150	*Nylanderia bourbonica*	Ant
151	*Nysius coenosulus*	
152	*Nysius kinbergi*	
153	*Nysius sp.*	seed bug
154	*Nysius terrestris*	
155	*Ochetellus glaber*	Ant
156	*Ochthera circularis?*	
157	*Odonata spp.*	Dragonfly
158	*Oestrus ovis*	Sheep Bot Fly
159	*Olla v-nigrum*	
160	*Omiodes blackburnii*	
161	*Omiodes continuatalis*	
162	*Oppia sp.*	
163	*Ornithonyssus bacoti*	Tropical Rat Mite
164	*Orobatidae spp.*	Orobatid Mite
165	*Orthemis ferruginea*	Libellulid dragonfly
166	*Orthomecyna keoniae*	

Number	Taxa	Common Name
167	*Orthomecyna sp*	
168	*Otobius megnini*	Ear Tick
169	*Pachodynerus nasidens*	
170	*Pachydynerus spp.*	Ichneumonid wasp
171	*Pagiopalus atomarius*	Cane hunting spider
172	*Pantala flavescens*	Globe skimmer
173	*Paratrechina longicornis*	Black Crazy ant
174	*Paurocephala sp.*	
175	*Pelypedilum nubiferum*	Chronomid midge
176	*Phanerotoma hawaiiensis*	
177	*Pheidole megacephala*	Big-headed ant
178	*Phidippus? audax*	
179	*Pigrita uuku*	
180	*Pigritia sp*	
181	*Placopsidella grandis*	
182	*Placosternus crinicornis*	Kiawe Round Headed Borer
183	*Platosciara adrostylata*	
184	*Platosciara perniciosa*	
185	*Platyzosteria soror*	White Margined Cockroach
186	*Plautia stali*	
187	*Polistes aurifer*	
188	*Polistes exclamens*	Common paper wasp
189	*Polistes spp.*	Ichneumonid wasp
190	*Porcellio laevis*	Isopod
191	*Proisotoma centralis*	
192	*Proprioseiopsis ovatus*	
193	*Protaetia fusca*	Mango Flower Beetle
194	*Pseudopterocheilus congruus*	Vespid wasp
195	*Psoroptes ovis*	Sheep Scab Mite
196	*Psudopterocheilus spp.*	Wasp
197	*Psuedomyrmex gracilis*	Elongate Twig Ant
198	*Psychoda nr. alternata*	
199	*Ptycta sp.1*	
200	*Ptycta sp.2*	
201	*Pycnoscelus indicus*	Burrowing cockroach
202	*Radfordia affinis*	Fur Mite
203	*Sarcophaga africa*	
204	*Scapheremaeus sinuosus*	
205	*Scaptomyza (Bunostoma) sp.*	
206	*Scatella bryani*	
207	*Scatella hawaiiensis*	
208	*Sceliphron caementarium*	

Number	Taxa	Common Name
209	*Scheloribates elegans*	
210	*Schistocerca nitens*	
211	*Scolopendra subspinipes*	
212	*Scopula personata*	
213	*Scymnodes lividigaster*	Yellow Shouldered lady beetle
214	*Seira terrestris*	
215	*Simosyrphus grandicornis*	
216	*Sinoxylon conigerum*	
217	*Sminthurides biniserratus*	
218	*Sminthurides lolelua*	Sminthurid springtail
219	*Sminthurinus kaha*	
220	*Solenopsis geminata*	Tropical Fire Ant
221	*Spanagonicus albofasciatus*	Whitemarked Fleahopper
222	*Spathius prusius*	
223	*Specularis impressithorax*	
224	*Sphaerochthonius suzukii*	
225	*Spinibdella bioculata*	
226	*Spoladea recurvalis*	Hawaiian Beet Webworm
227	*Stenocorse bruchivora*	
228	*Stoeberhinus testaceus*	
229	*Strymon bazochi*	Lantana Scrub Hairstreak
230	*Styringomyia didyma*	
231	*Sybra alternans*	
232	*Symploce capitata*	
233	*Syntormon flexibilis*	
234	*Tachinidae spp.*	Tachinid Fly
235	*Tamisca kawikae*	
236	*Tapinoma melanocephalum*	Ant
237	*Technomyrmex albipes*	White Footed Ant
238	*Tectocepheus sarekensis*	
239	*Tethina variseta*	
240	*Tethina willistoni*	
241	*Tetramorium bicarinatum*	Guinea Ant
242	*Tetramorium caldarium*	Ant
243	*Tetramorium simillmium*	Ant
244	*Thyanta custator (?)*	Red shoulder stink bug
245	*Thyrocopa epicapna*	
246	*Thyrocopa kanaloa*	
247	*Toxomerus marginatus*	
248	*Tramea lacerata*	Black saddlebags, ragedy skimmer
249	*Trichocorixa reticulata*	Water Boatman

