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February 24, 2017

RECEIVED
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OFC. OF ENVIRONMENTAL QUALITY CONTROL

Mr. Scott Glenn, Director
Office of Environmental Quality Control
Department of Health, State of Hawaii
235 S. Beretania Street, Room 702
Honolulu, Hawaii 96813

Dear Mr. Glenn:

With this letter, the Division of Forestry and Wildlife of the Department of Land and Natural Resources hereby transmits the draft environmental assessment and anticipated finding of no significant impact (DEA-AFONSI) for the Lehua Island Ecosystem Restoration Project situated at TMK: 1-1-01:2, in the Waimea District on the island of Lehua for publication in the next available edition of the Environmental Notice.

Enclosed is a completed OEQC Publication Form and one copy of the DEA-AFONSI. The Adobe Acrobat PDF file of the DEA-AFONSI, an electronic copy of the OEQC publication form in MS Word, and this letter has also been sent via electronic mail to your office.

If there are any questions, please contact Patrick Chee of the Division of Forestry and Wildlife at 808-587-4191.

Sincerely,

David G. Smith
Administrator

Enclosures:
OEQC Publication Form
Lehua Island Ecosystem Restoration Project Lehua DEA-AFONSI

17-381

AGENCY
PUBLICATION FORM

Project Name:	Lehua Island Ecosystem Restoration Project
Project Short Name:	Lehua Island Ecosystem Restoration Project
HRS §343-5 Trigger(s):	Using State funds
Island(s):	Lehua Island
Judicial District(s):	Waimea
TMK(s):	1-1-01:2
Permit(s)/Approval(s):	Permits and approvals come under the following authorities. Federal: National Environmental Policy Act (NEPA) National Historic Preservation Act (NHPA) Endangered Species Act (ESA) Migratory Bird Treaty Act (MBTA) Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) Marine Mammal Protection Act of 1972, as amended Water Pollution Control Act of 1948, as amended Coastal Zone Management Act of 1972, as amended State: Hawaii Administrative Rules 13-124 Hawaii Revised Statutues 343 Various permits under the above Federal laws have been delegated to the State to administer. Further authorities for action can be found under the Regulatory Framework section of the Draft EA
Proposing/Determining Agency:	Department of Land and Natural Resources, Division of Forestry and Wildlife
Contact Name, Email, Telephone, Address	Patrick Chee, LehuaRestoration@hawaii.gov, 808-587-4191, 1151 Punchbowl St. Rm. 325, Honolulu, HI 96813
Accepting Authority:	(for EIS submittals only)
Contact Name, Email, Telephone, Address	
Consultant:	
Contact Name, Email, Telephone, Address	

Status (select one)	**Submittal Requirements**
__X__ DEA-AFNSI	Submit 1) the proposing agency notice of determination/transmittal letter on agency letterhead, 2) this completed OEQC publication form as a Word file, 3) a hard copy of the DEA, and 4) a searchable PDF of the DEA; a 30-day comment period follows from the date of publication in the Notice.
____ FEA-FONSI	Submit 1) the proposing agency notice of determination/transmittal letter on agency letterhead, 2) this completed OEQC publication form as a Word file, 3) a hard copy of the FEA, and 4) a searchable PDF of the FEA; no comment period follows from publication in the Notice.
____ FEA-EISPN	Submit 1) the proposing agency notice of determination/transmittal letter on agency letterhead, 2) this completed OEQC publication form as a Word file, 3) a hard copy of the FEA, and 4) a searchable PDF of the FEA; a 30-day comment period follows from the date of publication in the Notice.
____ Act 172-12 EISPN ("Direct to EIS")	Submit 1) the proposing agency notice of determination letter on agency letterhead and 2) this completed OEQC publication form as a Word file; no EA is required and a 30-day comment period follows from the date of publication in the Notice.
____ DEIS	Submit 1) a transmittal letter to the OEQC and to the accepting authority, 2) this completed OEQC publication form as a Word file, 3) a hard copy of the DEIS, 4) a searchable PDF of the DEIS, and 5) a

searchable PDF of the distribution list; a 45-day comment period follows from the date of publication in the Notice.

____ FEIS	Submit 1) a transmittal letter to the OEQC and to the accepting authority, 2) this completed OEQC publication form as a Word file, 3) a hard copy of the FEIS, 4) a searchable PDF of the FEIS, and 5) a searchable PDF of the distribution list; no comment period follows from publication in the Notice.
____ FEIS Acceptance Determination	The accepting authority simultaneously transmits to both the OEQC and the proposing agency a letter of its determination of acceptance or nonacceptance (pursuant to Section 11-200-23, HAR) of the FEIS; no comment period ensues upon publication in the Notice.
FEIS Statutory Acceptance	Timely statutory acceptance of the FEIS under Section 343-5(c), HRS, is not applicable to agency actions.
____ Supplemental EIS Determination	The accepting authority simultaneously transmits its notice to both the proposing agency and the OEQC that it has reviewed (pursuant to Section 11-200-27, HAR) the previously accepted FEIS and determines that a supplemental EIS is or is not required; no EA is required and no comment period ensues upon publication in the Notice.
____ Withdrawal	Identify the specific document(s) to withdraw and explain in the project summary section.
____ Other	Contact the OEQC if your action is not one of the above items.

Project Summary

The Hawaii Department of Land and Natural Resources' (DLNR) Division of Forestry and Wildlife (DOFAW), in cooperation with the members of the Lehua Island Restoration Steering Committee (see EA for membership) are proposing a conservation action that will continue the restoration of Lehua Island.

Lehua Island's natural ecosystem supports one of the largest and most diverse seabird colonies in the main Hawaiian Islands, and it has the potential to become a refuge to species displaced by sea level rise. However, damaging invasive Pacific rats were introduced decades ago, and have far reaching impacts on the island's seabird and native plant populations. For Lehua to reach its full potential as a bird sanctuary, Pacific rats must be completely removed from the Island.

DOFAW is proposing the eradication of rats from Lehua using bait containing rodenticide. The potential risks to non-target species have been evaluated and are considered low. Mitigation strategies described in this EA will minimize the risks. The eradication of Pacific rats from Lehua will have long lasting benefits for native species on Lehua, particularly seabirds which outweighs the temporary risks posed by this proposed action.

Draft Environmental Assessment
Lehua Island Ecosystem Restoration Project
March 2017

Lead Agency:

Hawaii Department of Land and Natural Resources, Division of Forestry and Wildlife

Cooperating Federal Agencies:

U.S. Fish and Wildlife Service

U.S. Department of Homeland Security, U.S. Coast Guard

U.S. Department of Agriculture, Animal and Plant Health Inspection Service, Wildlife Services

Point of Contact:

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Pacific Cooperative Studies Unit, University of Hawaii
In cooperation with
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Honolulu, HI
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LehuaRestoration@hawaii.gov

Responsible Official:

David Smith, Administrator
Division of Forestry and Wildlife
Department of Land and Natural
Resources
1151 Punchbowl St., Rm 325
Honolulu, HI 96813

Prepared in compliance with the Hawaii HRS 343 and all associated regulations.

Note: The U.S. Fish and Wildlife Service is a cooperator and federal sponsor on this project. However, the Fish and Wildlife Service will be preparing a separate document that complies with the requirments for the National Environmental Protection Act.

Cover photo courtesy of Kenneth Wood

Executive Summary

Lehua Island is a 284-acre island located three-fourths of a mile off the northern shore of Niihau (a privately owned 46,080-acre island). Lehua is a state-designated seabird sanctuary managed by the Hawaii Department of Land and Natural Resources (DLNR) and federally owned by the U.S. Coast Guard (USCG). Lehua is one of Hawaii's most important seabird colonies because of its size and height above sea level. It also offers a unique opportunity for restoring an island ecosystem.

DLNR Division of Forestry and Wildlife (DOFAW), in conjuction with federal sponsor United States Fish and Wildlife Service (USFWS), technical partner Island Conservation (IC), and the cooperating members of the Lehua Island Restoration Steering Committee (LIRSC) are proposing to complete the eradication of rats from Lehua Island so further restoration efforts can move forward in the future.

The LIRSC is a multidisciplinary stakeholder body including representatives from: DOFAW, USFWS, the U.S. Department of Agriculture, Animal and Plant Health Inspection Service, Wildlife Services (WS), U.S. Coast Guard (USCG), National Tropical Botanical Gardens (NTBG), the Owners of Niihau, and IC.

In 2005, DOFAW and the USFWS embarked on a plan to restore Lehua Island. As part of the compliance for the actions proposed in the plan, both Federal and State Environmental Assessments (EA) were submitted, commented on by the public, and resulted in a Finding of No Significant Impact (FONSI) for both the 2005 Lehua EAs and the supplemental EAs in 2009. The alternatives approved in the EAs were followed and the actions resulted in the complete eradication of rabbits from Lehua in 2006 and an incomplete eradication of rats in 2009. (See *Summary of Final EA 2005, Supplemental EA 2009, and Purpose of this EA* for further details)

The purpose of the proposed actions in this document is to restore Lehua Island's ecosystem through completing the eradication of rats, and to ensure restoration success by keeping Lehua rat free. The proposed action could improve seabird nesting habitat and could aid in the recovery of rare endemic seabirds such as Band-rumped Storm Petrels, Hawaiian Petrels, and Newell's Shearwaters, and native coastal plants and insects. The proposed project is not anticipated to have any significant negative environmental effects.

The proposed preferred alternative involves the aerial and hand broadcast of bait pellets containing the rodenticide diphacinone (followed by the rodenticide brodifacoum if necessary) into all rat territories on Lehua Island. Rat eradication would occur in the summer dry season to minimize risk of rain washing rodenticide pellets into the ocean and to maximize the efficacy of eradication by targeting the rats at the low point in their population cycle.

DOFAW, USFWS, and IC have conducted extensive scoping since 2005 of the proposed actions, and additional scoping following on the 2009 incomplete eradication attempt. As a result of comments from interested public, Federal and State agencies, and conservation groups, DOFAW identified a number of environmental issues. These issues are: 1) Restoration efficacy; 2) Impacts on non-target species; 3) Increase in weed abundance caused by rat eradication; 4) Impacts on cultural resources; 5) Impacts on human health and safety; and 6) Introduction of non-native species caused by project activities. Following the 2009 rat eradication attempt, there was a coincidental fish mortality event reported on Niihau and a dead whale calf also was found around the same time. Several tests of the affected fish and whale were done and showed no rodenticide in tissues. Nonetheless, further analysis and research has been included in this document to address impacts to marine species.

To address these environmental issues, DOFAW prepared three alternatives, including the proposed action. Each alternative was developed to respond to the environmental issues identified. USFWS and DOFAW also considered many other alternatives and methods to eradicate rats on Lehua Island but rejected the methods that failed to meet the purpose and need of the project.

Within this Draft EA, DOFAW describes the affected environment for the project. This section describes what is currently known about the status and trend of affected island resources, including the physical features of the island, and its terrestrial and marine resources. There is also an analysis of the environmental consequences that could occur should any of the alternatives presented be chosen for implementation, and a description of proposed mitigation measures.

The DOFAW Administrator is responsible for the final decision on the proposed action, in addition to plan implementation and monitoring.

Table of Contents

I: Glossary of Terms

Anticoagulant a class of drugs that work to prevent blood clotting. As a pharmaceutical group, anticoagulants can be used as a medication for thrombotic disorders (blood clots inside blood vessels). As a rodenticide, they act by blocking the vitamin K cycle, resulting in internal bleeding. Rodents are particularly sensitive to anticoagulant drugs.

Behaviorally plastic change in an organism's behaviors or habits that results from change in the environmental conditions, such as a shift to a new primary food source due to changes in food abundance.

Brodifacoum a second-generation rodenticide that requires only one feeding for a rodent to receive a toxic dose.

Colony (of seabirds) a large group of birds from one or more species that nest or roost (sleep) close to each other at a particular location. Most seabirds are social nesters and they display extraordinary site fidelity.

Colonization the process in biology by which a species successfully spreads to a new area.

Diphacinone a first-generation rodenticide which requires multiple feedings over several days for a rodent to receive a lethal dose.

DLNR Department of Land and Natural Resources of the State of Hawaii.

DOFAW Division of Forestry and Wildlife, a subset of DLNR, State of Hawaii.

EA Environmental Assessment which lays out the environmental consequences of a proposed plan, policy, program, or project prior to the decision to move forward with that proposed action.

Endemic a species that is native to just one place.

EPA U. S. Environmental Protection Agency which protects human health and the environment

Ephemeral (plants) those which sprout, reproduce, and die back very quickly as an evolutionary adaptation to take advantage of brief wet periods in an otherwise dry climate

Eradication the complete removal of a damaging species from a specific location to enable ecosystem recovery.

Extinction when the last of a species dies and that species ceases to exists anywhere in the world.

Extirpation the complete removal of an organism from a specific location but it continues to exist in other places. Also known as local extinction.

FIFRA The Federal Insecticide, Fungicide, and Rodenticide Act, a federal law that regulates pesticides to protect applicators, the public, and the environment

FONSI a Finding of No Significant Impact is issued when an environmental analysis and interagency review finds a project to have no significant negative impacts on the quality of the environment

GIS a Geographic Information System is a computer program designed to analyze and manage spatial and geographic data

GPS a Global Positioning System allows users to determine their exact location anywhere in the world regardless of weather or other conditions

Granivory seed predators feed on the seeds of plants as a main or exclusive food source leaving seeds damaged and not viable

Haemorrhaging the flow of blood out from a blood vessel; bleeding

Herpetofauna amphibians (frogs, toads, salamanders and newts) and reptiles (snakes, lizards, turtles, tortoises and crocodilians)

Hopper a piece of equipment used in many types of industry to discharge products at a steady rate.

Immigration the movement of an organism to a new area from elsewhere, assisted or unassisted

Insectivorous an animal that eats insects as a primary or exclusive food source

Ionic strength (of seawater) a measure of the concentration of ions in a solution which affects important properties such as the dissociation or solubility of different salts

LD_{50} the amount of an ingested substance that kills 50% of test samples

LOEL Lowest Observed Adverse Effect Level, the lowest dosage of a substance that attains adverse effects in test samples

LIPP Lehua Island Protocols and Procedures, a set of rules required for personnel accessing Lehua as set out in Appendix F

Mitigation steps taken to reduce or avoid negative environmental impacts

NEPA National Environmental Policy Act a national law that protects the environment through a broad national framework

OEQC Office of Environmental Quality Control, oversees the environmental review process within the State of Hawaii

Palatability having an agreeable or pleasant taste that is accepted by the target consumer

Pinnipeds seals; a diverse group of carnivorous semi-aquatic marine mammals

Predation the act of one organism killing and eating other organisms, can refer to both animals and plants

Pyranine a fluorescent dye commonly found in highlighters and used as a biological stain to show ingestion pathways

Recruitment the ability of juvenile organisms to survive and add to the population of that species

USCG U. S. Coast Guard, owner of Lehua Island

USDA U. S. Department of Agriculture, manages laws related to farming, agriculture, forestry, and food

USFWS U. S. Fish and Wildlife Service, manages fish, wildlife, plants and natural habitats

II: Background

Summary of Final EA 2005, Supplemental EA 2008, and Purpose of this EA

DLNR-DOFAW and USFWS in conjunction with Island Conservation (IC) and the Offshore Islet Restoration Committee (OIRC) formulated the proposed actions in the draft Environmental Assessment of 2005 to reverse the ecological degradation occurring on Lehua Island caused by non-native Pacific Rats (*Rattus exulans*) and European Rabbits (*Oryctolagus cuniculus*). The purpose of the proposed actions was to restore Lehua Island's ecosystem through eradication of rats and rabbits, to ensure restoration success by keeping Lehua rat and rabbit free, and to further Lehua Island's ecosystem quality through native plant restoration. The OIRC has since been disbanded.

Three alternatives were proposed for rat and rabbit eradication: 1) no action; 2) diphacinone (50ppm) followed by brodifacoum (25ppm) for rat eradication and hunting and trapping for rabbit eradication; and 3) brodifacoum (25ppm) for rat eradication and hunting and trapping for rabbit eradication. The proposed preferred alternative was the aerial and hand broadcast of bait pellets containing the rodenticide diphacinone, followed by the rodenticide brodifacoum, only if necessary, into all rat territories on Lehua Island, as well as removal of all rabbits via hunting and trapping. Rat eradication was proposed to occur in the summer dry season to minimize risk of rain washing rodenticide pellets into the ocean and to maximize the efficacy of eradication by targeting the rats at the low point in their population cycle and low food availability. Rabbit eradication, which involved more on the ground activity than rat eradication, would occur in the winter, at the low point in the annual seabird breeding season, to minimize risk of disturbance to nesting seabirds. Plant restoration would occur after rat and rabbit removal to ensure that native plants could thrive without being eaten by these invasive species.

In September 2005, the USFWS and the DLNR DOFAW, as joint lead agencies, and the U.S. Department of Homeland Security, U.S. Coast Guard, as the cooperating agency published the *Final Environmental Assessment for the Lehua Island Ecosystem Restoration Project*. The finding of No Significant Impact (FONSI) was dated 09/30/05. As documented in the FONSI, the DOFAW Administrator and the USFWS Assistant Regional Director, Ecological Services, Region 1 selected the proposed action, Alternative 2, which included the following:

1) Eradication of the non-native European rabbit and Pacific rat on Lehua Island, followed by implementation of a long-term ecological restoration strategy;

2) Adoption of a preventive strategy to reduce the potential for non-native animals and plants to be accidentally reintroduced to Lehua Island during and after restoration activities occur (island biosafety/quarantine strategy);

3) Reintroduce appropriate native plant species that cannot effectively recolonize on their own; and

4) Monitor project actions for effectiveness and overall restoration success.

Following completion of the 2005 Final EA for ecological restoration of Lehua Island, European rabbits were eradicated from Lehua through intensive hunting efforts in 2005 and 2006.

In 2008, the USFWS and DLNR, as joint lead agencies, determined that the original 2005 EA should be supplemented to evaluate the impacts associated with modifications to the rat eradication operation on Lehua Island associated with Alternative 2 (Diphacinone followed by Brodifacoum if necessary). A Finding of No Significant Impact (FONSI) per National Environmental Policy Act (NEPA) was concluded and no significant impacts were determined per Hawaii Revised Statutes (HRS) Chapter 343.

The rat eradication proposed by the Supplemental EA was carried out in January of 2009 and it failed to eradicate Pacific rats from Lehua island (see pages 11-12 for a discussion of factors that may have led to failure).

Both final EAs are available from the Point of Contact on the cover of this supplement. This information merely supports and does not change the analyses in this EA, which supersedes the original 2005 FEA and the 2008 supplemental EA regarding the rat eradication followed by native plant restoration on Lehua Island.

The purpose of this EA is to present alternatives for a rat eradication on Lehua.

Outcomes of previous invasive species removal efforts on Lehua Island

Successful eradication of rabbits

There are no native mammals recorded on Lehua presently or historically. The European rabbit (*Oryctolagus cuniculus*) was detected during the first survey in 1936 and caused ecosystem-wide negative impacts on Lehua Island. The project to eradicate rabbits began in November 2005. Approximately 95% of rabbits were killed in the first 10 days and rabbits were finally eradicated in January 2006 (Murphy et. al. 2010).

Consequences of rabbit eradication to weed growth

Vegetation monitoring began in 2003 prior to the 2005 rabbit eradication effort and continued twice annually until April 2008. Rabbit eradication was followed by a roughly 60% increase in vegetation cover that was made up mostly of non-native grasses (83.3% cover) and shrubs (79% cover) (Eijzenga 2011). Plant diversity increased by 31.7 %. Ten new species of herbaceous flowering plants (forbs) and grasses were recorded after rabbit eradication, with one forb being native. (Eijzenga 2011)

Long-term consequence of rabbit eradication to plant and seabird communities

The removal of rabbits from Lehua was followed by an increase in vegetation cover that resulted from a combination of eliminating herbivory pressure and higher than normal rainfall levels. The increase in vegetation cover was mainly due to non-native grasses proliferating but allowed greater stabilization of the soil, resulting in less erosion and greater nest stability for burrowing seabirds. Two species of native plants (*Sicyos maximowiczii* and *Sida fallax*) increased in abundance (Eijzenga 2011).

Lehua Plant Restoration

Summary of plant restoration phase 1

The plant restoration portion of the project began in 2007 with a survey of the habitat and development of an out-planting species list. In February 2008 the first plants were transported to the islet by helicopter sling load. A total of 27 trips were undertaken from the beginning of the project in 2007 to last in May 2014.

The construction of a permanent structure and composting toilet was completed in 2007 to house field staff. Two roof catchment systems feeding three tanks for watering plants were installed and equipped with battery timers, irrigation lines and emitters.

Out-planting began in February 2008 with 282 native plants of 20 species. Additionally, seeds were distributed in 2009 and 2010. Plant survivorship was 10%.

Challenges encountered

Water stress to the plantings was determined to be the major hurdle to overcome. The catchment and irrigation system had great success allowing early plantings to survive. The Pacific rats on the island began chewing on the irrigation lines and making the system ineffective despite regular repairs and maintenance during the course of the project. Despite the challenges of alien plant competition and rat damage to the irrigation system the project still met with successes. Valuable lessons were learned and ultimately greater success will be achieved after the eradication of rats on Lehua.

Summary of alternative used for rat eradication

In January 2009, two aerial applications of Diphacinone-50 Conservation (0.005%), a fish-flavored, pelletized rodenticide measuring 12 mm in diameter and weighing approximately 1 g, were made seven days apart. Subsequent analysis of DNA from the rodent populations found on the island before and after the operation suggested that the rodent population persisted through the eradication and that the 2009 attempt was not successful (Parkes and Fisher 2011).

Probable reasons that contributed to rat eradication failure

An in-depth review of the rat eradication attempt on Lehua in 2009 was conducted by Parkes and Fisher (2011) which provided some insight into what may have caused or allowed the rat population to survive the operation. This was a thorough analysis but did not point to a single factor for the failure due to the multiple variables involved. The proposed factors identified were:

- Widespread availability of competing food sources: Heavy rains came to Lehua in December 2008, triggering vigorous new growth in vegetation immediately before the eradication. Coupled with the increase in island-wide vegetative biomass as a result of the rabbit eradication, there was a wide range of foods available to rats at the time the eradication was conducted.
- Bait product palatability and efficacy: A study conducted by Pitt et al. (2011) found that Diphacinone-50 Conservation was not preferred over "laboratory chow" and only caused mortality in 40% (n = 5) of wild-caught *R. exulans* involved in a 7 day two choice trail conducted according to GLP standards. The results from this study contrast with the successful eradication of *R. exulans* from Mokapu Island (Dunlevy and Swift 2011) and the successful control of rodents within a montane forest site on the island of Hawaii (Spurr et al. 2013) – both projects used Diphacinone-50 Conservation.
- Rodenticide type & function: Diphacinone is a multi-feed rodenticide that requires rats to consume several doses over a course of several days in order to reach lethal levels in 100% of a rat population (Parkes et al. 2011). During the 2009 Lehua eradication attempt, bait may not have been available for long enough in all potential rat territories for all rats to accumulate a lethal dose of the rodenticide.
- Gaps in bait coverage: There is at least one known gap in bait coverage from the first application – a section of steep shoreline that was within the wave-wash zone during the bait application (Fisher and Dunlevy 2010). However, it is unlikely that rats were living or foraging within this gap.
- Restraints on the bait application: The Hawaii Department of Agriculture stipulated that bait could not be broadcast within 30 m of the shoreline (Parkes and Fisher 2011) and the implementing partners made a joint decision to proceed with the understanding that if the project failed because of this restriction, the restriction needed to be removed for future attempts to eradicate rodents from offshore islands. It is likely that rats living and foraging within this exclusion zone did not have access to lethal doses of bait.
- Monitoring for survivors: The EA made provisions for re-treating the island, should rats be found on the island after the eradication operation was completed. Searches for surviving rats lasted one week beyond the second application and no additional searches were planned or budgeted for. However,

it is unlikely that surviving rats would have been detected and successfully removed directly after the 2009 eradication attempt on Lehua (Russell et al. 2008).

Although the 2005 EA and 2008 supplemental EA both indicated the use of brodifacoum as a follow-up treatment if eradication were not achieved with diphacinone, the follow-up was never carried out. The reasons for the lack of follow-are not clear from the records. Not carrying out the follow-up treatment once rats were discovered after the 2009 eradication attempt is the primary reason that rats remain extant on Lehua.

Description of Modified Project

In 2014, an assessment of the technical, social, and political feasibility of eradicating Pacific rats from Lehua Island after the failed attempt of 2009 was commissioned by DLNR and conducted by Island Conservation. The National Fish and Wildlife Foundation's Pacific Seabird Program provided funding for this assessment through a grant awarded to Island Conservation. The feasibility assessment was based on the application of the well-established principles of eradication which are derived from successful eradications worldwide. The fundamental principles of eradication are:

1. All target animals or plants within the targeted population can be put at risk by the eradication strategy.
2. Target animals or plants must be eliminated at a rate exceeding their rate of increase.
3. The benefits from the eradication must outweigh the potential risk to non-target species.
4. Immigration must be zero.
5. The eradication strategy must be known by, and acceptable to project partners, stakeholders, and local communities.

Of the ~500 island rodent eradications worldwide, all but the smallest island eradications applied the principles by:

1. Appplying bait bait containing a rodenticide into every potential rodent territory.
2. Timing the eradication when the rodents are most likely to consume the bait, and the least number of non-target species are present.
3. Evaluate and adopt strategies to minimize risks to non-target species wherever possible.

The assessment concluded that the rat eradication operation on Lehua is technically feasible and that there are many precedents for eradicating rodents from islands similar in size and topography. It also recommended that the strategy employed to eradicate rats from Lehua must take into consideration the constraints of the local legal, social and political environment, which includes federal and state regulatory limitations on the application of restricted use pesticides and the level of risk that project stakeholders (such as the Niihau community) and the general public will accept based on information regarding the potential risks and benefits resulting from this action.

In an effort to establish an open dialogue about the Lehua rat eradication project, a multi stakeholder Steering Committee was formed and staffed with representatives from the DLNR, the USFWS, the US Coast Guard, the USDA, the National Tropical Botanical Gardens (NTBG), Island Conservation and the owners of Niihau. The Steering committee held meetings regularly and made several decisions and recommendations for the project. A Lehua Project Management Team including DLNR and IC has also been created as an executive committee for the project.

This EA focuses on the Pacific rat eradication from Lehua and it proposes changes to the supplemental FEA of 2009 to increase the project's likelihood of success. These changes are as follows:

Time change to summer

Typically, the best time to eradicate rats from island ecosystems is when the rat population is either in decline or approaching a low point in its annual cycle, which is primarily driven by food availability. On Lehua Island, food abundance (vegetation, invertebrates), availability of water, and rat activity is high during the winter/rainy season (October – April). Food availability and rat abundance decreases as the dry season progresses. Therefore, from a rat biology perspective, the best operational window for the eradication on Lehua is the summer months between May and September.

The second important component in the timing of the eradication is the potential risk to non-target species. The summer months between July and September would minimize impacts on breeding seabirds. During these months, wedge-tailed shearwaters and red-footed boobies will still be nesting on Lehua, but the breeding season for black-footed (*Phoebastria nigripes*) and Laysan albatross (*Phoebastria immutabilis*) will be approaching the end. All albatross chicks are expected to have fledged by the end of July (Wood et al., 2004 and VanderWerf et al., 2007). In addition, timing the eradication with the dry season would minimize the chances of rain storms washing rodenticide pellets into the ocean.

The best biological window to eradicate rats from Lehua would be during the dry season (May-September) (Tamarin and Malecha 1971). During these months, wedged-tail shearwaters and the red-footed boobies will still be nesting on Lehua but both the Black-footed and Laysan Albatross will only be present in small numbers, if at all.

Finally, the summer months are the best option from an operational perspective. The weather and ocean conditions during the summer are more suitable and predictable which increases the likelihood for a successful operation.

Figure 2. Timing matrix for Lehua Island rat eradication based on parameters that influence decisions for operational considerations and non-target species. Dark grey = high influence, light grey = moderate influence and white = minimal influence

Operational considerations:	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Rat Breeding												
High vegetation cover												
High rainfall												
High winds												
High ocean swell												
Fishing and tour boats												
Non-target species consideration	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Black-footed and Laysan Albatross												
Wedge-tailed Shearwater												
Red-footed and Brown Boobies												
Red-tailed Tropicbird												
Frigate birds												
Hawaiian Noddy												
Pacific Golden Plover												
Wandering Tattler												
Ruddy Turnstone												

Bait product

Selection of the most appropriate bait containing a rodenticide for the specific conditions of a project is one of the primary decisions for any rat eradication project. Bait must be applied in an adequate amount that ensures all rodent are exposed to a lethal dose but low enough to minimize adverse environmental effects from the rodenticide, especially impacts to non-target species.

Marsh (1985) advised selecting the rodenticide for which the target rodent has a high susceptibility and non-target wildlife species have a low susceptibility, thereby maximizing effectiveness and minimizing adverse effects, especially to non-target species. Maximizing effectiveness of the selected rodenticide involves combining the critical factors of bait palatability, concentration of the active ingredient in the bait formulation, the method of application, the bait application rate, and the seasonal timing of bait application (when rodent populations, reproduction, and alternative foods are lowest) to ensure that all target rodents are exposed to a lethal dose. Both the selection of the appropriate rodenticide and the technical considerations must also consider the complexity of the physical terrain and the size of the island to be treated.

The technical considerations of efficacy are more straightforward than those involved in minimizing adverse effects on non-target species and other public trust environmental resources. Minimizing overall adverse effects is possible in a variety of ways; most mitigation methods for reducing hazards to non-target species involve (Kalmbach 1943, Marsh 1985):

- Applying bait when non-target species are not present, present in seasonally low numbers, or not breeding or raising young;
- reducing bait toxicity to non-target species;
- reducing the acceptance/availability of bait (exposure) to non-target species;
- minimizing or avoiding exposure of non-target species (e.g., via protective stations);
- minimizing rodenticide residues in the tissues of target and non-target species.

In summary, the selection of the appropriate rodenticide in an effective bait formulation for a specific project must ensure a high potential for efficacy in eliminating invasive rodents when conducted according to the description of the proposed action during the optimum seasonal time frame, while having the lowest potential for adverse impacts to non-target species.

The New Zealand Department of Conservation (NZ DOC) implemented a policy in October 2000 that placed restrictions on the use of brodifacoum for conservation purposes on the New Zealand mainland because of documented levels of direct and indirect poisoning of non-target species. NZ DOC conducted a study using diphacinone 0.005% formulations of pellets and blocks in mainland control situations that demonstrated the efficacy of diphacinone in the field (Gillies et al. 2006). Studies in Hawaiʻi have also documented the efficacy and lower non-target impacts of diphacinone in field and laboratory studies (Swift 1998, Dunlevy et al. 2000, Dunlevy and Campbell 2002, Nelson et al. 2002, Spurr et al. 2003a and 2003b, Eisemann and Swift 2006).

Aerial application of rodenticide without coastline buffer

Improved effectiveness of bait distribution to all rats on Lehua will be achieved by not excluding areas adjacent to coastlines for bait application, thus ensuring a uniform and complete distribution of bait in shoreline areas used by rats.

Chapter 1: Purpose & Need

Purpose

The purpose of the project is to restore the Lehua Island ecosystem by creating a predator-free, fully protected refuge for threatened and endangered Hawaiian species including the IUCN Endangered Newell's Shearwater, and others facing extinction from a variety of pressures, including rising sea levels related to climate change.

Lehua Island is one of the largest and most diverse seabird colonies in the main Hawaiian Islands. It provides habitat for 17 seabird species, including two IUCN Near Threatened Species which are also US Federal Species of Concern – the black-footed albatross and the Laysan albatross. It is also home to 11 plant species endemic to Hawai`i and 14 native plant species.

The island has sustained ecological damage over many years, caused primarily by the presence of invasive non-native species, most notably rats and rabbits. The first step taken to restore Lehua Island was the eradication of the non-native rabbit population in 2006. Since that eradication, native plant cover on Lehua has grown significantly. Eradicating introduced rats from Lehua Island will eliminate their predatory pressure on seabird colonies, promoting an increase in colony size and recolonization by species such as the Newell's Shearwater that are no longer breeding on the island. Furthermore, it will allow for the re-establishment of a healthy native plant community, improved seabird nesting habitat, and reduced soil erosion leading to improved water quality and nearshore marine habitat.

Need for Action

Introduced Species and the Importance of Island Ecosystems

It is now widely accepted that current rates of species extinctions are dramatically higher than the background extinction rate (Raup 1988), that most current extinctions can be directly attributed to human activity (Diamond 1989), and that for ethical, cultural, aesthetic, and economic reasons, this current rate of extinction is cause for considerable concern (Ehrlich 1988; Ledec & Goodland 1988). Of 170 animal extinctions for which the cause is known, over half (54%) included the effects of invasive species and in 34 cases (20%), invasive species was the only cause cited (Clavero & Garcia-Berthou, 2005).

Island ecosystems are key areas for conservation. Islands occupy approximately 5.5% of the terrestrial surface area but house a disproportionate number of species with more than 15% of terrestrial species (Kier et al. 2009). Additionally, 61% of all recently extinct species, and 37% of all critically endangered species on the International Union of the

Conservation of Nature (IUCN) Red List were island species (Tershy et al. 2015). Invasive non-native mammals are the main cause of animal extinctions on islands and are one of the most important threats to remaining insular biodiversity (Tershy et al., 2015; Clavero & Garcia-Berthou, 2005; Szabo et al., 2012).

Island biotas are under threat of extinction but islands provide great conservation opportunities. By restoring and protecting islands, functioning ecosystems can be maintained at relatively low costs and with less conflict with human populations. Moreover, the eradication of invasive mammal species from islands has become a common conservation tool and yields important benefits to insular species, including reduction of risk category on the IUCN Red List (Jones et al., 2016)

Introduced Rat Species

There are three species of rats in the genus *Rattus* that have been introduced to Hawai`i and other islands throughout the world. In order of decreasing body size, they are: the Norway or brown rat (*R. norvegicus*), the ship or black rat (*R. rattus*), and the Pacific rat (*R. exulans*). They have different dietary preferences, distributions and histories of introduction, but all three species are omnivorous, can adapt to diverse ecological conditions, have high reproductive rates, and can survive in a variety of habitats (Atkinson 1985; Moors *et al*. 1992). These traits make them ideally suited to survive on a variety of predator-free islands. One or more of these species occurs on an estimated 82% of all island groups worldwide (Atkinson 1985).

Impacts of Introduced Rodents on Island Ecosystems

The most pronounced impact of introduced rodents on island ecosystems is the extinction of endemic species. Introduced rats are responsible for an estimated 40-60% of all bird and reptile extinctions (Island Conservation analysis of World Conservation Monitoring Centre data; Atkinson 1985). They have caused the extinction of endemic mammals, birds and invertebrates on islands throughout the world's oceans (Andrews 1909; Daniel and Williams 1984; Meads *et al*. 1984; Atkinson 1985; Hindwood 1940; Tomich 1986; Clavero & Garcia-Berthou, 2005).

Even if extinctions do not occur, rats can have ecosystem-wide effects on the distribution and abundance of native species through direct and indirect effects. For example, comparisons of rat-infested and rat-free islands, and pre- and post-rat eradication experiments, have shown that rats depressed the population size and recruitment of birds (Thibault 1995; Campbell 1991; Jouventin *et al.* 2003), reptiles (Bullock 1986; Cree *et al.* 1992; Whitaker 1973; Towns 1991), plants and terrestrial invertebrates. Rats are known to cause disturbance to sensitive breeding seabirds, causing failed breeding attempts and higher susceptibility to predation by other species (Jouventin *et al*. 2003; Tomkins 1985). Rats have also been shown to affect the abundance and age structure of intertidal invertebrates (Navarrete and Castilla 1993).

Where rats occur together with other predators (such as cats or predatory birds) the direct impact of the rats on seabirds is greater than the sum of the individual impacts because the rats, themselves a food source, artificially support a greater population of the predators when the seabirds are absent (Atkinson 1985; Moors and Atkinson 1984).

In addition to preying on local seabird colonies, introduced rats feed opportunistically on plants, and alter the floral communities of ecosystems into which they are introduced (Campbell and Atkinson 2002), in some cases degrading the quality of nesting habitat for birds that depend on the vegetation. For example, on Tiritiri Matangi Island, New Zealand, ripe fruits and seeds and understory vegetation cover increased after rats were eradicated from the island, indicating their previous impacts on the vegetation (Graham and Veitch 2002). On Palmyra, within 3 months of the removal of rats from Palmyra Atoll, Pisonia seedlings emerged from the forest floor, and within 5 years, seedlings were documented to be viable trees (N.Holmes, pers. Comm.)

Each of the three species of introduced *Rattus* has been implicated in extinctions and changes in prey population structure. Although all rat species are dangerous to insular biota, due to their different natural histories each species has slightly different impacts. For example, of the three introduced rat species, *R. norvegicus* tends to have the greatest impact on burrow-nesting seabirds, *R. rattus* tends to prefer preying on tree-nesting birds, and *R. exulans* appears to impact both types of nesters (Atkinson 1985). Consequently, the introduction of new *Rattus* species should be avoided, even to islands that already have introduced rats (Moors *et al*. 1992).

Rodents in Hawai`i

All three species of introduced rats are present on the Hawaiian Islands. *R. rattus* occupies all of the eight major islands, and *R. exulans* has been confirmed on all of the major islands. *R. norvegicus,* the least abundant species, is absent on Kaho`olawe and Ni`ihau but present on the six other major islands (Tomich 1986). *R. rattus* was documented on Midway Atoll but has since been eradicated. *R. exulans* is found on Lehua and was eradicated from Mokapu Islands and is likely the species present on Ka`ula Rock.

R. exulans was introduced to Hawai`i by Polynesian settlers, and *R. norvegicus* and *R. rattus* arrived in either the 18^{th} or 19^{th} century, although there is disagreement as to exactly when. Atkinson (1977) suggests that *R. rattus* did not arrive until the late 1800s, after which they very rapidly expanded their population and began having large effects on Hawai`i's ecosystem.

Impacts on Hawaiian Seabirds

Introduced rodents have wreaked havoc on seabirds in Hawai`i. On Kure Atoll, *R. exulans* preyed on Wedge-tailed Shearwaters (*Puffinus pacificus*), Laysan Albatross, and

Bonin Petrels (*Pterodroma hypoleuca*), and was implicated as the cause of drastic declines in the population of Bulwer's Petrels (*Bulweria bulwerii*) on Popoi`a Island near O`ahu (Tomich 1986).

R. rattus had impacts on nest success in Bonin Petrels on Midway Atoll (Seto 1994; Seto and Conant 1996), but reproductive success increased after rats were eradicated from Midway (Seto, *pers. comm.*). Similarly, after *R. rattus* control on Mokoli`i Islet near O`ahu, nesting success of Wedge-tailed Shearwaters increased (D. Smith *pers. comm*.).

Impacts on Terrestrial Birds

Impacts of introduced rodents on terrestrial Hawaiian birds are documented throughout the history of human settlement on the islands. *R. exulans*, introduced by Polynesian settlers, likely contributed to the extinction of some of the at least 39 species of land birds that disappeared in the period before European arrival, especially flightless and ground-nesting species (Olson and James 1982). Atkinson (1977) argues that the introduction of the *R. rattus* in the late 1800s was the primary cause of the sudden extinction of 30 species or subspecies of endemic Hawaiian forest birds between 1890 and 1910. Since then, *R. rattus* has continued to have severe effects on Hawai`i's landbirds. Additionally, *R. rattus* caused the extinction of the Laysan Rail (*Porzanula palmeri*) from its last refuge of Midway Atoll, and contributed to the extirpation of the Midway population of Laysan Finch (*Telespiza cantans*) (Fisher and Baldwin 1946; Tomich 1986).

Furthermore, nest predation by *R. rattus* has been implicated as the primary cause of decline of the endangered O`ahu `Elepaio (*Chasiempis sandwichensis ibidis*) (VanderWerf 2001). Another nest predation study that focused on multiple bird species in the rainforest of Maui found that in areas of high rat density, nest predation rates by *R. rattus,* a prolific tree climber, can reach 50% (Stone *et al*. 1985, cited in Amarasekare 1993). In areas of high nest densities, it has been suggested that even a small population of rats can have a large predatory effect because rats often prefer bird eggs to other food sources and will feed on them opportunistically whenever they encounter a nest. Rats have been confirmed as predators of eggs and nestlings of the Maui `Alauahio (*Paroreomyza montana*) (Baker and Baker 2000), and the Puaiohi, or Small Kaua`i Thrush (*Myadestes palmeri*) (T. Ka`iakapu *pers. comm.*).

Impacts on Hawaiian Invertebrates

Rats contributed to the decimation of *Achatinella mustelina*, a tree-snail endemic to a small mountain range on O`ahu (Hadfield *et al.* 1993). Rats have also been documented to feed on endemic crickets and weevils (Stone and Howarth 2005).

Impacts on Hawaiian Plants

Rats eat seeds, bark, fruits, leaves and shoots of Hawaiian plants. Rats strip the bark of koa (*Acacia koa*) saplings, girdling and killing the young trees (Scowcroft and Sakai 1984). The endemic vetch (*Vicia menziessii*) has also been girdled by rats (Clarke *et al.* 1982, L. Pratt *pers. comm.*). Rat herbivory has been shown to prevent reproduction in the wild of *Hibiscadelphus* sp. (Baker and Allen 1978) and *Pittosporum* sp. (L. Pratt *pers. comm.*). Rat seed predation has affected populations of *Pritchardia* sp. (Beccari and Rock 1921; Male and Loeffler 1997), and rat granivory has also been implicated in the reproductive failure of numerous rare endemic plant species on Mokapu Island near Moloka`i (K. Wood unpub. data). Rat herbivory has also been observed on *Dubautia* sp. (T. Ka`iakapu *pers. comm.*).

Rodents on Lehua Island

Caum (1936) reports that lighthouse personnel on Lehua saw "small rats" that may have been *R. exulans* as early as 1931. The first positive documentation of rodents on the island, however, was in 1960 with the discovery of a carcass, thought to be *R. rattus* but never positively identified (Richardson 1963, Tomich 1986). Wood *et al.* (2004) found the carcasses of two *R. exulans* during surveys of the island in 2003 and 2004, the first positive identification of a Lehua rodent to species. USDA *et al*. (2004) confirmed the identification during rodent trapping surveys that yielded seven *R. exulans* individuals. Although the population density of rats on Lehua is not known, four days of rodent surveys using inked tracking boards yielded an average 28% visitation and showed that rats inhabited much of Lehua, with the highest activity found in the vegetated gulches in the southwest portion of the island. Observations from 2001-2004 indicate that rat numbers increase in the wet winter season and decrease in the dry summer season.

Figure 1. Wedge-tailed Shearwater egg partially eaten by *R. exulans* on Lehua Island.

Rats on Lehua have been demonstrated to impact terrestrial invertebrates and vegetation. USDA *et al*. (2004) found rat stomach contents to consist of up to 44% invertebrates and up to 38% vegetation. Removing rats would positively contribute to the recovery of native island vegetation and likely increase invertebrate populations on top of positive effects on seabird populations.

The most obvious evidence of the effects of introduced rodents on Lehua has been the many seabirds found dead on the island with injuries characteristic of rat predation. Richardson (1963) found dead Bulwer's Petrels that were likely killed by rats, USDA *et al*. (2004) found rat-chewed Wedge-tailed Shearwater eggs (Figure 1), and Wood *et al.* (2004) found carcasses of both Bulwer's Petrels and Wedge-tailed Shearwaters with flesh from the breast and neck eaten away and the rest of the body intact, an indicator of rat predation (Kepler 1967). A 2016 study of nest content for Wedge-tailed Shearwaters, Red-tailed Tropic Birds and Bulwer's Petrel showed that the lack of fledgling success can be positively correlated to the presence of rats on Lehua (Appendix D, Table 13). In addition, an artificial egg study done in 2004 yielded a rat-chewed artificial Band-rumped Storm-petrel egg (C. Swenson, *pers. comm.*). The same study showed 20 of 22 clay and 27 of 30 quail eggs missing, likely due to rats removing and caching the eggs.

Rat predation on Lehua is probably also reflected in the complete absence or very low breeding densities of seabird species that are highly susceptible to rat predation and disturbance (Flint 1999; Atkinson 1985). Small surface-nesting species such as Brown Noddies (*Anous stolidus*) (Lehua historically supported a breeding colony of 500 Brown Noddies, in the 1960s), Sooty Terns (*Sterna fuscata*), and Gray-backed Terns (*S.lunata*), are not breeding on Lehua despite the abundance of nesting habitat and their breeding activities on nearby Ka`ula Rock. Low numbers of Band-rumped Storm-petrel (*Oceanodroma castro*) persist on the island, suggesting that similar ground nesters susceptible to rat predation, along with all other nesting seabirds (present or potential) on Lehua Island, would greatly benefit from rat removal (*e.g*., Newell's Shearwater (*Puffinus newelli*), Hawaiian Petrel (*Pterodroma sandwhichensis*), Christmas Shearwater (*P. nativitatis*), and Bulwer's Petrel (VanderWerf *et al*. 2007).

Scope of Proposed Action

The proposed actions in this EA focus on the eradication of Pacific rats from the island of Lehua.

Regulatory Framework

The proposed action would be carried out in compliance with the State and Federal laws and regulations listed below.