Number	Taxa	Common Name
250	*Trichorhina tomentosa*	
251	*Trupanea crassipes*	
252	*Udara blackburni*	Hawaiian Blue Butterfly
253	*Uroplata girardi*	Leaf mining Lantana beetle
254	*Urosigalphus bruchi*	
255	*Vepracarus sp.*	
256	*Xenopsylla cheopis*	Oriental Rat Flea
257	*Xenylla yucatana*	
258	*Xylocopa sonorina*	Carpenter bee
259	*Xystrologa sp.*	
260	*Zelus renardii*	Leaf Hopper Assassin Bug

Appendix G. Arthropods on Kahoʻolawe. (Ants N=18)

Literature Cited for Arthropods on Kahoʻolawe (Appendix G)

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APPENDIX H - KIR Biosecurity Signs

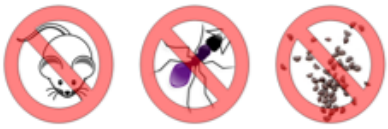
APPENDIX H

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 **I**nvasive **A**lien **S**pecies (**IAS**) from Entering the Kaho`olawe Island Reserve (KIR).

- **PREVENTION**
- **DETECTION**
- **QUARANTINE**
- **ERADICATION**
- **EDUCATION**

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

APPENDIX I - Tango® Instructions for Control 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. The granules are also inactivated by rainfall. They are made of corn and vegetable oil and the ant will extract the oil out of the granule and leave the rest behind. Therefore, ants can consume a gel bait far more easily than a granular product.

Tango® is a concentrate pesticide that contains S-methoprene which is an insect growth regulator (IGR). This chemical prevents the affected larvae from completing pupation but has no effect on the worker ants. It also slows down egg production by the queen and ant colonies baited with IGR slowly die out over a period of a few months. Hence they are effective for long term management.

Personnel Protective Equipment (PPE)

- Rubber or chemical gloves
- Chemical resistant apron
- Eye protection
- Shoes and socks
- Long Sleeved shirt and long pants
- Access to faucet and soap for washing your hands after mixing

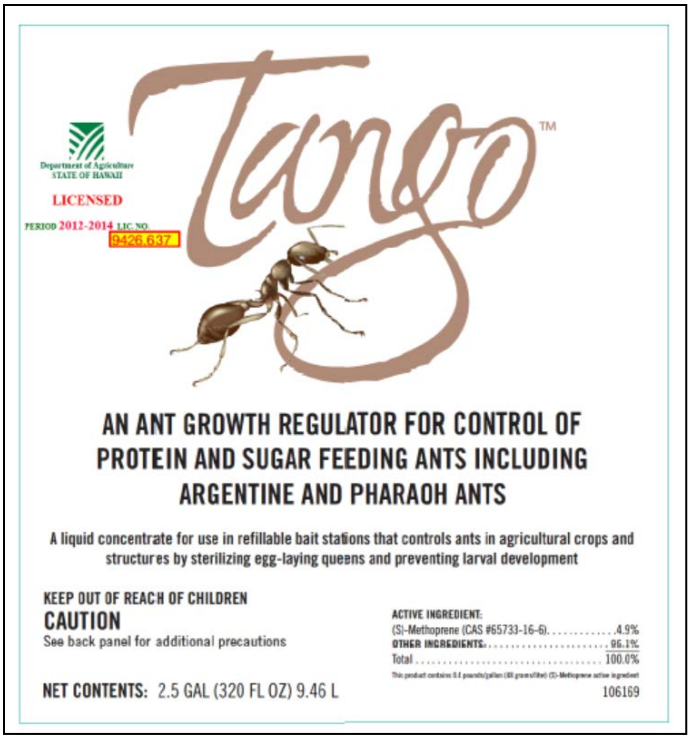
Instructions:

- Obtain SDS Sheet for Tango®
- Read all instructions on Tango® label.
- Only make enough bait for immediate use and do not store excess bait
- A 40 oz batch requires 3 cups warm water, 2 buttercups corn oil or other vegetable oil, 4 tablespoons Tango®, 1 tablespoon xanthan gum, and 2 teaspoons smooth peanut butter.
- Mix for a final concentration of 0.25% S-methoprene.
- Repeat every 4 to 6 weeks.