Federal Laws

National Environmental Policy Act (NEPA) - NEPA requires that Federal actions be evaluated for environmental impacts, that these impacts be considered by the decision maker(s) prior to implementation, and that the public be informed. This EA has been prepared in compliance with NEPA (42 USC Section 4231, et seq.,); the President's Council for Environmental Quality Regulations, 40 CFR Section 1500 – 1508.

National Historic Preservation Act (NHPA) – The NHPA requires: 1) Federal agencies to evaluate the effects of any Federal undertaking on cultural resources, 2) consult with the State Historic Preservation Office regarding the value and management of specific cultural, archaeological and historic resources, and 3) consult with appropriate

American Indian tribes or Native Hawaiians to determine whether they have concerns for traditional cultural properties in areas of these Federal undertakings.

Endangered Species Act (ESA) - It is Federal policy, under the ESA, that all Federal agencies shall seek to conserve endangered and threatened species and shall utilize their authorities in furtherance of the purposes of the ESA (Sec.2(c)). Section 7 consultations with the Service are conducted to use the expertise of the USFWS to ensure that "any action authorized, funded, or carried out by such an agency . . . is not likely to jeopardize the continued existence of any endangered or threatened species. Each agency shall use the best scientific and commercial data available" (Sec. 7(a)(2)).

Migratory Bird Treaty Act (MBTA) - The MBTA protects over 1000 species of birds, including the species native and not native to Hawaii, by implementing U.S. obligations under four treaties within the United States. The MBTA provides that it is unlawful to pursue, hunt, take, capture, kill, possess, sell, purchase, barter, import, export, or transport any migratory bird, or any part, nest, or egg of any such bird, unless authorized under a permit issued by the Secretary of the Interior.

Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) - FIFRA requires the registration, classification, and regulation of all pesticides used in the United States. The Environmental Protection Agency (EPA) is responsible for implementing and enforcing FIFRA. All chemical methods integrated into any selected program as implemented by the Service or other cooperating agencies must be registered with and regulated by the EPA (FIFRA Section 3).

Marine Mammal Protection Act of 1972, as amended
This act protects all marine mammals, including cetaceans (whales, dolphins, and porpoises), pinnipeds (seals and sea lions), sirenians (manatees and dugongs), sea otters, and polar bears within the waters of the United States.

Water Pollution Control Act of 1948, as amended
A law enacted by Congress to address the problems of water pollution in the United States. Now commonly known as the Clean Water Act

Coastal Zone Management Act of 1972, as amended
A law enacted by Congress to encourage and assist the states to exercise effectively their responsibilities in the coastal zone through the development and implementation of management programs to achieve wise use of the land and water resources of the coastal zone, giving full consideration to ecological, cultural, historic, and esthetic values as well as the needs for compatible economic development.

Executive Order (EO) 13112 on Invasive Species as amended 12/08/2016 by E0 13751 - Section 2. Federal Agency Duties.

(a) Each Federal agency for which that agency's actions may affect the introduction, establishment, or spread of invasive species shall, to the extent practicable and permitted by law,

(1) identify such agency actions;

(2) subject to the availability of appropriations, and within administrative, budgetary, and jurisdictional limits, use relevant agency programs and authorities to:

(i) prevent the introduction, establishment, and spread of invasive species;

(ii) detect and respond rapidly to eradicate or control populations of invasive species in a manner that is cost-effective and minimizes human, animal, plant, and environmental health risks;

(iii) monitor invasive species populations accurately and reliably;

(iv) provide for the restoration of native species, ecosystems, and other assets that have been impacted by invasive species;

(v) conduct research on invasive species and develop and apply technologies to prevent their introduction, and provide for environmentally sound methods of eradication and control of invasive species;

(vi) promote public education and action on invasive species, their pathways, and ways to address them, with an emphasis on prevention, and early detection and rapid response;

(vii) assess and strengthen, as appropriate, policy and regulatory frameworks pertaining to the prevention, eradication, and control of invasive species and address regulatory gaps, inconsistencies, and conflicts;

(viii) coordinate with and complement similar efforts of States, territories, federally recognized American Indian tribes, Alaska Native Corporations, Native Hawaiians, local governments, nongovernmental organizations, and the private sector; and

(ix) in consultation with the Department of State and with other agencies as appropriate, coordinate with foreign governments to prevent the move- ment and minimize the impacts of invasive species; and

(3) refrain from authorizing, funding, or implementing actions that are likely to cause or promote the introduction, establishment, or spread of invasive species in the United States unless, pursuant to guidelines that it has prescribed, the agency has determined and made public its determination that the benefits of such actions clearly outweigh the potential harm caused by invasive species; and that all feasible and prudent measures to minimize risk of harm will be taken in conjunction with the actions.

(c) Federal agencies shall pursue the duties set forth in this section in coordination, to the extent practicable, with other member agencies of the Council and staff, consistent with the National Invasive Species Council Management Plan, and in cooperation with State, local, tribal, and territorial governments, and stakeholders, as appropriate, and in consultation with the Department of State when Federal agencies are working with international organizations and foreign nations.

(d) Federal agencies that are members of the Council, and Federal interagency bodies working on issues relevant to the prevention, eradication, and control of invasive species, shall provide the Council with annual information on actions taken that implement these duties and identify barriers to advancing priority actions.
(e) To the extent practicable, Federal agencies shall also expand the use of new and existing technologies and practices; develop, share, and utilize similar metrics and standards, methodologies, and databases and, where relevant, platforms for monitoring invasive species; and, facilitate the interoperability of information systems, open data, data analytics, predictive modeling, and data reporting necessary to inform timely, science-based decision making.

Executive Order 13186 – Responsibilities of Federal Agencies to Protect Migratory Birds. (66 FR 3853, Jan. 17, 2001) It requires federal agencies, to the extent practicable, to avoid or minimize adverse impacts on migratory bird resources when conducting agency actions, and to restore and enhance the habitat of migratory birds. Specifically, it requires federal agencies to develop and use principles, standards, and practices that will lessen the amount of unintentional take reasonably attributed to agency actions.

Executive Order 13089 on Coral Reef Protection (June 11, 1998) **-** Section 3, on Federal agency responsibilities, states: In furtherance of section 2 of this order, Federal agencies whose actions affect US coral reef ecosystems, shall, subject to the availability of appropriations, provide for implementation of measures needed to research, monitor, manage, and restore affected ecosystems, including, but not limited to, measures reducing impacts from pollution, sedimentation, and fishing. To the extent not inconsistent with statutory responsibilities and procedures, these measures shall be developed in cooperation with the US Coral Reef Task Force and fishery management councils and in consultation with affected States, territorial, commonwealth, tribal, and local government agencies, nongovernmental organizations, the scientific community, and commercial interests.

Hawai`i State Laws

State of Hawaii Administrative Rules – Title 13 Department of Land and Natural Resources, Subtitle 5 Forestry and Wildlife, Part 2 Wildlife,

- Chapter 124, Indigenous wildlife, endangered and threatened wildlife, injurious, wildlife, introduced wild birds, and introduced wildlife, Subchapter 4, Scientific, propagation, and educational permits. Permits for collecting, possessing, killing, selling or offering for sale, and transporting indigenous wildlife, introduced wild birds, game birds, or game mammals may be issued by the board or its authorized representative for scientific or educational purposes including cultural activities, or for activities which will enhance the survival of the wildlife species. PIFWO would apply for a Protected Wildlife Permit for Scientific

Research for the collection of native and non-native birds protected by the State of Hawaii. Incidental take would be covered under the collection authorization.

Hawaii Department of Agriculture, Pesticides Branch – The Pesticides Branch has at their discretion the authority to inspect any site where pesticides are being used.

Hawai`i Revised Statutes Chapter 344, Environmental Policy Act
Contains comprehensive environmental policy, goals, and objectives for conserving the natural resources, so that land, water, mineral, visual, air and other natural resources are protected by controlling pollution, by preserving or augmenting natural resources, and by safeguarding the State's unique natural environmental characteristics in a manner which will foster and promote the general welfare, create and maintain conditions under which humanity and nature can exist in productive harmony, and fulfill the social, economic, and other requirements of the people of Hawaii.

Hawai`i Revised Statutes Chapter 343, Environmental Impact Statements
Provides the guidance to develop an informational document prepared in compliance with the rules adopted under section 343 and which discloses the environmental effects of a proposed action, effects of a proposed action on the economic welfare, social welfare, and cultural practices of the community and State, effects of the economic activities arising out of the proposed action, measures proposed to minimize adverse effects, and alternatives to the action and their environmental effects.

Hawai`i Revised Statutes Chapter 341, Environmental Quality Control Act
Creates the Office of Environmental Quality and Control, which facilitates the Hawai`i environmental review process. The office announces the availability of environmental assessments (EAs) and environmental impact statements (EISs) for public review and comment in its semi-monthly publication, The Environmental Notice

Hawai`i Revised Statutes Chapter 128D, Environmental Response Law
This statute establishes authority at the state level to respond to releases of hazardous substances. It is fashioned after the 1980 Comprehensive Environmental Response, Compensation & Liability Act (CERCLA), commonly known as the Federal Superfund Law, which grants authority to the United States Environmental Protection Agency (USEPA). The HERL grants certain authority and responsibility to the HDOH to respond to both emergency and non-emergency hazardous substance releases or threats of releases.

Hawai`i Revised Statutes Chapter 342D, Water Pollution
HRS §342D-50(a) requires that "No person, including any public body, shall discharge any water pollutant into state waters, or cause or allow any water pollutant to enter state waters except in compliance with this chapter, rules adopted pursuant to this chapter, or a permit or variance issued by the director." As such, water pollutants that

enter State waters from all sources, point or non-point, shall comply with applicable requirements as established in HAR, Chapter 11-54.

Hawai`i Revised Statutes Chapter 321, Department of Health
Creates the State of Hawaii Department of Health, which houses the Office of Environmental Quality and Control.

Hawai`i Revised Statutes, Title 12, Conservation and Resources Chapter 183D, Wildlife
This statute exists to Manage and administer the wildlife and wildlife resources of the State. Additionally, to enforce all laws relating to the protecting, taking, hunting, killing, propagating, or increasing the wildlife within the State and the waters subject to its jurisdiction.

Authorities for Implementing Action

The proposed action is authorized by the State and Federal laws, regulations, and guidelines listed below.

Hawai`i Department of Land and Natural Resources Statutes

a) Hawai`i Revised Statutes, Chapter 26-15. Provides general authorities to the Department of Land and Natural Resources to manage and administer public lands, including wildlife resources and coastal areas.

b) Hawai`i Revised Statutes, Chapter 195D-5 (general agency authorities in Hawai`i to conserve, manage and protect indigenous species) §195D-5 Conservation programs. (a) The department shall conduct research on indigenous aquatic life, wildlife, and land plants, and on endangered species and their associated ecosystems, and shall utilize the land acquisition and other authority vested in the department to carry out programs for the conservation, management, and protection of such species and their associated ecosystems. In addition, the department is hereby authorized to acquire by purchase, donation or otherwise, lands or interests therein needed to carry out the programs relating to the intent and purpose of this chapter.

c) Hawai`i Revised Statutes, Chapter 183D-4 (agency authorities to manage wildlife sanctuaries, including Lehua State Seabird Sanctuary) §183D-4 Game management areas, wildlife sanctuaries, public hunting areas. (a) For the purposes of preserving, protecting, conserving, and propagating wildlife, the department shall establish, maintain, manage, and operate game management areas, wildlife sanctuaries, and public hunting areas on land under its control and, as it deems desirable, enter into agreements for taking control of privately owned lands for those purposes.

US Fish and Wildlife Service Statutes

The Endangered Species Act of 1973 (16 U.S.C. 1531-1544, 87 Stat. 884), as amended, directs the USFWS to conserve ecosystems upon which threatened and endangered species depend. The Fish and Wildlife Act of 1956 (16 U.S.C. 742a-742j, not including 742 d-l, 70 Stat. 1119), as amended, gives general guidance which can be construed to include alien species control, that requires the Secretary of the Interior take steps "required for the development, management, advancement, conservation, and protection of fish and wildlife resources."

US Coast Guard Guidelines

The guidelines for the management of natural resources for the USCG are listed in Commandant Instruction Manual 5090.3, and state that the USCG shall inventory, preserve, restore, and enhance natural resources on its administered lands to the maximum extent practicable and in the best public interest.

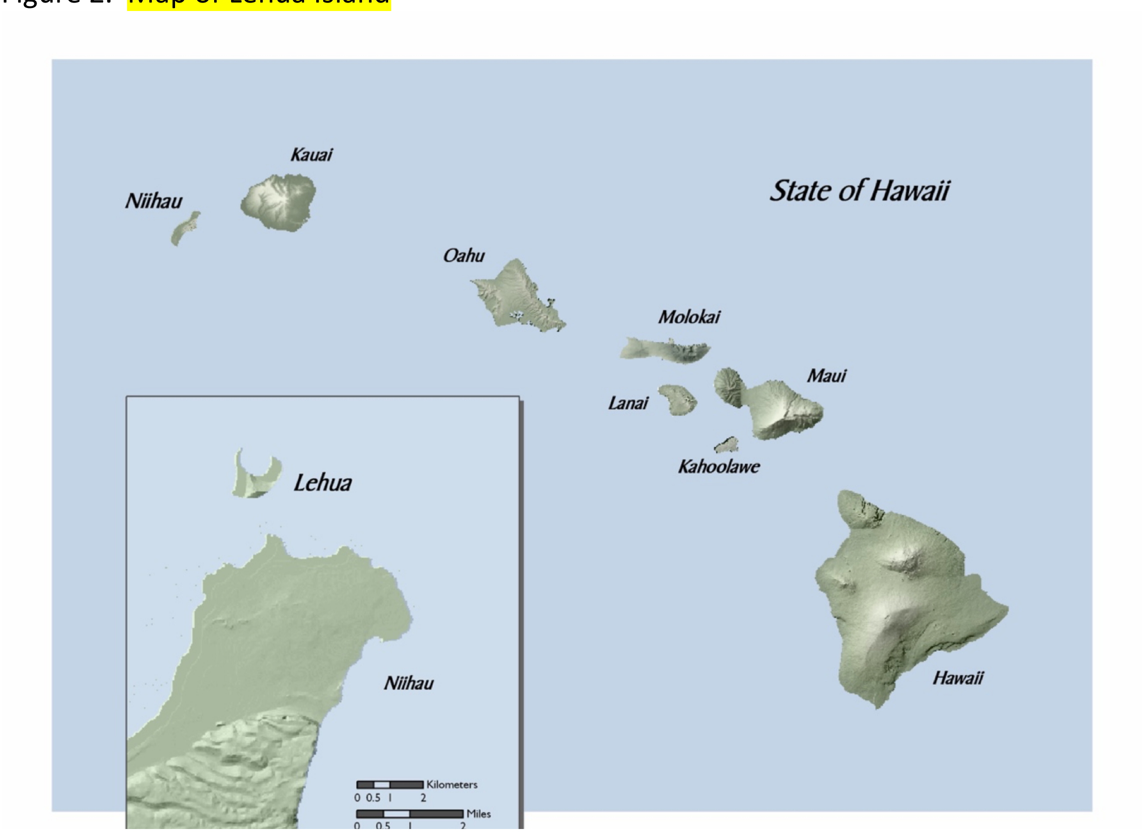
Chapter 2: Affected Environment

The area affected by this operation, the Affected Environment, is considered to be the Island of Lehua, its immediate surrounding waters, and the species that use them. The north end of the island of Niihau, may experience some effects from this operation due to its proximity across a deep ocean channel from Lehua as well as its being the preferred staging area for the LIERP. If Niihau is unavailable as the staging area, an alternate staging area on Kauai would be chosen.

Physical Characteristics

Lehua Island in the Hawaiian Island Chain is located three-fourths of a mile off the northern shore of Ni`ihau (a privately owned 46,080-acre island), and roughly 19 miles west of Mana Point on the island of Kaua`i (Figure 2). Lehua is a crescent-shaped volcanic crater open to the sea on its north side (Figure 3). It is approximately 284 acres in total area, with a maximum elevation of 699 ft (State of Hawai`i Data Book 2002, Figure 2).

Figure 2. Map of Lehua Island



Lehua is a volcanic cinder tuff cone. The substrate is gray to brown in color, with stratifications that are particularly visible on the inner crescent wall. The porous rock has weathered to form numerous cavities on exposed surfaces, which provide nesting habitat for ground-nesting seabirds including Wedge-tailed Shearwaters and Bulwer's Petrels (Wood *et al.* 2004). Rock is exposed on vertical cliffs throughout the island, and has eroded to form deeply carved fissures that are especially common near sea level on the inner crescent. Higher up the slopes of the inner crescent, parallel stratified beds are exposed to form a series of relatively level shelves, appearing somewhat like a natural amphitheater. Portions of the Lehua shoreline are composed of benches that are at least partially above sea level. The bench on the shoreline of the island's inner crescent contains large tide pools (Palmer 1937; Wood *et al*. 2004). There is no source of perennial fresh water on the island. Rain water runs off the steep slopes to the ocean and collects in small puddles which evaporate quickly. The physical characteristics of Lehua Island would not be changed with the implementation of any of the proposed action alternatives.

<u>Helicopter/ Baiting operational area</u>

The preferred bait storage and loading area would be located on the island of Niihau. Niihau is a small elongate island (29 x 10 km) that stretches from southwest to northeast containing 145 km of variable coastline including sand, boulder and lava bench habitat. Niihau lies at the far northwest end of the main Hawaiian Islands and is the low lying subaerial remains of a volcanic shield volcano. It is three-quarters of a mile south of Lehua at the closest point.

The designated area for bait storage and bait loading during the aerial broadcast at Lehua will be on the north end of Niihau at Nanina. The site is a third of a mile inland from the beach at Kaakuu Bay and is exposed to regular helicopter operations, boat landings, and motorized vehicle traffic connected to tourist and ranching activities. The habitat at Nanina is dominated by bare lava with intermittent Kiawe (*Prosopsis pallida*) that is in the form of low growing bushes. No ESA listed plants or birds exist within this habitat but the Hawaiian monk seal is known to frequent the sandy beach located due west of Nanina at Kaakuu Bay. The area is also visited by feral pigs and sheep that are the remnants of previous ranching activities.

The storage of the rodenticide bait will be at Nanina in locked shipping containers placed on the lava substrate. The shipping containers will protect the bait from exposure to the elements and will allow a controllable area to access bait during aerial broadcast operations. A separate site at Nanina with close proximity to the helicopter landing site will be used to store fuel. This fuel for the helicopter will be in 55 gallon drums and will be held in a EPA approved Spill Prevention and Preparedness Regulations (SPCC) containment area and covered to prevent water intrusion to the fuel.

The only potential ESA listed species affected by the operations would be the Hawaiian monk seal. The behavior of seals might be affected by the overflight of the helicopter. Helicopter operations are regularly conducted at this site but mitigation measures will be employed to prevent hazing of seals. If seals are present on the beach during operations, the helicopter will avoid flying over the beach at Kaakuu Bay and then head to Lehua once clear of the shoreline.

Terrestrial Environment

Seabirds

Sixteen species of seabirds have been recorded during the five known surveys of Lehua (Wood *et al.* 2004; Appendix A, Table 6). At least eight species of seabirds currently breed on the island. Lehua is home to the largest breeding colonies of Brown Boobies and second largest for Red-Footed Boobies in the Hawaiian Islands, the fifth-largest Hawaiian breeding ground for Wedge-tailed Shearwaters, and an important large colony of Red-tailed Tropicbirds. The island contains the westernmost colony of Hawaiian Black Noddies.

Of the species known to breed on Lehua, two are listed in the IUCN Red List of Threatened Species and are also Federal Species of Concern – the Black-footed Albatross (Near Threatened) and the Laysan Albatross (Near Threatened). The only Black-footed Albatross breeding colonies on the major Hawaiian Islands are on Lehua and Ka`ula Islands, and both of these species nest in relatively few sites worldwide, making these colonies important for conservation of this species (Wood *et al.* 2004). At least three additional species are suspected but not confirmed to nest on Lehua. The Newell's Shearwater is listed by both the IUCN (Endangered) and the USFWS (Threatened). Band-rumped Storm-petrels (USFWS Endangered) may also be attempting to nest. The Hawaiian Petrel, listed by USFWS as Endangered, has also been seen at Lehua and may be attempting to nest.

Seabird populations on Lehua have changed somewhat over the period of occasional monitoring from 1931 to the present. Specifically, the colony of Wedge-tailed Shearwaters has probably grown, and colonies of Laysan and Black-footed Albatross have recently appeared, while the historical colony of Brown Noddies has disappeared (Wood *et al.* 2004). The explanations for these changes are unclear. However, predation from non-native animals is a likely component in the disappearance of the Brown Noddy, while Laysan Albatross are making a general recovery worldwide from severe population declines in the early 1900s (Harrison 1990; Whittow 1993).

While Lehua is already an important seabird breeding location in Hawai`i, it has the potential to support a greater diversity of species and larger populations of many of the species already there. The major threat facing many of the seabirds on Lehua is currently the presence of non-native predators such as rats. As discussed in Chapter One, if rats are successfully removed from the island, Lehua would be able to reach its full potential as a globally important seabird island.

Non-Native Terrestrial Passerines and Predatory Birds

Since 1931, five ornithological surveys of Lehua have been conducted (Caum 1936; Fisher 1951; Richardson 1963; Walker unpubl. data; Wood *et al.* 2004; Appendix A, Table 6). No native Hawaiian land birds have been reported on Lehua. Seven non-native passerines have been recorded in low numbers but only the Nutmeg Manikin (or Scaly-Breasted Munia) have been recorded recently in any significant numbers. None of these introduced bird species are rare.

Non-native Barn Owls are also present and have been documented to prey on the terrestrial vertebrates on Lehua. Pellets found in the vicinity of a Barn Owl roost on Lehua contained remains from rats, rabbits, and at least four species of seabirds including Wedge-tailed Shearwaters, Bulwer's Petrels, and Brown Noddies, the latter species now nearly extirpated from the island. Cattle egrets, another non-native predatory bird, are also present and consistently attempt to nest on Lehua. They are suspected of preying on seabird chicks and competing for roost space (Wood *et al.* 2004). Barn owls and cattle egrets are part of non-native species control programs in the state of Hawaii.

Shorebirds

Small numbers of migratory shorebirds have been consistently seen on Lehua, usually foraging along shorelines. Pacific Golden Plover, Wandering Tattler and Ruddy Turnstone are present in winter months and leave in the spring and summer to breed elsewhere. The numbers of shorebirds in Hawai`i have declined over the years but none of these species are considered endangered. However, the Pacific Golden Plover is considered a Species of Concern by the Federal government. We are mitigating impacts upon our native migratory shorebirds by timing the operation to not coincide with their presence on the island. As migrators, they are only present during the winter months.

Invertebrates

The Hawaiian Islands originally possessed a great diversity of endemic insects and arachnids, many highly specialized and limited to very small ranges (Carlquist 1980). Unfortunately, the lack of historical data on Lehua's invertebrate fauna prevents a comprehensive analysis of trends among invertebrate populations there. Surveys conducted in 2001 and 2003 identified 1 indigenous, 12 endemic species and 48 non-native species (Wood *et al.* 2004; Appendix A, Table 5). The persistence of some endemic species on Lehua is encouraging and indicates potential for invertebrate restoration. Among the non-native species identified, the most important is the Big-headed Ant, which has been shown to have a negative impact on arthropod fauna native to Hawai`i (Liebherr and Polhemus 1997; LaPolla *et al.* 2000; Jahn and Beardsley 2000). An alien grasshopper, *Schistocerca nitens*, which has impacted native vegetation on Nihoa Island, was also found on Lehua.

Native Mammals

Only two mammals are native to the Hawaiian archipelago, the Hawaiian Monk Seal (*Monachus schauinslandi*) and the Hoary Bat (*Lasiurus cinereus*) (Tomich 1986). There are no records of the Hoary Bat on Lehua and only the Monk Seal has been recorded. Monk Seals will be discussed later in this chapter under "Marine Environment."

Herpetofauna

The island supports no amphibians and only two reptiles – the non-native Snake-eyed Skink and the House Gecko. Both species of terrestrial lizards are widespread in Hawai'i. The skink has not been recorded recently on Lehua and it may have been extirpated from the island from predation by the rats. House geckoes were more recently introduced to Lehua but it is unknown exactly when.

Flora

Surveys by Caum (1936) and Wood *et al.* (2004) found a total of 11 endemic plant species on Lehua, although Wood's 2001-2003 surveys were unable to locate two of endemics identified by Caum, making an extant total of nine endemic species (Appendix A, Table 3). Wood et al. (2004) found an additional 13 native (indigenous) plant species extant on the island in small numbers, and a total of 27 non-native species (Wood *et al.* 2004). Vegetation monitoring began in 2003 prior to the 2005 rabbit eradication effort and continued twice annually until April 2008. Rabbit eradication was followed by a roughly 60% increase in vegetation cover that was made up mostly of non-native grasses (83.3% cover) and shrubs (79% cover) (Eijzenga 2011). Plant diversity increased by 31.7 %. Ten new species of herbaceous flowering plants (forbs) and grasses were recorded after rabbit eradication, with one forb being indigenous. (Eijzenga 2011)

Marine Environment

Of the many marine species present in the immediate waters of Lehua Island, only two species are protected: the Hawaiian Monk Seal and the Green Sea Turtle.

Marine Mammals

The Hawaiian Monk Seal is a highly endangered (IUCN and USFWS) pinniped that resides primarily in the Northwest Hawaiian Islands, with occasional sightings on the main islands (Zevin 1995). They generally breed on islands that have little or no human presence, and encroachment by humans into their natural territories is one of the threats facing this endemic mammal (Tomich 1986). Entanglement in debris from human activities such as fishing is a major danger as well (Boland and Donohue 2003). The Lehua population of seals is relatively small, around 15 individuals. There are no documented cases of monk seals breeding on Lehua. However, nearby Niihau Island hosts the largest population of monk seals in the main Hawaiian Islands.

Sea Turtles

Green Sea Turtles, listed as a Threatened species under the Endangered Species Act, are sometime seen in waters around Lehua but there are no records of sea turtles crawling out onto the rocky shelves around Lehua and there is no suitable turtle nesting habitat on Lehua. Lehua's rocky and steep shoreline makes sea turtle access very difficult and prevents any attempts to excavate nests. On 10 visits in 2001-2004, no sea turtles were sighted on Lehua Island, but one individual was spotted swimming in the surrounding waters (Wood *et al.* 2004).

Marine Fish and Algae

See Table 7 in Appendix A for a list of fish seen off the shores of Lehua during snorkeling surveys conducted in 2004 and Table 4 Appendix A for a list of marine algae collected on Lehua shorelines. None of the species listed in the appendices are known to be particularly rare. Additional information on fish species was collected during surveys of interactions between fish and inert bait in 2004 and 2015 (Tables 14 and 15)

Human Uses and Values

Cultural and Archeological Value

The remains of stone platforms and cairns have been discovered on Lehua, which may have been built by bird hunters or fishermen (Palmer 1937). The number and distribution of sites of archeological significance have been mapped and documented on Lehua (Yent and Carpenter 2009). The lack of fresh water, poor soils for supporting agriculture, and steep, rugged and exposed topography likely account for the lack of evidence of permanent occupation of Lehua Island by Hawaiians. The sites on Lehua suggest that the early Hawaiians landed on the island, probably to fish and collect birds, while living on adjacent Ni`ihau or Kaua`i.

Ownership and Current Uses

Lehua Island is Federal property administered by the USCG.. It was set aside for public purposes by Territorial Governor Wallace R. Farrington on August 10th, 1928, under Executive Order No. 343. It was placed under the management and control of the US Department of Commerce for use as a United States Lighthouse Station. Following this, President Calvin Coolidge issued a Proclamation on September 14th, 1928, stating that the land would be owned by the United States government for use as a lighthouse station.

The guidelines for the USCG management of natural resources are listed in Commandant Instruction Manual 5090.3. It states the USCG shall inventory, preserve, restore, and enhance natural resources on its administered lands to the maximum extent practicable and in the best public interest. The USCG has been limited by the lack of funding and accessibility issues from conducting these activities on Lehua. Restoration activities on Lehua would also help the USCG to meet their requirements under Presidential Executive Order 13112, Invasive Species, which requires Federal agencies to provide for restoration of native species and habitat conditions in ecosystems that have been invaded. Additionally, the LIERP would help to reduce erosion from the island, thereby helping to protect the coral reefs in the area, as required under Section 3 of Executive Order 1309, for Coral Reef Protection.

The waters around Lehua, including the intertidal zone, are State property. Lehua Island itself is zoned as a Conservation District and is also a Hawai`i State Seabird Sanctuary. State regulations prohibit overnight camping, hunting or disturbing wildlife. Landing on the island is by USCG permission only. However, the surrounding waters are a popular destination for SCUBA and snorkeling trips departing from Kaua`i. Lehua's remoteness makes this trip a full-day undertaking, so use is light compared to most dive sites in Hawai`i. Sportfishing, subsistence fishing, bird watching, and tourism also occur in the waters around Lehua. People sometimes gather Opihi (marine limpets) from Lehua's intertidal areas.

Chapter 3 – Alternatives

Introduction

This chapter will describe the three alternatives that will be considered for implementation, including the "no-action" alternative. This chapter identifies the environmental issues used to formulate the alternatives derived from the 2005 EA, the 2009 supplemental EA, and ongoing discussions with regulatory agencies, stakeholders, and the public since the 2009 rat eradication attempt.

Alternative Development

Section 102(e) of NEPA states that all Federal agencies shall "study, develop, and describe appropriate alternatives to recommend courses of action in any proposal which involves unresolved conflicts concerning alternative uses of available resources." In addition to responding to unresolved conflicts, an environmental analysis must "rigorously explore and objectively evaluate all reasonable alternatives" [40CFR 1502.14(a)].

The proposed action aims to reverse the ecological degradation occurring on Lehua Island caused by non-native Pacific Rats (*Rattus exulans*).

The alternatives detailed below were developed to focus on the issues identified by USFWS and DOFAW biologists, invasive mammal control experts, rat eradication specialists, State and Federal regulatory agencies, and the general public.

Internal Scoping and Public Involvement

This section summarizes the scoping that was conducted to identify environmental issues to be considered.

DOFAW has an extensive record of studying the impact of and responding to control or eradication of invasive mammals throughout the State of Hawai`i, including the Northwest Hawaiian Islands. DOFAW, USFWS, and IC have each successfully conducted eradications of invasive species (including rats) from a number of Hawaiian Islands, including Midway, Kure, Mokapu, and Manana. In addition, the USFWS has funded studies that focus on the ecology and control of rats on public lands.

External Scoping

The external scoping refers to the effort the USFWS and DOFAW made and will make to solicit input from the public, State and Federal regulatory agencies, and non-governmental organizations. The following were completed for the 2005 EA:

- The USFWS and DOFAW published a Notice of Intent (NOI) in the Federal Register (on May 17, 2004) and the State of Hawai`i OEQC Bulletin (on May 23, 2004), announcing an environmental analysis, purpose and need and the proposed action. The USFWS also sent press releases to local newspapers, resulting in four articles in two local newspapers announcing the public meeting date and location.

- A public meeting was held in Lihue, Kaua`i, June 9, 2004. The USFWS paid for the publication of an announcement in a local Kaua`i newspaper indicating the date, time and location of the meeting. Project biologists gave a presentation at the meeting that outlined the purpose and need and the proposed action. Public comments were requested.

- On May 21, 2004, a scoping letter describing the proposed action was mailed out to individuals and organizations that had previously expressed interest in USFWS/DOFAW management, other State and Federal agencies that may have oversight or regulatory concerns about the project.

- The USFWS and DOFAW met with regulatory government agencies that may have oversight or regulatory concerns regarding the project, including the US Coast Guard, National Marine Fisheries Service, U.S. Department of Agriculture, Hawai`i Department of Health, Hawai`i Department of Agriculture, and U.S. EPA.

As a continued effort to engage the public, state and federal regulatory agencies, and non-governmental organizations, the following has been or will be pursued:

- As part of the Lehua Island Feasibility Assessment effort, in 2012 the Lehua Island Restoration Steering Committee was created. The committee was comprised of stakeholders DOFAW, USFWS, IC, USDA, US Coast Guard, NTBG, and the Owners of Niihau. The Steering Committee has met to discuss Lehua's restoration potential on a quarterly basis and more recently on a monthly basis. Following the findings of the feasibility study, these key stakeholders have continued to meet and discuss the issues that helped to determine the alternatives outlined below.

- A Pre-Consulation Letter regarding this Draft EA along with information answering potential questions about the Lehua Island Ecosystem Restoration Project was sent out to over 100 potential interested parties in the Kauai community including Kauai County Council members and multiple community and conservation organiations.

- Along with the release of this EA on the OEQC's Environmental Notice, USFWS and DOFAW will be holding an additional public meeting to gather comments related to this EA during the 30 day comment period.

Alternatives Being Considered

<u>Alternative 1: No Action</u>

Rats would remain on Lehua for the foreseeable future under this alternative and the negative impacts of rats on native flora and fauna would continue on Lehua Island under this alternative with the lost opportunity to restore the island and its species.

Features Common to All Action Alternatives

The proposed methodology for rat removal would meet the fundamental principles established for all island eradications (see Cromarty et al. 2002):

1. All individual rats can be removed with the eradication strategy.
2. Rats must be removed faster than they can replace themselves.
3. Immigration of rats through natural means or via transport by people must be maintained at zero. i.e., prevent rats from re.

Rodents – rats and mice, have been successfully removed from over 500 islands worldwide (from Database of Island Invasive Species Eradications - DIISE). In all but the smallest of islands have utilized rodenticides, predominantly the anticoagulant rodenticides as the primary and main tool for the eradication. In each case, bait was delivered into every potential rat territory either with the use of bait stations laid out on a grid pattern, broadcast by hand or helicopter or a combination of the two. Aerial broadcast is the most widely used method today, and is effective in delivering bait into every potential rat territory, especially on islands with steep and inaccessible cliffs where safety risks preclude people from gaining access. Due to the steep cliffs and inability to get bait into every potential territory on Lehua safely by walking or climbing, an aerial broadcast approach will be the primary method of removal, supplemented by hand broadcast, bait stations, and/or mechanical means (traps, or equivalent).

<u>Aerial Bait Application:</u> Bait will be distributed over the entire surface of the island, up to, but not including the intertidal zone, primarily using an aerial broadcast approach modeled after other similar projects conducted in the United States, Canada, Mexico and internationally.

Aerial broadcast would be carried out utilizing a hopper suspended from a helicopter (Figure 3), technology adopted from the agricultural industry to evenly apply and spread fertilizer and pesticides on food crops in Hawaii and US mainland. The approach utilized will model other successful rat eradication projects that have been conducted elsewhere in the United States, Canada, Mexico and internationally. The hopper isan inverted cone with an opening at the bottom that bait flows through, and onto a spinning plate. Bait is spread from the plate in a horizontal 360 degree pattern (the swath width). Bait flow out of the bucket is under full control of the pilot that can remotely open and close the bait bucket opening with an onboard trigger in the cockpit. When flying over the ocean to access the island, bait will not flow out when the bucket opening is closed, and will prevent bait application in the marine environment.

Figure 3: hopper suspended from a helicopter.

An onboard computer linked to a GPS and light bar will guide the pilot to fly along pre-programmed flight lines over the island, to ensure an even application rate. The helicopter will have to fly over the near shore marine environment to line up the helicopter along pre-programmed flight lines, guided by the GPS and a light bar. No intentional baiting will occur over the marine environment. The helicopter will fly over the ocean with a full bait bucket when transiting from the bait loading area on either Niihau or Kauai.

Calibration and testing of the bait application equipment using non-toxic placebo bait will take place on Kauai to ensure that the equipment is fully operational and functioning according to specifications. Any issues identified will be corrected and tested again prior to the application on Lehua Island. Calibration of target bait application rates will be followed according to established protocols. Calibration will measure gravity bait flow through the bucket, effective swath width (how far bait is spread to either side of the flight line), bucket application rate (total bait applied over test area flown) at a given flight speed, ground application rate (as measured by total pellets in known plot areas). Adjusting either flight speed or bait flow through the bucket (orifice size at mouth of bucket controlled by insertion of donut shaped discs; larger discs increases flow of bait, smaller discs decreases flow of bait) or swath width will change application rates over a given area. Calibration will be used to confirm optimal flight speed and rate of bait flow (disc size) through the bucket to achieve the target application rates. Monitoring of the application will be conducted in near real time during the bait application on Lehua to ensure that the application rate stays within the legal and optimal application rates. Any deviation will be adjusted immediately during the on island operation.

The helicopter charter company and pilot used will be certified for aerial bait application and in compliance with both FAA and Hawaii State law.

<u>Cliffside and Marine Ecosystem:</u> Every reasonable effort would be made to minimize the risk of bait drift into the marine ecosystem. The hopper would be fitted with a deflector that spreads bait out to only one side, in an approximately 120-degree pattern, to minimize the risk of bait application directly into the ocean when flying along vertical cliffs and shoreline. Hand broadcast and/or bait stations may be used to supplement the aerial broadcast in areas where aerial broadcast is not effective (e.g. caves and under infrastructure) when it does not pose an undue risk to the safety of personnel.

Bait: The bait used will be legally registered in compliance with FIFRA and will be licensed by the HDoA for use for conservation purposes in Hawaii. The bait will have a label that establishes the parameters of the bait application including bait application rates, safety precautions, and other requirements. All bait applications will be made in compliance with the label.

<u>Bait Application Monitoring:</u> The onboard computer linked to the GPS will serve as the primary method of monitoring where bait was applied to the island. Data from the onboard computer would be downloaded from the computer and evaluated on a laptop computer to assess where bait was applied and total area treated, in order to calculate the bait application rate.

<u>Staging Area and Bait Loading:</u> The baiting operation would be staged either on the north end of the island of Niihau or on Kauai. All support staff, supplies (fuel, power, tools), bait, and spare equipment will be staged to support the operation. An operational plan will be developed to ensure compliance with all applicable State and Federal laws to ensure a safe, and effective staging area.

Bait would be delivered in shipping containers at the point of manufacture from the US Midwest. Bait will be in either 50 lb bags, or in large brailer bags (up to 700 lbs), loaded into “pods”, i.e., large cardboard boxes on skids. The shipping containers would remain locked, and staged on Kauai and/or on Niihau, opened periodically for inspection prior to the eradication, and during the baiting operation itself. Bait would be loaded either manually by hand from bags into the hopper, or direct from brailer bags.

The two staging areas and mitigations being considered for the operation are:

Niihau: Niihau is a small elongate island (29 x 10 km) that stretches from southwest to northeast containing 145 km of variable coastline including sand, boulder and lava bench habitat. Niihau lies at the far northwest end of the main Hawaiian Islands and is the low lying subaerial remains of a volcanic shield volcano. It is three-quarters of a mile (1.2 km) south of Lehua at the closest point.

The designated area for bait storage and bait loading during the aerial broadcast at Lehua will be on the north end of Niihau at Nanina. The site is a third of a mile inland from the beach at Kaakuu Bay and is exposed to regular helicopter operations, boat landings, and motorized vehicle traffic connected to tourist and ranching activities. The habitat at Nanina is dominated by bare lava with intermittent Kiawe (*Prosopsis pallida*) that is in the form of low growing bushes. No ESA listed plants or birds exist within this habitat but the Hawaiian monk seal is known to frequent the sandy beach located due west of Nanina at Kaakuu Bay. The area is also visited by feral pigs and sheep that are the remnants of previous ranching activities.

The storage of the rodenticide bait will be at Nanina in locked shipping containers placed on the lava substrate. The shipping containers will protect the bait from exposure to the elements and will allow a controllable area to access bait during aerial broadcast operations. A separate site at Nanina with close proximity to the helicopter landing site will be used to store fuel. This fuel for the helicopter will be in 55 gallon drums and will be held in a EPA approved Spill Prevention and Preparedness Regulations (SPCC) containment area and covered to prevent water intrusion to the fuel.

The only potential ESA listed species affected by the operations would be the Hawaiian monk seal. The behavior of seals might be affected by the overflight of the helicopter. Helicopter operations are regularly conducted at this site but mitigation measures will be employed to prevent hazing of seals. If seals are present on the beach during operations, the helicopter will avoid flying over the beach at Kaakuu Bay and then head to Lehua once clear of the shoreline.

Kauai: A potential site on west Kauai has been identified as a backup bait loading site that would be used if Niihau became unfeasible. The Kauai Raceway Park is located in Kekaha next to the landfill, agricultural fields, and a decommissioned shooting range. The Park is mainly used on weekends for drag racing events. The west end of the drag strip has a paved helicopter landing zone that would be used for bait loading and helicopter fueling operations.

No endangered species would be impacted if the bait loading and fueling operations were relocated here. The Kauai Raceway Park is fenced, paved, and regularly used for construction, automotive and other impactful human activities. Bait would be loaded from a container on the back of a truck with a forklift. Helicopter fuel would be kept in 55 gallon drums on the asphalt a short distance away from the bait loading.

Staging the operation from Kauai instead of Niihau would greatly increase the distance for the helicopter to fly over water to get to Lehua. This significantly increases the time it will take to complete the operation as well as the costs associated with helicopter time and fuel use. It also increases the risk that in an emergency a full bucket load of rodenticide pellets could be jettisoned into the water. Because of these factors, Niihau is the preferred staging location.

Helicopter Transit to the Island and Return: The helicopter would transit with a full bait bucket from the staging area, transiting either 0.75 miles over the ocean from Niihau, or approximately 20 miles from Kauai. At no time will bait be intentionally broadcast into the marine environment. The helicopter will return to the staging area for refueling and/or bait loading before returning to Lehua island. Total number of transit flights with full bait bucket is expected to be approximately 10.

Operational Plan: The implementation of the action alternatives will be guided by an Operational Plan that would be developed to specify the procedures of the baiting operation, ensuring compliance with HEPA and all permit requirements, ensure optimum safety precautions, organizational structure of the personnel to ensure clear communications, and monitoring protocols.

The operational plan will specify protocols for the bait application, records to be kept, personnel that will participate, and methodology to stage, load bait, support the helicopter operations, and apply bait effectively.

Validation and Effectiveness Monitoring: A monitoring plan will be established and executed to demonstrate the bait was applied in an effective manner as described below, the eradication is progressing as expected (mortality of rats), and potential risks and impacts of the rodenticide in the environment and to non-native species are documented and in compliance with HEPA and permits. At a minimum, marine water and any fish, bird and rodent carcasses found during or soon after rodenticide operations would be sampled and analyzed for rodenticide concentrations to determine the environmental impacts of the operation. Follow-up sampling would occur at an appropriate time (to be determined) after the end of rodenticide applications to determine the persistence of chemical residues in the environment. . Additional monitoring requirements will be carried out under required permit conditions.

A safety plan will be prepared in case of a need to respond to any accidents to people, equipment failures, and/or wildlife incidents as a result of the bait application.

Alternative 2: Rat Eradication with Diphacinone, followed by Brodifacoum if Necessary

Toxicant: Rats would be removed with the use of bait containing 50 ppm diphacinone, a first generation anticoagulant rodenticide. If rats persist after diphacinone treatment as prescribed below, bait containing 25 ppm brodifacoum may be used to complete the eradication.

Application Rate: Bait containing diphacinone would be broadcast at a maximum of 30 Kg/ha (17.8 lb/acre) per treatment to ensure adequate bait is available for long enough to all the rats, as per the calibration trial conducted in 2015 (Mazurek et al. 2015). Brodifacoum bait would be applied no higher than the label rates of 18kg/ha for the first application.

Number of Applications: At least three diphacinone applications would be made, approximately 7-20 days apart depending on weather conditions. If necessary, one or two applications of brodifacoum would be applied no higher than the label rates of 18 kg/ha for the first application and 9 kg/ha for the second.

Alternative 3: Rat Eradication with Brodifacoum

Toxicant: rats would be removed with the use of bait containing 25 ppm brodifacoum, a second generation anticoagulant.

Application Rate: Brodifacoum bait would be broadcast at a maximum of 18 kg/ha followed by a second application of 9 kg/ha.

Number of Applications: Two applications, approximately 7-20 days apart, depending on weather conditions.

Alternatives Considered and Dismissed from Detailed Analysis

Bait Stations and Hand Broadcast and/or snap traps Exclusively

The use of bait stations and/or hand application of bait was considered but dismissed. On Lehua Island, it would be challenging to meet the fundamental principle of rodent eradication with a strategy that solely employed bait stations and/or hand application of bait because of the island's steep cliffs, difficult terrain, and associated logistical challenges. Bait cannot be delivered into every potential territory using a ground based approach. A ground-based eradication strategy would also require the implementation team to spend several months on Lehua. To achieve this by hand, island restoration personnel would face unnecessarily high safety risks, because of the island's steep terrain, in order to ensure every rat in every potential rat territory is eliminated. By comparison, aerial broadcast of bait requires fewer personnel to be on the island, and overall less hazard for project personnel. Snap traps would require significantly greater effort than bait stations, and has never been successfully used on any island the size of and with similar terrain as Lehua.

Use of Diphacinone by Aerial Broadcast without Brodufacoum Back-up

The use of only diphacinone was considered but dismissed. Diphacinone has been used successfully in over 25 rat eradications around the world as compared to brodifacoum that has been used successfully in over 430 islands. Although there are benefits to using diphacinone, this toxicant does not have a track record as extensive as brodifacoum. The application strategy to be used under alternative 2, would ensure bait is delivered to every potential rat territory and would put all individuals at risk. Although it is anticipated that the baiting strategy used in alternative 2 will be successful without the follow-up with brodifacoum, the back-up plan to use brodifacoum is important to insure successful eradication. Assuming no operational failures, if rats are encountered after all diphacinone applications, it will be important to use the alternative toxicant to ensure complete eradication.