The 2 (EE) Recommendation of FIFRA must be in the possession of the user at the time of pesticide application. Apply with a good quality spray bottle.

EPA Reg No. 2724-420. Active ingredient (S)-Methprene (CAS #65733-16-6) 4.9%.

Tango® Instructions for Control of Ants



Literature Cited

Mixing Hal Gel Bait with Tango® for Control of Little Fire Ants. LFA Fact Sheet 5 (Version 5.5: May 2014) Hawaii Ant Lab, Pacific Cooperative Studies Unit, University of Hawaii.

APPENDIX J- Hawaiʻi 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)
        -

Hawaiʻi 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)

APPENDIX K - 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.

Kahoʻolawe Island Reserve Commission, 811 Kolu St., Ste. 201, Wailuku, Hawai'i 96793.
Tel: (808) 243-5020

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APPENDIX K

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.

Kahoʻolawe Island Reserve Commission, 811 Kolu St., Ste. 201, Wailuku, Hawai'i 96793. 2
Tel: (808) 243-5020

APPENDIX L - 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 M - Rodent Control Log

Rodent Control Log
Kihei Boat House Facility
Contrac (active indgredient - 0.005% Bromadiolone)

1 oz. bait blocks (3-16 blocks per label)
Sticky Traps (S), Snap traps (ST)

"X" indicates a number is needed
When filling in caught or killed index indicate mice (M), rats (R).

Date MM/DD/YYY	(X) traps set (if needed)	Caught or killed index (X)	Number of rats sighted monthly (X)	Placed (X) new stations	Refreshed bait in (X) stations	Total lbs. of bait used (X)	Comments

Include diagram of rodent control at facility
Dispose of spoiled bait at an approved waste disposal facility
Service schedule monthly or sooner as needed if rodent sign is evident

APPENDIX N - Biosecurity Self Audit Check Sheet

Kaho’olawe Quarantine Self Audit Check Sheet

One quarantine form to be completed by every person traveling to island. Please bring this form with you.

Date:	Date inspected:
Name:	Destination:

Prior to arrival for quarantine check all clothing and equipment must have been recently washed, dried and cleaned of any seeds, organic material and insects. Footwear must have been scrubbed clean in a weak bleach solution. Any unclean items will not be permitted onto the island. Pay particular attention to any Velcro, pockets, the inside and pockets of bags for seeds etc.

	Tick if in compliance	**Inspected by quarantine officer**	**Comments-**
Boots			
Other footwear			
Socks			
Clothing			
Waterproof leggings			
Parka			
Coat			
Field equipment **Tent** **Sleeping bag**			
Food stores (boxed/bagged)			
Other **Cultural materials**			
SIGNED: visitor			**SIGNED: Quarantine Officer**

APPENDIX O - List of Ants in Hawai‘i and Kaho‘olawe

As of 2003, all species of ants (Formicidae) intercepted at U.S. 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, invasive species. 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).

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

Ants In Hawaiʻi		
Number	**Taxa**	**Common Name**
42	*Strumigenys emmae*	
43	*Strumigenys godeffroyi*	
44	*Strumigenys lewisi*	
45	*Strumigenys membranifera*	
46	*Strumigenys rogeri*	
47	*Syllophopsis sechellensis*	
48	*Tapinoma melanocephalum*	
49	*Tapinoma sessile*	
50	*Technomyrmex albipes*	White Footed Ant
51	*Technomyrmex difficilis*	
52	*Technomyrmex pallipes*	
53	*Technomyrmex vitiensis*	
54	*Tetramorium bicarinatum*	Guinea Ant
55	*Tetramorium caldarium*	
56	*Tetramorium insolens*	
57	*Tetramorium lanuginosum*	
58	*Tetramorium simillimum*	
59	*Tetramorium tonganum*	
60	*Trichomymex destructor*	
61	*Wasmannia auropunctata*[1]	Little Fire Ant (LFA)

Ants found in Hawaiʻi

[1]By law, LFA 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 and Xstinguish® were the most preferred by the Black Crazy ant, (*P. longicornus)* foragers followed by sugar water and sugar water and boric acid (H_3BO_3). Bait preferences for ant taxa is listed in the following Table.

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

Bait preference for ant taxa

Note: Both ant taxa found on Kahoʻolawe.