Use of Chemosterilants or Hormonal Treatment to prevent Rodent Breeding

The use of hormonal treatments for the eradication of rats on Lehua Island was considered and dismissed because the current available treatments have been designed and tested for population control in urban areas and have never been used to achieve complete eradication.

BioControl of Rats with Introduction of Another Species

The introduction of another species such as cats, or mongoose to the island to control rodents would not be effective, and would be in violation of Hawaii state law. The predators would consume some rodents, but natural history in Hawaii has confirmed that these predators would turn on the native and non-native birds on the island, and the rats would persist. The impact of the introduced species of rats and the new predators would have a greater impact on the birds and island ecosystem than if the rats were present alone.

Chapter 4 – Environmental Consequences and Mitigation

Introduction

This chapter analyzes the environmental consequences of implementing each alternative described in Chapter 3. Potential risks to non-target species will be described as consequences of rodenticide toxicity and exposure; and as a consequence of the operation (operational hazard).

Rodenticide toxicity and exposure

Risk of rodenticide poisoning for an animal is based on both the toxicity of the chemical and its exposure to the chemical. Exposure can arise from directly ingesting the rodenticide (i.e., primary exposure) or eating an animal that has ingested the rodenticide (i.e., secondary exposure). For the purposes of this EA, exposure is a function of the quantity of the rodenticide in the environment and the frequency of occurrence of the animal in the environment where the rodenticide is applied. The former is addressed with the application rate (described in previous section) and the latter is addressed in this section. Toxicity is taxa specific and is determined by the quantity of active ingredient (ai) for a given body weight (bwt) to achieve a certain effect, usually measured as mg ai / kg bwt. Toxicity is most frequently represented as the LD_{50} and LC_{50}. LD_{50} is the chemical dose where 50% of the test animals died and is usually administered as a single dose. LC_{50} is the concentration of the chemical in feed where 50% of the test animals died and the test is usually administered over a multi-day period (e.g. five to 10 days). A third measure of toxicity is the LLD, the lowest lethal dose of a chemical at which a test animal died. The lower the LD_{50}, LC_{50}, or LLD value, the more toxic the chemical, or more sensitive the species. LD_{50}, LC_{50}, and LLD measure the lethality of a chemical to the subject species. Toxicants are also evaluated by their sublethal effects on animals. These are represented by metrics, such as NOEL (no observable effect level) and LOEL (lowest observable effect level). NOEL is the highest dose or exposure level of a toxicant that produces no measureable toxic effect on the test group of animals and LOEL is the lowest dose or exposure level of a toxicant that produces a measurable toxic effect on the test group of animals. Sublethal effects observed in the anticoagulant acute oral studies included lethargy, subcutaneous, intramuscular, and internal hemorrhaging, piloerection, diarrhea, bloody diarrhea, and anorexia (Anderson et al. 2011).

It is recognized that the LD_{50} is a poor measure of toxicity for first generation anticoagulant rodenticides (FGARs) such as diphacinone (Jackson and Ashton 1992). FGARs are designed to deliver a lethal dose over multiple days of feeding, whereas LD_{50} results are obtained by giving different groups of test animals a single dose of varying quantities of the chemical via gavage. This has been found to underestimate the toxicity of FGARs. LC_{50}, LLD, LOEL, and NOEL are more accurate measures of the sensitivity of birds and mammals.

Individual species of birds and mammals vary in their relative sensitivity (i.e., the toxicity) to different rodenticides. For mammals, diphacinone and brodifacoum are considered “very highly toxic” as measured by acute oral toxicity (LD_{50}) and dietary toxicity (LC_{50}) (Anderson et al. 2011). For birds, diphacinone for birds is considered “slightly toxic” (LD_{50}) and “moderately toxic” (LC_{50}), respectively.

The potential ecological and human health risks associated with broadcasting diphacinone in native Hawaiian ecosystems has been examined (Eisemann and Swift 2006) and the results relevant to the proposed action have been adapted to the species of interest. The potential ecological and human health risks of brodifacoum has also been extensively studied and is presented in the following sections. It should be noted, that all pellets will not be available to all non-target species. A significant, but undetermined, portion of the pellets are expected to be deposited in crevices in the soil and cracked lava substrate, out of reach of most non-target species, yet still accessible to Pacific rats. Moreover, Pacific rats are expected to quickly begin consuming and caching bait, further reducing the quantity of bait available to non-target species.

Alternative 1 – No Action Alternative

Restoration Efficacy

Under the no action alternative, rats will be allowed to persist on Lehua Island, subject to the natural processes of the island ecosystem. There would be no use of rodenticides on Lehua. With no action on the island, the rat population will not be eradicated, and population sizes would fluctuate within an annual cycle – population levels increasing during the rainy season, and declining during the dry season. Additionally, plant communities would continue to be over harvested by rat herbivory, and would have increased numbers of invasive species which have evolved to withstand predation and can outcompete native species in the presence of rats, and do not represent a healthy native plan community. Adoption of the no-action alternative would not meet the objective of restoring the Lehua Island ecosystem.

Rat herbivory would continue to damage the vegetation communities on the island. Native vegetation in general would continue to be negatively impacted, and the seabirds and invertebrates that depend on vegetation would still suffer from poor-quality habitat that would limit their populations on Lehua. Furthermore, the risk of erosion due to a lack of vegetation would continue to pose a risk to the nearshore marine ecosystem, including coral, which is a critical resource for the marine life surrounding the island. This potential harm to the nearshore environment would extend throughout the trophic levels of Lehua’s marine ecosystem, potentially reducing habitat quality for the federally listed endangered Hawaiian Monk Seal, sea turtles, fishes, and marine invertebrates.

Introduced rats would continue to prey on nesting seabirds on the island, preventing them from reaching their full population potentials and possibly contributing to accelerated decline in the population, while preventing species such as Newell's shearwaters from re-colonizing the island.

Non-Target Species Impacts

There would be no effects to non-target species under this alternative. However, rats would continue to be a threat to seabird and native plant populations.

Increase in Weed Abundance

Weed distribution would be dictated by herbivory pressure from rats on Lehua Island. Invasive species would have increased numbers of invasive species which have evolved to withstand predation and can outcompete native species in the presence of rats

Impacts on Cultural Resources

There would be no impact on cultural resources on Lehua Island. However, rats would continue to constitute a threat to any subterranean archaeological resources, both discovered and undiscovered, due to the de-stabilization of soils caused by their herbivory.

Impacts on Human Health and Safety

There would be no potential impact to human health and safety. However, the public waters around the island would continue to be at risk from soil erosion due to lack of vegetation cover onshore. This erosion is unlikely to affect the health of divers and snorkelers that visit the island, but would continue to threaten the health of the marine ecosystem that makes Lehua's waters a valuable ecotourism destination.

Non-native Species Introduction

Each visit to the island presents a risk of introducing non-native species. Under this alternative, there would be no risk of introducing non-native species due to the operation. However, there would be ongoing monitoring requiring visits to the island that present a risk of introduction.

The presence of one species of rodent makes the detection of additional species much more difficult since they eat any contingency bait put out, trigger traps and block up tracking tunnels. Therefore, the ongoing presence of Pacific rats means that an incursion of any of the other three species will likely not be detected until it is well established. All four species have different and often cumulative impact.

Individuals that come to the island are typically either USFWS or DOFAW sponsored scientists who voluntarily comply with the DOFAW Lehua Protocols and Procedures

Alternative 2 - Rat Eradication with Diphacinone, followed by Brodifacoum only if Necessary

Restoration Efficacy

<u>*Rat Eradication*</u>

The eradication of rats using rodenticides has been successfully carried out on over 400 islands worldwide (from Database of Island Invasive Species Eradications - DIISE). For islands that share similar topography or are of comparable size to Lehua, rats have been eradicated by the placement of bait containing a rodenticide into every potential rat territory with the use of a helicopter aerially broadcasting pellets, and in some cases, supplemented by the placement of bait by hand and bait stations.

Diphacinone, the primary rodenticide proposed in this alternative, is the preferred rodenticide for controlling introduced rodents for conservation purposes throughout the State of Hawai`i (Swift 1998). Diphacinone is an anticoagulant rodenticide that causes death by internal bleeding. One advantage of anticoagulant rodenticides is that rats die several days after eating the bait, which decreases the possibility that rats would associate anticoagulant symptoms with the bait and would continue to feed. Thus, bait shyness (deliberate avoidance of the bait due to the toxic rodenticide) does not occur, and rats can be successfully eradicated.

A number of laboratory and field studies have evaluated the efficacy of the use of bait with diphacinone for rodent control for conservation purposes in Hawai`i. A laboratory trial found that 100% of 20, wild caught Hawaiian *R. exulans* that were fed bait containing 50 ppm diphacinone, died after consuming an average of 25 grams of bait (about 10 bait pellets) per animal over 8 days (Swift 1998). A hand broadcast trial using Ramik Green containing 50 ppm diphacinone resulted in a 100% kill of Pacific Rats, Black Rats and Norway Rats in two, 4-hectare study areas (Lindsey and Forbes 2000). Follow up hand broadcast trials in the same study areas were also highly effective in knocking down the rat population (Spurr *et al*. 2003). Early studies indicated that the broadcast baiting of Ramik Green containing 50 ppm diphacinone would have a high efficacy rate on wild rats in Hawaiian forests. A subsequent trial of Ramik Green, containing 50 ppm diphacinone broadcast into a 45.5 hectare forested area in Hawai`i killed 100% of the 21 radio-collared rats, within one week of bait application (Spurr *et al*. 2003). Within three weeks of bait application, there was a 99% drop in rat live trap success and teeth marks on chew blocks (used to measure rodent abundance), relative to the non-treatment area.

In 2016, a laboratory trial of the Bell Labs 50ppm Diphacinone Bait was conducted by USDA-APHIS in Hilo, HI. The trial results showed 100% mortality (26 individuals) of wild caught Pacific rats after 14 days, with an average time to death of 7.6 days (SD ±2.9 days).

Diphacinone has been successfully used to eradicate rodents from over 25 islands worldwide, including islands in the United Kingdom (Bell et al. 2011), Mexico (Donlan et al. 2003, Samaniego et al. 2011), Japan (Harrison 2010), Falkland Islands (Poncet et al. 2011), and in the United States Virgin Islands, Guam and Florida (Witmer et al. 2007). In Hawaii, Diphacinone was successfully used to eradicate rodents from three islands: Mokoli'i, Mokapu, and Moku'auina (Witmer et al. 2007, Marie et al. 2014). Successful eradications using Diphacinone deployed bait using bait stations or aerial/hand broadcast.

Taken all together, the successful bait trials, lab trials and previous eradications using Diphacinone 50ppm, strongly suggests a high likelihood of success for eradicating rats from the island of Lehua using rodenticide if delivered in a palatable bait.

If aerial broadcast of diphacinone on Lehua fails to eradicate rats, Alternative 2 proposes to conduct a follow-up aerial broadcast of bait pellets containing 25 ppm of brodifacoum.

Potential Impacts to Soil, Water, Invertebrates and Fish

Environmental Fate of Diphacinone and Brodifacoum in Soil and Water

Both diphacinone and brodifacoum have extremely low solubility in water and bind tightly to organic matter in soil where the rodenticide is degraded by soil micro-organisms and exposure to oxygen and sunlight. The half-life in soil is ~30 to 60 days for diphacinone, and ~ 84 to 175 days for brodifacoum, depending on the soil type and aerobic vs. anaerobic soil conditions. The rate of microbial degradation is dependent on climatic factors such as temperature, light, humidity, and the presence of molds and soil microbes that potentiate degradation. Therefore, in general, degradation time will increase in colder climates and decrease in warm sunny places like Hawai`i (Eason and Wickstrom 2001, Eisemann and Swift 2006). Due to the solubility of brodifacoum and diphacinone molecules and the ionic strength of seawater, seawater solubility of both these compounds is extremely low. The solubility of brodifacoum is 0.24 mg/l (Int Prog. Chem, Safety. Health Guide 93, 1995). The solubility of diphacinone is 0.3mg/l (Hayes and Lewis, 1990, Occupational Health Service MSDS sheet, 1991). The bait concentration of brodifacoum will be 25mg/kg of bait, or 116.25g per bait drop of 4650 kg. The total amount of diphacinone at 50 mg/kg per bait drop will be a maximum of 232.5g per drop. As a demonstration of low solubility, if all of the bait were dropped into the ocean, both brodifacoum and diphacinone would dissolve into the ocean and would be below the detection limit of analytical chemistry (0.003ug/l) in a volume of water the size of a football field 11 feet deep. Ocean currents would quickly dilute the chemicals to vanishing small concentrations.

On Mokapu, Hawaii, samples of surface seawater (as well as intertidal limpets and nearshore fish) were collected to address public concerns about contaminating marine life and to verify assumptions that the project would have no negative impacts to marine waters and organisms (see complete Mokapu sampling and laboratory report in Appendix I). These assumptions were based on data from extensive laboratory and field trials submitted to Hawai'i Department of Agriculture's Pesticides Branch and EPA during the rodenticide registration process. The finding of no residues in the seawater or in marine animal samples, indicates that project mitigation measures, low water solubility of diphacinone, rough winter seas, dilution, or some combination of these factors resulted in little or no rodenticide being released into or retained in the water column.

The threat of an accidental spill of rodenticide pellets is a remote possibility. In the event of serious flight difficulties requiring an emergency landing, the helicopter pilot would likely need to jettison the spreader bucket before landing, potentially resulting in up to 750 pounds of bait pellets going into the water. Since the pellets contain only 0.005% of active ingredient of diphacinone (or 0.0025% active ingredient in the case of brodifacoum), the actual amount of active chemical ingredient entering the water from a 750-pound bait pellet spill would be less than an ounce (8.5 g or 0.3 oz) for either rodenticide. Due to the low quantity of active ingredient, the entire amount of rodenticide would dissolve in a volume of water 30 feet across and 3 feet deep. Ocean currents would dilute the dissolved chemical to undetectable levels (0.003µg/ml) within minutes. At undetectable levels the chemicals could not pose a toxic risk to fish or marine mammals.

Water quality data collected after a massive brodifacoum spill into nearshore waters in New Zealand supports this statement. In 2001, a truck went off the road into the ocean on the east coast of New Zealand's South Island, prior to a rat eradication project. Twenty tons of 0.002% (20 ppm) brodifacoum bait was spilled into the ocean at a single point. Furthermore, because the seas were calm, the congealed bait material remained on the ocean floor for about a week, until it was diluted and dissipated by wave action. Despite expectations that a measurable amount of of brodifacoum would be dissolved into the water column, brodifacoum levels in water samples were no longer detectable 36 hours after the spill had occurred (Primus et al. 2005).

Effect analysis

Based on the best available information, the potential for contamination of seawater is extremely low for both diphacinone and brodifacoum. Lehua does not have any known permanent surface water or groundwater. Long-term soil contamination is also not of concern given the relatively short half-lives of both diphacinone and brodifacoum in soil. The overall benefits to soil stability outweighs the short-term risk of soil contamination.

Mitigation

Every reasonable effort will be made to minimize the risk of bait drift into the water. Possible mechanisms for rodenticide to reach the ocean include pellets bouncing off or rolling down steep slopes, being blown off course by high winds, or being washed into the ocean by heavy rains before they are eaten by rats. To minimize bait application directly into the water, the hopper would be fitted with a deflector that spreads bait out to only one side, in an approximately 120-degree pattern. The last two potential pathways will be minimized by not applying bait pellets in high winds (greater than 35 mph) or when heavy rains are forecast.

The bait will be applied to achieve eradication at the lowest rate possible, minimizing soil contamination.

Marine Invertebrates

Because diphacinone and brodifacoum are highly insoluble in water and the concentration of toxicants per pellet is so low, invertebrates, including corals, will not be exposed to sufficient harmful amounts of rodenticide dissolved in the water column. The potential pathways for contamination of marine invertebrates evaluated below are through primary exposure (direct feeding on bait pellets) and secondary exposure (feeding on contaminated prey items).

Primary exposure

Most marine invertebrates scavenge or graze on items on the ocean bottom or in the intertidal areas and could potentially eat bait pellets and pellet fragments before their complete breakdown in water. Analysis by two laboratories of whole limpets collected after the application of diphacinone on Mokapu Island in 2008 did not detect any diphacinone residues in tissues (Primus, 2009).
Complete breakdown of pellets in the water would be quick, especially in rough water conditions. Studies conducted after a rodent eradication in Anacapa island (Howald 2010) reported bait pellets were completely dissolved in seawater within five hours, which is similar to results reported from Kapiti Island, New Zealand (Empson and Miskelly 1999). During the inert bait trials on Lehua in 2015, data collected shows that pellets disintegrated within 30 minutes after application to seawater and no pellets were found after 24 hours (Island Conservation, Lehua inert bait trial final report, 2015). Therefore, primary consumption of pellets would have to occur within hours of bait drift into the water. Any residual rodenticide that may be in the ecosystem will dissolve in the ocean water or be transferred to the sediment, and subject to microbial degradation, and break down to its base components of water and carbon-dioxide. Diphacinone's half-life in soil is 30 to 60 days, and brodifacoum's is 84 to 175 days, depending on the soil type and aerobic vs. anaerobic soil conditions. The degredation rate in sea water has not been quantified, but is likely to be shorter than in soil, as microbial activity is high in tropical waters (Eason and Wickstrom 2001, Eisemann and Swift 2006

The coral cover around Lehua is very sparse but a large bed of *Sinularia abrupta* (a soft coral) is located off the northwest horn of the island. Unlike the majority of the marine invertebrates found on Lehua, this coral is a filter-feeder. The effects of rodenticides on corals is not well known, but the potential for primary exposure is minimal due to their feeding biology since most of the pellet fragments will be too large for them to consume through their filtering structure. Additionally, bait pellets and pellet fragments sink quickly to the bottom and would only be available for a very short time. After application of bait containing brodifacoum at almost 10x the application rate proposed for Lehua, on Palmyra Atoll, no documented evidence of any impact to corals despite multiple annual monitoring trips and diving/snorkeling in the nearshore marine environment (A. Wegmann, pers. Comm).

Secondary exposure

Marine invertebrates could potentially eat prey items that consumed bait.

Invertebrates collected after the use of diphacinone on Mokapu Island and on Lehua Island, did not contain any diphacinone residue in their tissues (Orazio et al., 2009. See Appendix 1), including liver tissue. These data suggest that these organisms were not exposed to detectable levels of diphacinone through secondary exposure, and is not likely and exposure pathway of concern.

Low levels of brodifacoum residues have been documented in marine invertebrates for a short period of time after aerial eradications. A study following the eradication of rats on Palmyra Atoll found residues of brodifocaum in terrestrial hermit crabs (Pitt et al., 2015). In a worst-case scenario, small amounts of brodifacoum residues were documented in marine invertebrate tissues (filter feeders) following an accidental spill of large amounts of this rodenticide into the ocean on the east coast of the South Island of New Zealand prior to an eradication project.

Operational Hazard

There is no foreseen operational hazard to marine invertebrates.

Effect analysis

A pathway of exposure exists for both rodenticides. There are no known consequences of exposure for marine invertebrates to either rodenticide. There is no known physiological mechanism by which this anticoagulant could affect invertebrates since they do not have the same blood clotting system as vertebrates. Therefore, no adverse effects to marine invertebrate populations is expected in the event of contamination by brodifacoum.

Mitigation

Every reasonable effort will be made to minimize the risk of bait drift into the water. No bait application will be deliberately made into the nearshore marine ecosystem as rats do not forage in the ocean. Possible mechanisms for rodenticide to reach the ocean include pellets bouncing off or rolling down steep slopes, being blown off course by high winds, or being washed into the ocean by heavy rains before they are eaten by rats. To minimize bait application directly into the water, the hopper would be fitted with a deflector that spreads bait out to only one side, in an approximately 120-degree pattern. Exposure pathways will be minimized by not applying bait pellets in high winds (greater than 35 mph) or when heavy rains are forecast.

<u>*Marine Fish*</u>

The potential pathways for contamination of marine fish evaluated below are through primary exposure (direct feeding on bait pellets) and secondary exposure (feeding on contaminated prey items). Disolved rodenticide in sea water would be at undetectable levels and would pose no toxicity risk to fish.

Primary exposure

To investigate the potential of direct fish exposure to rodenticide, an inert bait trial was conducted on Lehua Island. The trial was conducted by Island Conservation at DLNR's request in 2015 using inert bait pellets similar in size, shape and material to the pellets that would be used in the actual eradication. Individual bait pellets were tossed in the water with a diver observing fish behavior. During this trial, the number of fish that contacted and consumed bait was higher than that found in a similar survey conducted by USFWS surveys in 2008. It should be noted that the bait application rate for the 2015 survey was extremely high and would not be needed to eradicate rats from Lehua. Thus, this study may be viewed as a "worst case" scenario to determine the species that may interact with bait pellets should they enter the marine environment in large quantities (e.g. bait spill) (Appendix D, Table 17).

Subsequent laboratory studies recently conducted by USGS Columbia Environmental Research Center on the effects of rodenticide to Triggerfish showed that even though fish consumed inert bait, black triggerfish, smallmouth bass and fathead minnows refuse to eat bait pellets containing diphacinone. If the bait or rodenticide are administered by gavage, the fish rapidly regurgitate the feed (R. Riegerix, *pers. comm.*), which indicates that some fish species are able and will behaviorally avoid bait containing diphacinone, diminishing the potential for primary exposure. Data is not yet available on whether fish avoid bait pellets containing brodifacoum.

Observations of fish during bait applications on islands outside of Hawaii documented fish mouthing bait pellets or crushing them, but not directly consuming the bait (Howald et al. 2010). On Palmyra Atoll, fish were confirmed to have been exposed to brodifacoum after aerial application, possibly from primary exposure (Pitt et al. 2012).

Secondary exposure

Field sampling of several fish species following actual applications of diphacinone in Hawaii is suggestive of potential exposure around Lehua. The sampling program conducted at Mokapu Island, following aerial application of diphacinone bait, did not detect diphacinone residues in any of the tissue samples collected from three fish species (Primus, 2009, Gael et al., 2008) (Appendix E). All of the fishes collected were shoreline-associated predators that feed primarily on invertebrates and/or small fish and would be at risk for secondary exposure through contaminated prey items. Likewise, no diphacinone residues were found in fish tissues following application of diphacinone for the attempted rat eradication on Lehua Island in 2009 (Orazio et al. 2009)

Following the 2009 attempt to eradicate rats from Lehua using diphacinone, several dead fish washed ashore on Niiha`u beaches and a dead whale calf was found on Kauai raising public concern that the animal mortality was due to the operations on Lehua Island. Triggerfish samples were collected from Niiha`u beaches for testing, and no residues of diphacinone were found in the fishes' tissues. Furthermore, studies being conducted by USGS have shown that Triggerfish are some of the least sensitive species to diphacinone (R. Riegerix, *pers. comm.*) which means that they would need to consume very large amounts of bait to receive lethal doses of the toxicant. Whale calves feed exclusively on milk and would have had no possible contamination pathway by diphacinone. Taken altogether, the available evidence suggests that despite the coincidental timing of both events, the operations on Lehua could not have caused the death of neither the fish nor the whale calf. Additionally, a toxin associated with some freshwater blue-green algae that has proven to cause mortality in fish (Todd 1995) was detected in the gut content of the fish samples collected on Niiha`u, indicating a potential cause of the observed mortality.

Brodifacoum residues have been found in fish tissues after rat eradications. Most notably, studies following the rat eradication on Palmyra Atoll, detected rodenticide residues in all fish samples collected which included mullet fishes (*Moolgarda engeli* and *Liza vaigiensis*) and one puffer fish. Fish were found dead and collected opportunistically for this study (Pitt et al. 2015). Mullet fish contamination ranged from 0.058–1.160 µg/g and the single puffer fish sample had 0.44 µg/g of brodifacoum in homogenized tissue (Pitt et al., 2015). It is noteworthy that the very large amount of brodifacoum used on Palmyra Atoll at 80 Kg/ha and 75 Kg/ha for the first and second application respectively, was unprecedented which likely influenced the available brodifacoum residues consumed by non-target species. Fish samples were also collected from the lagoon which represents a low energy water body (i.e. no waves). Following the accidental brodifacoum spill in New Zealand, with a higher energy coast, more like that found on Lehua Island, fish samples were collected and only one individual fish had detectable rodenticide residues (Primus et al. 2005).

Operational Hazard

There is no foreseen operational hazard to marine fish.

Effect analysis

The best available data suggests that there is no reasonable concern for primary or secondary exposure of marine fish to diphacinone. In the unlikely event of fish contamination by diphacinone, recent studies using three fish species, indicate that they are amongst the least sensitive animals to the effects of diphacinone (R. Riegerix, *pers. comm.*). Therefore, there are no expected adverse effects to marine fish populations.

Brodifacoum contamination through primary and secondary exposure is possible. Brodifacoum residues have been documented in fish after brodifacoum application (see Pitt et al. 2015), including residues in mullet found dead nearshore. However, the impact was believed to be inconsequential at a population level, and there are no known sub-lethal impacts from brodifacoum exposure.

Mitigation

Every reasonable effort will be made to minimize the risk of bait drift into the water. Possible mechanisms for rodenticide to reach the ocean include pellets bouncing off or rolling down steep slopes, being blown off course by high winds, or being washed into the ocean by heavy rains before they are eaten by rats. To minimize bait application directly into the water, the hopper would be fitted with a deflector that spreads bait out to only one side, in an approximately 120-degree pattern. The last two potential pathways will be minimized by not applying bait pellets in high winds (greater than 35 mph) or when heavy rains are forecast within a few days of the bait application.

Birds

The potential pathways for contamination of birds evaluated below are through primary exposure (direct feeding on bait pellets) and secondary exposure (feeding on contaminated prey items).

The bird species expected to be present on Lehua during the summer months are:

Seabirds: Wedge-tailed shearwater (*Puffinus pacificus*), red-footed booby (*Sula sula*), brown booby (*S. leucogaster*), red-tailed tropicbird (*Phaethon rubricauda*), great frigatebird (*Fregata minor*), Bulwer's Petrel (*Bulweria bulwerii*) and the Hawaiian black noddy (*Anous minutus melanogenys*), Black-footed albatross (*Phoebastria* nigripes), and Laysan albatross (*Phoebastria immutabilis*).

Shorebirds: Kolea, Pacific Golden Plover (*Pluvialis fulva*) (MBTA protected), wandering tattler (*Tringa incana*), ruddy turnstone (*Arenaria interpres*). These species usually arrive at Lehua in September and leave the island in late April and are not present for most of the summer months.

Terrestrial birds: scaly -breasted munia (*Lonchura punctulata;* previously called nutmeg mannikin), ring-necked dove (*Streptopelia capicola*), house finch (*Haemorthous mexicanus*) (MBTA protected).

Birds of prey: barn owl (*Tyto alba*), and cattle egret (*Bulbucus ibis*). Twelve bird surveys performed on Lehua (1932 to 2016) have never recorded the presence of Pueo (*Asio flammeus sandwichensis*).

Primary Exposure - Seabirds

Seabirds are considered to be a low risk of primary exposure to rodenticide bait because they are generally predatory birds that forage offshore on live prey such as fish and squid. Although there is variation on foraging behavior, most seabirds are pelagic and feed away from the shoreline. Bait pellets that drift into the water would fall close to the shoreline far from the typical pelagic foraging area of most seabirds. Moreover, bait pellets degrade quickly in water and fragments sink to the bottom, so would only be available to seabirds for a very short period of time, and at best would be inadvertent exposure.

Seabirds do not typically feed on land and the probability of direct ingestion of bait pellets from the ground is very low for the majority of species. Data from a previous rat eradication on Anacapa Island in California, shows that seabirds did not eat bait pellets available on the ground (Howald et al., 2005). However, chicks of some species such as albatrosses and red-tailed tropicbirds have been documented to interact and eat objects found on the ground such as rocks, sticks, and foreign objects and could potentially ingest bait pellets or fragments.

Secondary exposure - Seabirds

There is no evidence of lethal secondary exposure of seabirds to diphacinone. No seabird carcasses were found following the aerial broadcast of diphacinone on Mokapu and Lehua (Gale et al., 2008; Orazio et al., 2009). Sub-lethal contamination by diphacinone in seabirds has not been documented following eradication attempts. Diphacinone is classed as moderately to minimally toxic to birds (U.S. EPA).

Brodifacoum is known to be very highly toxic to birds (Godfrey, 1986; Eason et al., 2002) and avian mortality is often reported following brodifacoum broadcasts (e.g. Eason et al., 2002; Dowding et al., 2006; Howald et al., 2009; Masuda and Jamieson, 2013). Brodifacoum residues were found in 12 birds found dead following the rat eradication on Palmyra Atoll (Pitt et al., 2005) and was likely cause of mortality. One year following the rat eradication on Rat Island, ~350 gull carcasses from two species had detectable levels of brodifacoum (Ebbert and Burek-Huntington, 2010) indicating primary or secondary exposure. In contrast, following the rat eradication on Haida Gwaii, using the same bait formulation as on Rat Island, only a small number of carcasses were collected and linked to brodifacoum exposure, even though hundreds of gulls were documented on and around the island during the operation. These contrasting results suggest that risk of exposure is project specific. Gulls are opportunistically omnivorous and will consume many varieties of objects perceived as food. No gull species are resident in the Hawaiian Islands and are only occasionally observed as vagrants, usually during winter months.

Operational Hazard - Seabirds

Bait application will be done primarily through aerial broadcast of bait pellets using helicopters, minimizing the need for ground-based personnel. However, a monitoring team will be staged on Lehua island and will conduct periodical checks on the amount of bait available on the ground, as well as interactions of non-target species with the bait and environmental consequences. The ground team could pose a risk of collapsing the burrows of burrow-nesting birds, such as the wedge-tailed shearwaters. Helicopter flights over Lehua Island may temporarily disturb seabirds and cause air-strikes.

Effect analysis diphacinone - Seabirds

Table 4.1: toxicicity of diphacinone bait product and contaminated fish to seabirds of Lehua. LD50 = lethal dose. LOEL = lowest observed effect level. POP. = population.

species	Body weight (g)	Daily food intake (g)	LD50 mg/kg	LD50 (mg of active ingredient)	LD50 (g of bait)	LD50 Secondary (g of fish)
Wedge tailed shearwater	340	65	96.8	33	658	28448
Buller's petrel	100	24	96.8	10	192	8621
Red-footed booby	975	103	96.8	95	1877	81543
Black noddy	130	29	96.8	10	208	8625
Black-footed Albatross	1950	198	96.8	188	3744	162056
Laysan albatross	2000	203	96.8	194	3840	167228
Red-tailed Tropicbird	660	87	96.8	64	1278	55172
Brown booby	1340	141	96.8	130	2594	112069

species	LOEL Primary (g of bait)	LOEL Secondary (g of fish)	Lehua pop.	Hawaii pop.
Wedge tailed shearwater	0.037	1.6	23000	302000
Buller's petrel	0.011	0.47	62	93000
Red-footed booby	0.1074	4.6	4288	12500
Black noddy	0.014	0.63	405	17000
Black-footed Albatross	0.215	9.27	32	110000
Laysan albatross	0.22	9.48	50	1200000
Red-tailed Tropicbird	0.07.	3.01	400	25800
Brown booby	0.14	6.4	975	1425

LD50 based on lowest reported avian toxicity (Rattner et al 2011). 96.8mg/kg body wt. in American Kestrels.

Fish contamination based on highest reported values (Pitt et al. 2015). 1.16mg/kg
Population data from annual surveys (Pacific Rims, http://kauaiseabirdproject.org/index.php/the-birds/other-seabirds/ and http://dlnr.hawaii.gov/wildlife/hswap/cwcs/hawaii/species/fact-sheets/)

Daily food intake calculated from allometric equation (Bird Feeding Rate = 0.059 x (W)0.67) (US EPA 40 CFR Ch. App D. Great Lakes Water Quality Initiative. Methodology for Development of Wildlife Criteria. 1995).

Effect analysis brodifacoum - Seabirds

Table 4.2: toxicicity of brodifacoum bait product and contaminated fish to seabirds of Lehua. LD50 = lethal dose. LOEL = lowest observed effect level. POP. = population.

species	Body Weight (g)	Daily food Intake (g)	LD50 mg/kg	LD50 (mg of active ingredient)	LD50 (g of bait)	LD50 secondary (g of fish)
Wedge-tailed shearwater	340	65	0.26	0.09	3.6	75.9
Buller's Petrel	100	24	0.26	0.03	1.0	21.1
Red-footed Booby	975	103	0.26	0.25	10	210
Brown Booby	1340	141	0.26	0.35	13.9	293
Black Noddy	130	29	0.26	0.03	1.1	24.2
Black-footed Albatross	1950	198	0.26	0.51	20	422
Laysan Albatross	2000	203	0.26	0.52	21	443
Red-tailed tropicbird	660	87	0.26	0.17	6.9	145

LD50 based on lowest reported avian toxicity (Erickson and Urban 2004) 0.26mg/kg body weight in Mallards.

Fish contamination based on highest reported values (Pitt et al. 2015). 1.16mg/kg
Population data from annual surveys (Pacific Rims, http://kauaiseabirdproject.org/index.php/the-birds/other-seabirds/ and http://dlnr.hawaii.gov/wildlife/hswap/cwcs/hawaii/species/fact-sheets/)
Daily food intake calculated from allometric equation (Bird Feeding Rate = 0.059 x (W)0.67) (US EPA 40 CFR Ch. App D. Great Lakes Water Quality Initiative. Methodology for Development of Wildlife Criteria. 1995).

The only seabirds that would potentially be affected by the operation through exposure to rodenticide are ground breeding nestlings of red-tailed tropicbirds and chicks of the two species of albatross through primary exposure (pica). There are no secondary exposure pathways of concern.

Red-tailed tropicbirds: An estimated 400 individuals have been recorded (based on survey high counts) and 200 was the maximum number of active nests recorded (2002 survey). A red-tailed tropicbird chick of 660 g body weight would have to ingest 1,278g of bait containing diphacinone or 6.9g of bait containing brodifacoum to receive a lethal dose. There will not be enough bait available on the ground within a 2-foot radius for any chicks to ingest a lethal dose at the maximum application rate of 30kg/ha. Tropicbird chicks do not leave the nest before fledging. It is possible that chicks could ingest a sub lethal dose that would cause a temporary reduction in blood clotting efficiency, but chicks would be expected to recover within a few days. To receive a sublethal dose of diphacinone, that same bird would need to eat about 0.07g of bait, which is less than one pellet. Corresponding values for brodifacoum have not been determined in the literature. It is not expected that the operation will cause mortality of red-tailed tropicbird chicks.

Black-footed albatross: 32 individuals have been recorded on Lehua (based on survey high counts) and a maximum of 28 actives nest was recorded in 2003. A black-footed albatross chick of 1950g body weight would have to ingest 3744g of bait containing diphacinone or 20g of bait containing brodifacoum to receive a lethal dose. There will not be enough bait available on the ground within 3 feet surrounding individual nests for chicks to ingest a lethal dose at the maximum application rate of 30Kg/ha. It is possible that a few chicks on inaccessible nests could ingest the pellets in the vicinity of their nest. To receive a sublethal dose of diphacinone, an albatross chick would need to eat about 0.215g of a pellet. Corresponding value for brodifacoum has not been determined in the literature. It is anticipated that albatross chicks on nests that are not accessible for field staff to remove nearby bait pellets will ingest the bait. Chicks consuming either diphacinone or brodifacoum will experience reduced blood clotting ability, but will recover within a few days. It is not expected that the operation will result in the death of any black-footed albatross chicks.

Laysan albatross: 50 individuals have been recorded on Lehua (based on survey high counts) and a maximum of 11 nests were recorded in 2003. A Laysan albatross chick of 2000g would have to ingest 3840g of bait containing diphacinone or 21 g of bait (11 bait pellets) containing brodifacoum to receive a lethal dose. There will not be enough bait available on the ground around an individual nest for any chicks to ingest a lethal dose, but it is possible that chicks on nests inaccessible to monitoring personnel could have access to as many as 4-6 pellets in the 28 square feet surrounding a nest. To receive a sublethal dose of diphacinone an albatross chick would need to eat about 25% of a pellet. The corresponding value for brodifacoum has not been determined in the literature. It is anticipated that albatross chicks on nests that are not accessible for field staff to remove nearby bait pellets will ingest the bait. Chicks consuming either diphacinone or brodifacoum will experience reduced blood clotting ability, but will recover within a few days. It is not expected that the operation will result in the death of any Laysan albatross chicks.

Wedge-tailed shearwater: ground-based personnel may accidentally step on and collapse an unknown number of burrows. There are an estimated 23,000 wedge-tailed shearwater nests on

Lehua Island. It is not expected that accidental burrow collapses will have population level effects.

Mitigation - *Seabirds*

Based on observations by Wood et al. (2004) and VanderWerf et al. (2007) virtually all juvenile albatrosses have left Lehua Island by the end of July. To mitigate potential impacts to albatrosses, the operation will be conducted in the summer months after most chicks have fledged. Additionally, all known active albatross and red-tailed tropicbird nests will be mapped and special attention will be given to remove bait pellets near any active nests, when it does not pose an undue risk to the safety of personnel.

Ground-based personnel will be instructed to avoid walking over known active shearwater burrows. If active burrows are accidently collapsed by personnel, every effort will be made to re-open the nest entrance.

Primary exposure - Shorebirds

Shorebirds documented on Lehua include Pacific Golden Plover (Kolea), Ruddy Turnstone, and Wandering Tattler, which are common winter visitors throughout the Hawaiian Islands. During the proposed bait application period in the summer season, the vast majority of these birds would be on their nesting territories on the mainland and would not be present on Lehua. However, given bait degradation rates, there is a risk that bait could still be available to shorebirds arriving on Lehua after the operation is completed.

All species of shorebirds are at risk of primary and secondary exposure and could potentially consume bait pellets, if present during the operation and or residues are available in the foodweb on Lehua. No shorebirds could ingest a quantity of bait to cause a lethal dose of diphacinone (double their body weight), but could suffer temporary reduction in blood clotting ability.

Shorebirds have been confirmed to be attracted to and consume bait pellets after aerial broadcast. For example, on Palmyra Atoll, primary poisoning of shorebirds was confirmed after bait with brodifacoum was applied to eradicate rats (Pitt et al. 2015).

Secondary exposure – Shorebirds

If present on Lehua at the time of the operation, the two species of shorebird could be at risk of exposure to rodenticide through secondary exposure.

There have been reported incidents of avian mortality due to secondary exposure to Brodifacoum after eating ants and cockroaches (Godfrey, 1985) and other invertebrates exposed to brodifacoum (Pitt et al., 2015). During the inert bait trial of 2015, ants and cockroaches were reported to interact and consume inert bait (Island Conservation, Lehua inert bait trial final report, 2015), creating a potential secondary exposure route to shorebirds.

Operational Hazard - Shorebirds

Shorebirds may be at risk of disturbance from ground crews working on the island, and helicopter overflights. However, the effects of disturbance are believed to be inconsequential, as birds will fly to another part of the island where no disturbance will take place, or to either Niihau or Kauai.

Effect analysis diphacinone - Shorebirds

Table 4.3: toxicicity of diphacinone bait product and contaminated invertebrates to shorebirds of Lehua. LD50 = lethal dose. LOEL = lowest observed effect level. POP. = population.

Species	Body weight (g)	Daily food intake (g)	LD50 (mg of active Ingredient)	LD50 Primary (g of bait)	LD50 secondary (g of cockroach prey)
Kolea	110	22	10.6	212	3607
Ruddy Turnstone	130	23	12.6	252	4262
Wandering Tattler	120	22	11.6	232	3934

Species	LOEL primary (mg of active ingredient)	LOEL Primary (g of bait)	LOEL Secondary (g of cockroach prey)	Max. Summer Pop.	Main Hawaiian Islands pop.	Global pop.
Kolea	0.012	0.24	4.1	2	74,000	190-250,000
Ruddy Turnstone	0.014	0.29	4.8	8	512	455,000
Wandering Tattler	0.013	0.26	4.5	2	81	10,000-25,000

LD50 based on lowest reported avian toxicity (Ratner et al 2011). 96.8mg/kg in Am. Kestrels.
Cockroaches contamination baed on highest recorded values (Pitt et al 2015). 3.05 mg/kg
Population data from annual surveys (Pacific Rims, http://kauaiseabirdproject.org/index.php/the-birds/other-seabirds/ and http://dlnr.hawaii.gov/wildlife/hswap/cwcs/hawaii/species/fact-sheets/)
Daily food intake calculated from allometric equation (Bird Feeding Rate = 0.059 x (W)0.67) (US EPA 40 CFR Ch. App D. Great Lakes Water Quality Initiative. Methodology for Development of Wildlife Criteria. 1995).

Effect analysis brodifacoum

Table x: toxicicity of brodifacoum bait product and contaminated invertebrates to shorebirds of Lehua. LD50 = lethal dose. LOEL = lowest observed effect level. POP. = population.

Species	Body weight (g)	Daily food intake	LD50 (mg of active Ingredient)	LD50 Primary (g of bait)	LD50 secondary (g of cockroach prey)	Max. summer pop.	Main Hawaiian Islands pop.	Global pop.
Kolea	110	22	0.029	0.24	1.2	2	74,000	190-250,000
Ruddy Turnstone	130	23	0.034	0.28	1.4	8	512	455,000
Wandering Tattler	120	22	0.031	0.24	1.2	2	81	10,000-25,000

LD50 based on lowest reported avian toxicity (Erickson and Urban 2004).
Cockroaches contamination baed on highest recorded values (Pitt et al 2015).
Population data from annual surveys (Pacific Rims, http://kauaiseabirdproject.org/index.php/the-birds/other-seabirds/ and http://dlnr.hawaii.gov/wildlife/hswap/cwcs/hawaii/species/fact-sheets/)
Daily food intake calculated from allometric equation (Bird Feeding Rate = 0.059 x (W)0.67) (US EPA 40 CFR Ch. App D. Great Lakes Water Quality Initiative. Methodology for Development of Wildlife Criteria. 1995).

The three species of shorebirds would potentially be affected by the operation through exposure to rodenticide if present on Lehua Island during the operation or shortly after the last bait application.

Shorebirds are presented as winter visitors on Lehua Island in small numbers. The maximum number recorded during bird surveys was two Kolea, eight ruddy turnstones and two wandering tattlers. These species are normally not present on Lehua in summer months. Because of their omnivorous diet, all these species are potentially at risk from both primary and secondary poisoning; however, consumption of invertebrates that have fed on rodenticide pellets poses the greatest risk to these birds. It is likely that the Kolea will be attracted to invertebrates feeding on the bait pellets. The amount of insects ingested to cause mortality from diphacinone is calculated at 3607g, which is impossible for a bird with a daily food consumption of only 22 g. The secondary toxicity from brodifacoum, however, is probable, with consumption of only 1.2g of insects resulting in the median lethal dose. Therefore, it is possible that up to two Kolea, eight Ruddy Turnstones and two wandering tattlers could be killed by the proposed project. It is not expected that this would pose a risk to any of the species at the Hawaiian population level.

<u>Mitigation</u> - *Shorebirds*

The operation will be conducted in the summer when migratory shorebirds are unlikely to be present on Lehua. The pellets will be dyed a green color that birds are less attracted to (Day and Matthews 1999; Hartley et al., 1999; Oppel et al. 2016) to mitigate the potential for primary exposure.

<u>Primary exposure – Terrestrial Birds</u>

Terrestrial birds (or landbirds) are defined here as the small, non-native columbiform and passerine birds observed on Lehua, including rock and zebra doves, house finches and scaly-breasted munia (previously called nutmeg manikin) (Wood *et al*., 2004). These birds have been introduced to the United States from foreign countries, and with the exception of the house finch, are exempted from protection under the Migratory Bird Treaty Act (MBTA) by the state Hawaii injurious wildlife list. House finches are protected under MBTA and an Incidental Take Permit will be requested for this species.

Only one species of terrestrial bird is expected to be present in relatively large numbers (maximum of 34 recorded) on Lehua during the summer months when the operation will take place, the scaly-breasted munia (previously called nutmeg manikin) which is a seed eater (Hawai`i Audubon Society 1993). These birds forage on land and could potentially consume bait pellets and fragments on the ground. Rodenticide bait pellets will be comprised of natural cereal grains and other human grade food items that could attract seed-eaters. House sparrows (*Passer domesticus*) have been observed to eat bait pellets containing rodenticide from bait stations (Elliot et al., 2013). Mixed flocks of terrestrial birds are often observed on Lehua, and house finches and ring-necked doves could be present in small numbers.

Secondary exposure – Terrestrial Birds

The scaly-breasted munia feeds exclusively on plants, mainly on seeds but are also known to eat small berries and algae. Plants have not been documented to absorb and store rodenticides and therefore there is not a possible secondary exposure pathway for this species. House finches and scaly-breasted munia may consume terrestrial invertebrates, and could be at risk for secondary exposure.

Operational Hazard - Terrestrial Birds

There is no foreseen operational hazard to terrestrial birds.

Effect Analysis Diphacinone

Table 4.4: toxicicity of diphacinone bait product and contaminated invertebrates to terrestrial birds of Lehua. LD50 = lethal dose. LOEL = lowest observed effect level. POP. = population.

species	Body weight (g)	Daily food intake (g)	LD50 mg/kg	LD50 (mg of active ingredient)	LD50 (g of bait)	LD50 (g of cockroach prey)	LOEL Primary (g of bait)	LOEL Secondary (g of cockroach prey)	Lehua population
Scaly breasted munia	9.5	2.0	400	3.8	76	1085	0.44	7.2	34

Ring-necked dove	175	26	400	70	1440	20000	8.12	133	45
House finch	21	4.4	400	8.4	168	2400	0.97	15.9	3

LD50 based on lowest reported avian toxicity (Ratner et al 2011). 96.8mg/kg Am. kestrel
Cockroaches contamination baed on highest recorded values (Pitt et al 2015). 3.05mg/kg
Population data from annual surveys (Pacific Rims, http://kauaiseabirdproject.org/index.php/the-birds/other-seabirds/ and http://dlnr.hawaii.gov/wildlife/hswap/cwcs/hawaii/species/fact-sheets/)
Daily food intake calculated from allometric equation (Bird Feeding Rate = 0.059 x (W)0.67) (US EPA 40 CFR Ch. App D. Great Lakes Water Quality Initiative. Methodology for Development of Wildlife Criteria. 1995).

Effect analysis brodifacoum - Terrestrial Birds

Table 4.5: toxicicity of brodifacoum bait product and contaminated invertebrates to terrestrial birds of Lehua. LD50 = lethal dose. LOEL = lowest observed effect level. POP. = population.

species	Body weight (g)	Daily food intake (g)	LD50 mg/kg	LD50 (mg of active ingredient)	LD50 primary (g of bait)	LD50 Secondary (g of cockroach prey)	Lehua pop.
Scaly breasted munia	9.5	2	0.26	0.00247	0.098	0.70	34
Ring-necked dove	175	26	0.26	0.045	1.84	17.1	45
House finch	21	4.4	0.26	0.0055	0.22	1.57	3

LD50 based on lowest reported avian toxicity (Erickson and Urban 2004).
Cockroaches contamination baed on highest recorded values (Pitt et al 2015).
Population data from annual surveys (Pacific Rims, http://kauaiseabirdproject.org/index.php/the-birds/other-seabirds/ and http://dlnr.hawaii.gov/wildlife/hswap/cwcs/hawaii/species/fact-sheets/)
Daily food intake calculated from allometric equation (Bird Feeding Rate = 0.059 x (W)0.67) (US EPA 40 CFR Ch. App D. Great Lakes Water Quality Initiative. Methodology for Development of Wildlife Criteria. 1995).

Scaly-breasted munia, house finch, and ring-necked dove: It is likely that incidental impacts to scaly-breasted munia, house finches, and ring-necked dove would result from the proposed action. Both species are consistently observed on Lehua Island and their diets make it likely they would ingest rodenticide. Both species primarily eat vegetation, much of their diet consisting of seeds (Badyaev et al. 2012); hence, they would likely eat the grain-based bait. A 21 g house finch would need to eat about 8 times its body weight of diphacinone bait pellets over multiple days (e.g. 5 days) to ingest a lethal dose, based on data presented above. To receive a sublethal dose, that same bird would need to eat about 4% of a pellet. The corresponding sublethal dose value for brodifacoum has not been determined in the literature. It is likely that all birds would have access to enough brodifacoum bait to receive a lethal dose of and an unknown number of birds could be killed or sublethally affected by the proposed project if brodifacoum is required after a failure of diphacinone to eradicate the rats. In the worst case scenario, the maximum number of birds present on Lehua Island (34 scaly-breasted munia, 45 house finches, and 3 ring-necked doves respectively) and all have access to a lethal doses of brodifacoum, the operation in not likely to lead to population level effects.

<u>Mitigation</u> - *Terrestrial Birds*

Bait pellets will be dyed a green color that birds are known to avoid (Day and Matthews 1999; Hartley et al., 1999; Oppel et al. 2016). To further reduce the risk of primary exposure, the bait will be formulated into a bait pellets large enough that it would be difficult for a small, seed-eating bird to consume the whole pellet.

<u>*Primary exposure – Birds of Prey*</u>

Birds of prey on Lehua include non-native barn owls and cattle egrets. These birds feed mainly on live prey and would not likely be attracted to bait pellets on the ground.

<u>*Secondary exposure – Birds of Prey*</u>

Barn owls feed on live animals, including rats, and are also known to scavenge carcasses. Therefore, a clear pathway for secondary exposure to rodenticide exists for this species. Likewise, cattle egrets eat a wide range of small prey items that are likely to include small rodents.

Based on data on American kestrels (*Falco sparverius*), birds of prey are the most sensitive species to diphacinone (*Rattner et al., 2011*). The oral acute toxicity of diphacinone to American kestrels (96.8mg/kg) was reported to be 20 times greater than that found for Northern bobwhite (*Colinus virginianus*) (>400mg/kg) and mallards (*Anas platyrhynchos*) (C50 of 906mg/kg).
Brodifacoum is highly toxic to birds of prey. On Rat Island, bald eagles (*Haliaeetus leucocephalus*) were among the recovered bird carcasses that contained brodifacoum residues (Ebbert & Burek-Huntington, 2010).

Additionally, ferruginous hawks (*Buteo regalis*) were reported to preferentially forage on areas treated with a rodenticide (Chlorophacinone) in order to have access to easier prey (Vyas et al., 2015) and avian predators scavenging on carcasses following eradications have been documented (Eason et al. 2002; Eason and Spurr 1995) indicating that birds of prey behavior may play an important role for secondary exposure.

Operational Hazard – Birds of Prey

There is no foreseen operational hazard to birds of prey.

Effect Analysis Diphacinone – Birds of Prey

Table 4.6: toxicicity of diphacinone bait product and contaminated rats to birds of prey of Lehua. LD50 = lethal dose. LOEL = lowest observed effect level. POP. = population.

species	Body weight (g)	Daily food intake (g)	LD50 mg/kg	LD50 (mg of active ingredient)	LD50 primary (g of bait)	LD50 secondary (g of rat liver)	LOEL (mg of active ingredient)	LOEL primary (g of bait)	LOEL Secondary (g of rat liver)
Barn Owl	530	80	96.8	51.3	1,026	1,768	0.058	1.16	0.10
Cattle Egret	370	56	96.8	35.8	716	1,234	0.041	0.82	0.071

LD50 based on lowest reported avian toxicity (Erickson and Urban 2004)
Rats contamination based on residues in liver from carcasses (Pitt et al 2015).
Population data from annual surveys (Pacific Rims, http://kauaiseabirdproject.org/index.php/the-birds/other-seabirds/ and http://dlnr.hawaii.gov/wildlife/hswap/cwcs/hawaii/species/fact-sheets/)
Daily food intake calculated from allometric equation (Bird Feeding Rate = 0.059 x (W)0.67) (US EPA 40 CFR Ch. App D. Great Lakes Water Quality Initiative. Methodology for Development of Wildlife Criteria. 1995).

Effect analysis brodifacoum – Birds of Prey

Table 4.7: toxicicity of brodifacoum bait product and contaminated rats to birds of prey of Lehua. LD50 = lethal dose. LOEL = lowest observed effect level. POP. = population.

Species	Body weight (g)	Daily food intake (g)	LD50 mg/kg	LD50 (mg of active ingredient)	LD50 Primary (g of bait)	LD50 Secondary (g of rat liver)
Barn Owl	530	80	0.26	51.3	5.52	4.75
Cattle Egret	370	56	0.26	35.8	3.84	3.31

LD50 based on lowest reported avian toxicity (Erickson and Urban 2004).
Rats contamination based on residues in liver from carcasses (Pitt et al 2015).
Population data from annual surveys (Pacific Rims, http://kauaiseabirdproject.org/index.php/the-birds/other-seabirds/ and http://dlnr.hawaii.gov/wildlife/hswap/cwcs/hawaii/species/fact-sheets/)
Daily food intake calculated from allometric equation (Bird Feeding Rate = 0.059 x (W)0.67) (US EPA 40 CFR Ch. App D. Great Lakes Water Quality Initiative. Methodology for Development of Wildlife Criteria. 1995).

Barn owl: a small number of barn owls persist on Lehua Island. The maximum number of individuals recorded during bird survey was two. Because they feed on live prey, including rats, these birds are at very high risk for secondary poisoning by brodifacoum or diphaicone. A barn owl would need to ingest more than 20 times its normal daily food consumption to receive a lethal dose of diphacinone at the measured concentration of rodenticide in livers of rats from Palmyra Atoll. The calculation of 1,768g of contaminated Pacific rat liver tissue to ingest a lethal dose of diphacinone would be very unlikely. If brodifacoum were needed to be used, he risk to owls and cattle egrets is much greater. A single feeding of 4.75g of contaminated rat liver would be a lethal dose for brodifacoum. Birds consuming sublethal doses of either diphacinone or brodifacoum will experience reduced blood clotting ability, but will recover within a few days.

Cattle egret: approximately 90 individuals have been recorded by bird surveys on Lehua. Cattle egrets may feed on live or dead Pacific rats and are at high risk for secondary poisoning by rodenticides. A cattle egret would need to ingest 1,234g of contaminated rat liver tissue to ingest a lethal dose of diphacinone and 3.31g for brodifacoum. The lethal risk from diphacinone is quite low, while brodifacoum poses a much greater risk, and will likely result in take of egrets if they are present and forage on the island during the risk window. Birds consuming sublethal doses of either diphacinone or brodifacoum will experience reduced blood clotting ability, but will recover within a few days.

Mitigation – *Birds of Prey*

Both the barn owl and the cattle egret are invasive species in Hawai`i and are included in sate control programs and regularly controlled on Lehua as part of this statewide effort to manage this invasive speces. Ongoing, planned hunting and removal would continue up until the bait application. No additional mitigation would be implemented.

Potential Impacts to Hawaiian Monk Seals

Hawaiian monk seals (*Monachus schauninslandi*) are a Federally-listed endangered species endemic to the Hawaiian Archipelago. The population is declining and only about 1,100 animals remain. The most serious threats to the population are food limitation, entanglement in fishing gear, and shark predation. The majority of seals are found in the northwestern Hawaiian Islands but small resident populations are present in the main Hawaiian Islands, including around Ni`ihau (NMFS 2007). They are potentially present around Lehua throughout the year and are often seen hauled out on Lehua's rocky ledges.

Since diphacinone and brodifacoum are highly insoluble in water, monk seals will not be exposed to sufficient harmful amounts of rodenticide dissolved in the water column that could be absorbed through the skin. The potential pathways for contamination of monk seals evaluated below are through primary exposure (direct feeding on bait pellets) and secondary exposure (feeding on contaminated prey items).

Primary exposure – monk seals

Hawaiian monk seals forage at sea in offshore areas and sometimes at depths of up to 500 meters in coral beds (NMFS 2007). They sometimes spend days at sea before returning to the islands where they sleep and digest their food. Spiny lobster, eels, flatfish, scorpaenids, larval fishes and octopus are the most commonly consumed prey. They do not forage on land, and therefore direct consumption of bait pellets from the ground is not a viable primary exposure pathway on land. Bait pellets that drift into the water would fall close to the shoreline far from the typical foraging area of monk seals. Moreover, bait pellets degrade quickly in water and fragments sink to the bottom, so would only be available to monk seals for a very short period of time.

Secondary exposure – monk seal

Fish and marine invertebrates are not likely to be contaminated by diphacinone as described in previous sections and therefore would not be an important pathway for secondary exposure of monk seals to this rodenticide.

Data collected after the rat eradication on Palmyra Atoll, demonstrated that the a marine lagoon environment may experience a higher risk for brodifacoum exposure than previously assumed since all samples of mullet fish collected dead after bait broadcast contained brodifacoum residues (Pitt et al., 2015). There is no reef surrounding Lehua Island and no lagoon, minimizing the potential for fish to consume spilled bait. Since fishes are a common prey item to monk seals, there is a theoretical risk of brodifacoum moving through the marine food web, but the potential is very low. Calculations of risk have been made based on the residues in fish after the Palmyra rat eradication, and these pose a very conservative assessment of possible risk.

The consequences of any exposure to monk seals is insignificant. There have been no known documented cases of marine mammals (seals and sea lions) after aerial bait application. There were no known impacts to Monk Seals after the 2009 bait application on Lehua Island. There is no evidence to suggest additional or any mitigation is necessary.

Operational Hazard

Bait application will be done through aerial broadcast of bait pellets using helicopters, minimizing the need for ground-based personnel. However, a monitoring team will be staged on Lehua island and will conduct periodical checks on the amount of bait available on the ground, as well as interactions of non-target species with the bait and environmental consequences. Both the helicopter and ground-based team could cause temporary disturbance to monk seals present during the operation.

Effect Analysis Diphacinone

Table 4.8: toxicicity of diphacinone bait product and contaminated fish to monk seals. LD50 = lethal dose. LOEL = lowest observed effect level. POP. = population.

Species	Body weight (Kg)	Daily food intake (g)	LD50 mg/kg	LD50 (mg of active ingredient)	LD50 Primary (g of bait)	LD50 secondary (g of fish)
Monk seal (juvenile)	100	9400	0.6	60	240	10344

LD50 based on value reported for coyotes (Erickson and Urban 2004) (0.6mg/kg body weight)
Fish contamination based on highest reported values (Pitt et al. 2015).
Daily food intake calculated from allometric equation (Bird Feeding Rate = 0.059 x (W)0.67) (US EPA 40 CFR Ch. App D. Great Lakes Water Quality Initiative. Methodology for Development of Wildlife Criteria. 1995).

Effect Analysis Brodifacoum

Table 4.9: toxicicity of brodifacoum bait product and contaminated fish to monk seals. LD50 = lethal dose. LOEL = lowest observed effect level. POP. = population.

Species	Body weight (Kg)	Daily food intake (g)	LD50 mg/kg	LD50 (mg of active ingredient)	LD50 primary (g of bait)	LD50 secondary (g of fish)
Monk seal (juvenile)	100	9400	0.25	25	960	41379

LD50 based on value reported for dogs (0.25mg/kg body weight)
Fish contamination based on highest reported values (Pitt et al. 2015).
Daily food intake calculated from allometric equation (Bird Feeding Rate = 0.059 x (W)0.67) (US EPA 40 CFR Ch. App D. Great Lakes Water Quality Initiative. Methodology for Development of Wildlife Criteria. 1995).

The risk assessment for monk seals uses the highest toxicity values for any mammal, because the sensitivity of monk seals has never been measured. It is unknown whether seals are as sensitive as dogs to anticoagulant rodenticides. Additionally, the concentration of residues in fish tissue are the highest ever recorded (Pitt et al. 2015), to make the risk assessment highly conservative. It is extremely unlikely that any fish could ingest enough spilled bait at Lehua to approach the levels modeled in this assessment. Additionally, a seal would have to eat 10-40 kg (22-88 lbs) of fish to receive the calculated doses.

Monk seals would only be at risk of secondary exposure to either diphacinone or brodifacoum in the unlikely event that a very large quantity of bait were accidently dropped into the ocean, and fish were able to consume it before ocean currents dissipated it. .

Mitigation

Every reasonable effort will be made to minimize the risk of bait drift into the water. Possible mechanisms for rodenticide to reach the ocean include pellets bouncing off or rolling down steep slopes, being blown off course by high winds, or being washed into the ocean by heavy rains before they are eaten by rats. To minimize bait being applied directly into the water, the hopper would be fitted with a deflector that spreads bait out to only one side, in an approximately 120-degree pattern. The last two potential pathways will be minimized by not applying bait pellets in high winds (greater than 35 mph) or when heavy rains are forecast.

All project personnel on the ground will maintain a 100 ft buffer from seals during operations. During aerial bait broadcast, helicopters will not hover near seals, and will avoid distributing pellets over seals on the shore. Helicopter activity over any point on the island would be brief as the flight speed would be greater than 35 knots.

Potential Impacts to Sea Turtles

The green sea turtle (*Chelonia mydas*) is a federally-listed threatened species, found in tropical and sub-tropical oceans. Approximately 90% of the Hawai`i's green sea turtle population nests at French Frigate Shoals (NMFS and USFWS 1998). A small number of turtles nest in the main Hawaiian Islands but no nesting has been recorded on Lehua, where the absence of any sandy shores makes nesting impossible for this species. Green sea turtles are uncommon and rare but sometimes use the waters around Lehua.

Primary exposure – sea turtles

Adult green sea turtles are obligate herbivores and feed on a variety of seaweeds and seagrasses (NMFS and USFWS 1998). However, sea turtles have been reported to feed on marine debris in several places (Carr 1987; Meylan 1988; Bjorndal et al., 1994; Coyne 1994; Bugoni et al., 2001) and could potentially consume bait pellets and fragments before it disintegrates in the water. Bait pellets that drift into the water will degrade quickly in water and would only be available to green sea turtles for a very short period of time.

No mortality of herpetofauna associated with the use of diphacinone has been recorded to date. Brodifacoum has been linked to mortality of terrestrial reptiles. Telfair's skinks (*Leiolopisma telfairii*) were found dead after eating 20 ppm brodifacoum bait used for eradication in New Zealand, and post-mortem analyses detected brodifacoum residues in tissue samples. Weir et al (2015) found that fence lizards (*Sceloporus occidentalis)* were extremely insensitive to both diphacinone and brodifacoum and none were killed at the highest dose administered of 1750mg/kg. Weir et al (2015) is the only quantitative data found on reptiles and has been used here to assess risk to turtles and skinks at Lehua.

Secondary exposure – green sea turtles

Green sea turtles forage in nearshore seagrass meadows within bays, lagoons and shoals. Adult green sea turtles feed exclusively on various species of seagrass and seaweed. They have also been observed grazing on various species of macroalgae, specifically *Caulerpa*, *Turbinaria*, *Spyridia*, *Codium*, and *Ulva*. Plants have not been documented to absorb and store rodenticides and therefore there is no possible secondary exposure pathway for this species

Operational Hazard

There is no foreseen operational hazard to sea turtles.

Effect analysis diphacinone

Table 4.10: toxicicity of diphacinone bait product and contaminated fish to seaturtles. LD50 = lethal dose. LOEL = lowest observed effect level. POP. = population.

Species	Body weight (Kg)	Daily food intake (g)	LD50 mg/kg	LD50 (mg of active ingredient)	LD50 Primary (g of bait)	LD50 secondary (g of fish)
Green sea turtle (juvenile)	15	450	1750	26250	525,000*	---

LD50 based on value reported for lizards (Weir et al 2015). .1750mg/kg body weight
Daily food intake calculated from allometric equation USEPA 2008. T-HERPS Version 1.0 User's Guide for Risk to Amphibians and Reptiles from Pesticides. Terrestrial Herpetofaunal Exposure Residue Program Simulation. Environmental Fate and Effects Division, Office of Pesticide Programs

Effect analysis brodifacoum

Table 4.11: toxicicity of brodifacoum bait product and contaminated fish to seaturtles. LD50 = lethal dose.

Species	Body weight (Kg)	Daily food intake (g)	LD50 mg/kg	LD50 (mg of active ingredient)	LD50 Primary (g of bait)	LD50 secondary (g of fish)
Green sea turtle (juvenile)	15	450	1750	26250	525,000*	---

LD50 based on value reported for lizards (Weir et al 2015).
Daily food intake calculated from allometric equation

USEPA 2008. T-HERPS Version 1.0 User's Guide for Risk to Amphibians and Reptiles from Pesticides

Terrestrial Herpetofaunal Exposure Residue Program Simulation. Environmental Fate and Effects Division, Office of Pesticide ProgramsMitigation

Every reasonable effort will be made to minimize the risk of bait drift into the water. Possible mechanisms for rodenticide to reach the ocean include pellets bouncing off or rolling down steep slopes, being blown off course by high winds, or being washed into the ocean by heavy rains before they are eaten by rats. To minimize bait drift into the water, the hopper would be fitted with a deflector that spreads bait out to only one side, in an approximately 120-degree pattern. The last two potential pathways will be minimized by not applying bait pellets in high winds (greater than 35 mph) or when heavy rains are forecast.

Terrestrial Reptiles

Primary exposure – snake-eyed skink and house gecko

Both the snake-eyed skink and house gecko are insectivores and feeds on live prey. Bait pellets will likely not be attractive to these species.

Secondary exposure

These insectivorous reptiles may be exposed to the rodenticide by consuming contaminated insects. During the inert bait trial of 2015, ants and cockroaches were reported to interact and consume inert bait (Island Conservation, Lehua inert bait trial final report, 2015), highlighting a potential secondary exposure pathway to skinks.

No mortality of herpetofauna associated with the use of diphacinone has been recorded to date. Weir et al (2015) found lizards to be very insensitive to both diphacinone and brodifacoum, which would imply there would be little risk to skinks on Lehua. However, brodifacoum has been linked to mortality of terrestrial reptiles. Brodifacoum has been implicated in terrestrial reptile mortality following rat eradications. In New Zealand, skinks were found dead and rodenticide residues were detected in tissue samples after an application of brodifacoum (Eason and Spurr, 1995).

Available data on post eradication trends in reptile population show an increase in population size after rat eradications. In New Zealand Island, the populations of skinks and other reptiles rebounded to higher levels than prior to eradication due to the release in predation pressure by rats. On Anacapa Island in California, the survivorship of juvenile side-blotched Lizards (*Uta stansburiana*) doubled after the aerial application of bait containing brodifacoum to remove introduced rats (T. Comendant, *pers. comm.*), with no apparent negative impact to salamanders (*Batrachoseps pacificus*) or alligator lizards (*Elgaria multicarinata*) *(Witmer et al. 2007)*.

Operational Hazard

There is no foreseen operational hazard to terrestrial reptiles.

Effect analysis diphacinone

Table 4.12: toxicicity of diphacinone bait product and contaminated invertebrates to terrestrial reptiles. LD50 = lethal dose.

Species	Body weight (g)	Daily food intake (g)	LD50 mg/kg	LD50 (mg of active ingredient)	LD50 Primary (g of bait)	LD50 secondary (g of fish)
Snake-eyed skink	1.7-3.5	1	1750	4.4	88	3793

LD50 based on value reported for lizards (Weir et al 2015).
Cockroaches contamination baed on highest recorded values (Pitt et al 2015).
Daily food intake calculated from USEPA 2008. T-HERPS Version 1.0 User's Guide for Risk to Amphibians and Reptiles from Pesticides

Terrestrial Herpetofaunal Exposure Residue Program Simulation. Environmental Fate and Effects Division, Office of Pesticide Programs*Effect analysis brodifacoum*

Table 4.13: toxicicity of brodifacoum bait product and contaminated invertebrates to terrestrial reptiles. LD50 = lethal dose.

Species	Body weight (g)	Daily food intake (g)	LD50 mg/kg	LD50 (mg of active ingredient)	LD50 Primary (g of bait)	LD50 secondary (g of fish)
Snake-eyed skink	1.7-3.5	1	1750	4.4	88	3793

LD50 based on value reported for lizards (Weir et al 2015).
Cockroaches contamination baed on highest recorded values (Pitt et al 2015).
Daily food intake calculated from allometric equation

USEPA 2008. T-HERPS Version 1.0 User's Guide for Risk to Amphibians and Reptiles from Pesticides

Terrestrial Herpetofaunal Exposure Residue Program Simulation. Environmental Fate and Effects Division, Office of Pesticide Programs

Mitigation

No mitigation measure is proposed since these are invasive species to Lehua.

Terrestrial Invertebrates

Terrestrial invertebrates can accumulate anticoagulant rodenticide residues. Brodifacoum residues were detected in land crab and cockroach tissues collected after the brodifacoum broadcast on Palmyra Atoll (Pitt et al., 2015). However, studies have shown that brodifacoum is non-toxic to land crabs (Pain et al. 2000). No cockroaches were found dead on Palmyra Atoll after very high doses were applied during rat eradication.

Anticoagulant rodenticides, such as diphacinone and brodifacoum, are not known to affect terrestrial invertebrates, likely because of their blood clotting mechanisms are different from those of mammals (Shirer 1992). Extensive field and lab trials have shown that beetles (Morgan *et al*. 1996; Eason and Spurr 1995; Stejskal *et al*. 1994; Tershy *et al*. 1992), cockroaches (Godfrey 1985), crickets (Morgan *et al*. 1996, snails, slugs, orthopterans, millipedes (Howald 1997), and ants (Godfrey 1985; Tershy *unpub. data*) are attracted to rodent baits and can survive on a diet of 20-50 ppm brodifacoum, a more toxic anticoagulant rodenticide than diphacinone. Johnston *et al*. (in prep) fed diphacinone bait to gastropods over a period of seven days with no apparent toxicity, confirming that the anticoagulants, including diphacinone, are not toxic to invertebrates. The terrestrial invertebrates would likely play a role in the removal of residual bait that is not consumed by rats, but would not be affected by the rodenticide in this operation. However, they could create potential secondary exposure pathways to species that prey on them.

Operational Hazard

There is no foreseen operational hazard to terrestrial invertebrates.

<u>Mitigation</u>

No mitigation measure is proposed.

Endangered Native Plants

There are no established populations of endangered native plants on Lehua Island. However, the native plant restoration project conducted in 2007 and 2008 out planted several species to Lehua Island, one of which was the listed *Conavalia napaliensis*. Although all adult out planted *Conavalia napaliensis* died after the restoration attempt, National Tropical Botanical Gardens (NTBG) personnel have observed seeds and there is a possibility that this species could still exist in the seed bank of Lehua Island (*pers. comm.* Mike DaMotta). Aditionally, *Portulaca villosa* has been recorded on Lehua Island but has not been seen recently in any of the NTBG's surveys.

Plants have not been documented to absorb and store rodenticides and therefore are not at risk for poisoning. Ground-based operations may pose a small risk to *Conavalia napaliensis*, in case they sprout from the seedbank and are present on Lehua during the operation.

<u>Mitigation</u>
Prior to the beginning of the operation NTBG will perform a plant survey to identify the presence or absence of *Conavalia napaliensis*. In case they are present, the site will be marked and all ground-personnel will be instructed to avoid contact with these plants.

Indirect effect of Rat Removal: Increase in Weed Abundance

Rat Eradication

An increase in the number and diversity of native plants growing on Lehua is expected as a direct impact of rat removal. An additional impact, however, could be an increase in abundance and growth of non-native plants and weeds. The nature of the changes to the vegetation composition may be complex. Although it is not clear what plants rats prefer, the weed response may be a detriment to the productivity of native plant species (Eijzenga 2011).

Mitigation

Both DOFAW and USFWS and other non-governmental organizations within the State of Hawai`i have a well-established infrastructure and policies for plant monitoring and response to newly introduced species and control of established weeds for the protection of native ecosystems. DOFAW and USFWS have established a monitoring program for Lehua and would implement a weed control program, as necessary, for the benefit of the native ecosystem. The implementation of the weed management program would be implemented under the current programs and policies of the DOFAW and USFWS, subject to availability of funds. All personale visiting or working on Lehua will also adhere to the Lehua Island Protocols and Procedures (LIPP) to prevent new alien species from becoming established on Lehua (Appendix F)

Impacts on Cultural Resources

Rat Eradication

As mentioned above, the number and distribution of sites of archeological significance have been mapped and documented (Yent and Carpenter 2009), so project operations would be planned to avoid cultural sites. Aerial broadcast of bait pellets would have no impact on cultural sites, due to the small size (about 2g each) of the bait pellets. It is an important goal of the project to avoid any negative impacts to cultural resources.

Mitigation

Prior to the operation, personnel will use the 2009 Archealogical Inventory Survey of Lehua Island to find and flag archaeological sites in the monitoring areas. All project personnel will be briefed and familiarized with the archealogical sites, and prohibited from walking on or disturbing any sites. All personale visiting or working on Lehua will also adhere to the Lehua LIPP regarding “Archeaological Site Avoidance” (Appendix F)

Impacts on Human Health and Safety

Rat Eradication

Rat eradication under this alternative would be carried out by aerial broadcast of grain-based bait pellets containing the anticoagulant diphacinone. In the event that eradication cannot be achieved with diphacinone, pellets containing the second-generation anticoagulant brodifacoum would be used. Any rodenticide application would be done in strict accordance with label directions and with EPA and Hawai`i Department of Agriculture regulations. Applications would be carried out under the supervision of a certified pesticide applicator.

Primary Exposure - Humans

It is not expected that the public would be directly exposed to the rodenticide pellets, unless they land on the island to intentionally seek out the bait on island and consume it. The bait application rate would be minimized to ensure that enough is available for all the rats on the island, but not so much that excess bait would be available. The bait would be in the environment for a short period of time before it is consumed by rats on the island or degraded. At the proposed application rate, pellets would be sparsely distributed and in such low density that it would be difficult to find enough pellets to warrant a concern.

Secondary exposure - humans

As previously discussed the likelihood of fish contamination by diphacinone is low. Brodifacoum residues were found in fish tissues collected after the eradication of rats from Palmyra atoll highlighting a potential risk of secondary exposure to this toxicant by human populations that consume contaminated fish. Studies on metabolic depletion of diphacinone and brodifacoum in fishj are being conducted by USGS Columbia Research Center and the data will inform about the necessity for any restrictions on food consumption post-eradication.

People periodically visit Lehua to harvest Opihi (limpets) in the intertidal zone. As discussed previously, there is a low probability of contamination of marine invertebrates by diphacinone. Brodifacoum residues were detected in marine invertebrate tissues collected after the rat eradication from Palmyra atoll, which indicates a potential pathway for secondary exposure.

Consequence of Exposure to Diphacinone

Diphacinone was first developed in 1952 by The Upjohn Company as a human pharmaceutical under the name Dipaxin (Correll *et al*. 1952). Like other anticoagulants, it was used to prevent and treat diseases associated with blood clots, such as deep-vein thrombosis, pulmonary embolism, stroke, and heart disease (The Upjohn Company 1976). Clinical trials demonstrated that it had a low incidence of side effects, and was easily counteracted with Vitamin K1 (Field *et al*. 1952, Duff *et al*. 1953, Pascale and Olwin 1953). The usual medical dosage of diphacinone was 20 to 30 milligrams the first day, followed by 10 to 15 mg the second day. The average maintenance dose was 3 to 5 mg daily (The Upjohn Company 1976). At 50 parts per million (ppm) of diphacinone, a person would need to consume 600g of bait to ingest a dose equivalent to 30 mg. Dipaxin remained a commonly prescribed medication in the U.S. until 1978, when it was discontinued for economic reasons (D. Welsh, Pharmacia Corp, *pers. comm*.).

The exposure to small amounts of diphacinone is considered to be a very low risk to humans. Diphacinone has been used quite commonly as an antithrombin medication, administered to human patients as a drug to 'thin' the blood preventing heart attacks and strokes. Diphacinone is a multi-dose drug and would require a person to be exposed to it daily to have therapeutic effect. Diphacinone overexposure is easily treated with the antidote Vitamin K1, a common and readily available vitamin. Studies have documented that workers who produce and handle brodifacoum, a more potent/toxic rodenticide, over a 9-month period did not show any signs of effects suggestive of significant exposure (ICI, in Taylor 1993).

Mitigation

Ground personnel will use safety equipment in accordance with bait product labels. Equipament will include, but are not restricted to, appropriate clothing, gloves and masks.

To minimize the risk for secondary exposure through consumption of contaminated fish, every reasonable effort will be made to minimize the risk of bait drift into the water. Possible mechanisms for rodenticide to reach the ocean include pellets bouncing off or rolling down steep slopes, being blown off course by high winds, or being washed into the ocean by heavy rains before they are eaten by rats. To minimize bait being applied directly into the water, the hopper would be fitted with a deflector that spreads bait out to only one side, in an approximately 120-degree pattern. The last two potential pathways will be minimized by not applying bait pellets in high winds (greater than 35 mph) or when heavy rains are forecast.

Consequence of Exposure to Brodifacoum

The exposure to small amounts of brodifacoum is considered to be a low risk to humans. There have been no reported human poisoning incidents with the field use of brodifacoum for the purpose of island rat eradication. A 70Kg adult would need to consume 350 pellets (2g each) to ingest a lethal dose of brodifacoum. For sublethal effects, LOEL is <1mg in an adult human. However, the antidote is Vitamin K administred for 30-90 days.

Mitigation

Ground personnel will use safety equipment in accordance with bait product labels. Equipament will include, but are not restricted to, appropriate clothing, gloves and masks.

To minimize the risk for secondary exposure through consumption of contaminated fish is to minimize risks of contamination from occurring in the first place, and confirm through monitoring. every reasonable effort would be made to minimize the risk of bait drift into the water. Possible mechanisms for rodenticide to reach the ocean include pellets bouncing off or rolling down steep slopes, being blown off course by high winds, or being washed into the ocean by heavy rains before they are eaten by rats. To minimize bait being applied directly into the water, the hopper would be fitted with a deflector that spreads bait out to only one side, in an approximately 120-degree pattern. The last two potential pathways will be minimized by not applying bait pellets in high winds (greater than 35 mph) or when heavy rains are forecast. In addition, outreach to the community, signage, and temporary closure of the island below the high tide line would be carried out. Monitoring of marine life will be conducted to confirm the presence or absence of brodifacoum residues.

Introduction of Non-Native Species

Rat Eradication

The action of moving people, equipment and supplies onto Lehua presents inherent risks of introducing non-native weeds, insects, rodents and other vertebrates to the island. Although the island has introduced insects (such as ants), plants and rats, the introduction of new species or individuals of the same species should be avoided at all possible costs to prevent the further degradation of the island ecosystem.

Mitigation

The DOFAW would take all reasonable steps to avoid the introduction of non-native species. The compressed grain pellets would be evaluated to ensure that no active seeds are embedded into the baits, which would result in the introduction of weed species. The bait used for the broadcast application would contain only inactive or baked grains to ensure that no active seeds are accidentally introduced onto the island. The bait application presents very little risk of weed seed introduction with basic mitigation and working cooperatively with the bait manufacturer.

The field crews and the equipment would also comply with the recommendations of the LIPP to ensure that non-native species are not inadvertently transported and introduced onto the island and respond to any such introductions should they happen.

Alternative 3 - Rat Eradication with Brodifacoum.

Restoration Efficacy

Rat Eradication

Under this alternative, brodifacoum would be the sole rodenticide used to eradicate Pacific rats from Lehua island. Brodifacoum is a second generation rodenticide and like other anticoagulants, brodifacoum disrupts the formation of blood-clotting factors. Death through internal hemorrhaging typically takes 3-10 days (Torr, 2002).

Brodifacoum has proven to be successful in over 226 eradications including all 14 eradications on islands greater than 500 ha. Specifically, brodifacoum has been the toxicant of choice in over 100 successful eradications of Pacific rats (DIISE). This has usually involved two aerial applications although eradication has been achieved with a single drop in at least two cases. Furthermore, brodifacoum has been used in a variety of climatic conditions including those similar to Lehua island.

Brodifacoum is highly toxic to rats in very small quantities, allowing a lethal dose to be consumed in a single feed, thus avoiding the consumption of sub-lethal doses and the associated risk of bait avoidance. Additionally, brodifacoum is a chronic toxicant, meaning that its action is delayed so that rodents do not associate any illness with the bait that was consumed.

Pacific rats are known to be highly susceptible to brodifacoum, and the simplified logistics for the use of this toxicant given its acute toxicity and therefore the need for fewer applications (likely 2) and less time of bait availability on the ground, would maximize cost-effectiveness for the operation.

Brodifacoum is highly insoluble in waters, and its propensity to bind to soil particles prevents its leaching into the substrate on which it is spread. Consequently, contamination of waterways and runoff into the marine environment are negligible, and it is less likely than other poisons to accumulate in either aquatic systems or plant material (Toxikos 2010); Ogilvie *et al*. 1997). Furthermore, the half-life of brodifacoum in the soil is reasonable short (12-25 weeks) depending on soil type and conditions.

The effects of brodifacoum to non-target species are well understood enabling planning to mitigate or minimize non-target impacts.

Based on the success with the use of brodifacoum to eradicate rodents from islands, including Pacific rats, the likelihood of a successful eradication on Lehua island using this toxicant is very high.

See previous section for information on the potential impacts of brodifacoum to non-target species, human health and safety.

Cumulative Impacts

The NEPA regulations (40 CRF Sec. 1508.7) require federal agencies to consider cumulative impact of their actions. The regulations define cumulative effects as:

"…the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time"

The Council of Environmental Quality Handbook, *Considering Cumulative Effects Under the National Environmental Policy Act* (CEQ 1997), recommends focusing on each *affected* resource, ecosystem, and human community when completing cumulative effects analyses. Therefore, this cumulative effects analysis will focus on the cumulative effects of the

Alternatives to shorebirds, terrestrial birds, birds of prey, and terrestrial reptiles since these are the nn-target species at risk from the proposed action.

The operation will be conducted on Lehua Island, and the affected environment does not extend beyond the boundaries of the island. The following is a summary of the past, present, and reasonable foreseeable future actions within land ownership that could contribute to cumulative impacts associated with the Alternatives. Direct and indirect impacts from the alternatives will be analyzed with the following list of activities to determine the cumulative impacts for a given alternative.

Past, Present, and Reasonably Foreseeable Future Actions

Past:

- An operation to eradicate the invasive rabbits was performed on Lehua in 2005 and 2006. Rabbits were removed by hunting and trapping. Because this operation did not use toxicants, cumulative effects of this previous operation and the proposed Pacific rat eradication are not expected.
- An attempt to eradicate Pacific rats with aerial broadcast of diphacinone 50ppm was conducted on Lehua Island in 2009. Given the short half-life of diphacinone in soil (30-60 days) cumulative effects of the previous attempt and the proposed Pacific rat eradication are not expected.

Current:

- Barn owl and cattle egret control programs are currently being implemented on Lehua Island. Cumulative effects of this activity and the proposed Pacific rat eradication are not expected.
- Diphacinone is currently used as an urban pest control toxicant in Hawaii. It is possible that barn owls that fly to Lehua Island from neighboring inhabited islands could have sublethal levels of diphacinone poisoning and that the proposed Pacific rat eradication could create cumulative impacts resulting is lethal doses.

Future:

- A native plant restoration project is planned for Lehua once the Pacific rats have been eradicated. Cumulative effects of this future activity and the proposed Pacific rat eradication are not expected.

Chapter 5 - Anticipated Determination, Findings, and Reasons for Supporting the Anticipated Determination

The Division of Forestry and Wildlife anticipates a **Finding of No Significant Impact** (FONSI) declaration for this project. In determining whether the proposed action will have a significant impact on the environment, DOFAW considered the phases of the proposed action, the expected consequences, both primary and secondary, and the cumulative as well as short and long-term effects of the action. In addition, DOFAW specifically evaluated the project under the following 13 significance criteria, as provided in HAR § 11-200-12:

The proposed actions do not involve an irrevocable commitment to loss or destruction of any natural or cultural resource. The actions will contribute to the restoration of a healthy native ecosystem on Lehua by eradicating nonnative rats.

The proposed actions will not curtail the range of beneficial uses of the environment. The activities proposed are intended to contribute to ecological restoration of the island and improve habitat for the native plants and nesting seabirds that inhabit or historically inhabited the island, prior to its degradation by invasive rats. Restoration of Lehua will thus improve the range of beneficial uses of the environment, including for endangered seabirds, Hawaiian monk seals and sea turtles.

The proposed actions will not conflict with the State's long-term environmental policies. The proposed actions will not conflict with the environmental policies set forth in HRS Chapter 343, the State's written and enforceable policies, and other statutes and regulations, since the proposed actions will not damage sensitive natural resources. Instead, they will improve the environment of Lehua.

The proposed actions will not substantially adversely affect the economic and social welfare of the community. The proposed activities utilize the most effective strategies to eradicate invasive rats as well as mitigating potential adverse impacts, thus contributing to the restoration of the ecosystem of Lehua. With ecosystem restoration, seabird populations will most likely increase and additional species will most likely return to Lehua, increasing its value as a State Seabird Sanctuary. Therefore, the proposed project will result in an improved environment, thus supporting eco-tourism and enhancing economic and social welfare.

The proposed actions will not substantially adversely affect the public health of the community. The rodenticides in the proposed action have been found to not have substantial impacts on water quality or on marine life that might be consumed by people.

The proposed actions will not involve substantial secondary impacts, such as population changes or effects on public facilities. Lehua is a small island designated as a State Seabird Sanctuary and is uninhabited and undeveloped. The project does not propose construction of public facilities or involve establishing a human population. Thus, the proposed actions will not affect any public recreational facilities and will not induce population growth or decline in the area.

The proposed actions will not involve a substantial degradation of environmental quality. The proposed action will not degrade Lehua Island. The restoration project will increase the environmental quality of the ecosystems of Lehua for its flora and fauna.

The proposed actions will not affect a rare, threatened or endangered species or its habitat. The operation will benefit native plant and animal species protected under the Federal and state endangered species laws. The limited and temporary human activities associated with the operation will have a negligible impact on listed species because either they will not be present or project actions combined with mitigation will result in no adverse impacts.

The proposed actions will not have cumulative impacts or involve a commitment for larger actions. The analyses show that the modified operation and mitigation measures integrated into the proposed actions, such as the use of diphacinone and conducting operations during the winter when presence of nontarget and listed species is minimal, will result in no cumulative impacts. No other known or potential actions would contribute to or cause any cumulative impacts.

The proposed actions will not substantially affect air or water quality or ambient noise levels. The proposed actions are fully consistent with both Federal and State water quality laws and regulations. The helicopter will cause temporary noise for a period of up to six non-consecutive days during aerial application of rodenticides on Lehua, but the effect will be highly temporary and no people not associated with the operation are anticipated to be present during the operation.

The proposed project is not located in an environmentally sensitive area (e.g. flood plain, tsunami zone and coastal zone). Although the site is in a State Seabird Sanctuary, the proposed actions are in accordance with HAR 13-125, as well as Federal and State Coastal Zone Management policies and enforceable policies. All actions will protect sensitive resources, including the coastal zone while meeting ecological management objectives.

The proposed actions will not substantially affect scenic vistas and view planes identified or State plans or studies. The project does not involve construction of any permanent structures or alteration of landscapes. Thus, it will not affect any sites or vistas.

The proposed project will not require substantial energy consumption. The main affected area of Lehua Island is not on a local power grid. The only energy uses will be using motorized vehicles for accessing points of departure to the island and for applying bait via helicopter. Most work will be conducted during daylight hours.

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Appendix A. Lehua Island Species Lists

Table 3. Comparative Checklist of Vascular Plants on Lehua (adapted from Wood *et al*. 2004)**.**

Symbols: End=Endemic V=Vulnerable P=Present on Lehua
Ind=Indigenous H=Historical [no longer present]
Nat=Naturalized

	Family	Species	Status	Presence
Angiosperms – Dicots	Aizoaceae	*Sesuvium portulacastrum*	Ind	P
	Asclepiadaceae	*Asclepias curassavica*	Nat	P
	Asteraceae	*Ageratum conyzoides*	Nat	P
		Artemisia australis	End	P
		Cirsium vulgare	Nat	P
		Conyza bonariensis	Nat	P
		Gamochaeta purpurea	Nat	P
		Pluchea carolinensis	Nat	P
		Pluchea indica	Nat	P
	Portulacaceae	*Portulaca oleracea*	Nat	P
		Portulaca pilosa	Nat	P
		Portulaca villosa	End, V	H
	Primulaceae	*Anagallis arvensis*	Nat	P
	Goodeniaceae	*Scaevola sericea*	Ind	P
	Solanaceae	*Solanum americanum*	Ind	P
	Sterculiaceae	*Waltheria indica*	Ind	P
	Urticaceae	*Pilea peploides*	Ind	P
	Verbenaceae	*Pluchea xfosbergii*	Nat	P
		Sonchus oleraceus	Nat	P
		Verbesina encelioides	Nat	P
		Xanthium strumarium	Nat	P
	Boraginaceae	*Heliotropium anomalum* var. *argenteum*	End	H
		Heliotropium curassavicum	Ind	P
	Cactaceae	*Opuntia ficus-indica*	Nat	H
	Chenopodiaceae	*Chenopodium murale* L.	Nat	P
	Convolvulaceae	*Ipomoea pes-caprae* subsp. *Brasiliensis*	Ind	H
		Jacquemontia ovalifolia subsp. *Sandwicensis*	Ind	P
	Cucurbitaceae	*Sicyos maximowiczii*	End	H
	Euphorbiaceae	*Chamaesyce hirta*	Nat	P
	Fabaceae	*Prosopis pallida*	Nat	P
		Lantana camara	Nat	H
	Zygophyllaceae	*Tribulus cistoides*	Ind	P
An gio	Cyperaceae	*Cyperus javanicus*	Ind	P
		Cyperus polystachyos	Ind	H

	Family	Species	Status	Presence
		Fimbristylis cymosa subsp. *umbellato-capitata*	Ind	P
	Poaceae	*Cenchrus ciliaris*	Nat	P
		Cenchrus echinatus	Nat	P
		Chloris radiate	Nat	P
	[Poaceae]	*Chloris virgata* Sw.	Nat	P
		Digitaria ciliaris	Nat	P
		Digitaria insularis	Nat	P
		Eragrostis amabilis	Nat	P
		Eragrostis variabilis	End	P
	Malvaceae	*Abutilon grandifolium*	Nat	P
		Sida fallax	Ind	P
	Nyctaginaceae	*Boerhavia repens*	Ind	P
	Oxalidaceae	*Oxalis corniculata* L.	Ind	P
	Papaveraceae	*Argemone glauca* var. *glauca*	End	P
		Heteropogon contortus	Ind	P
		Lepturus repens	Ind	P
		Panicum fauriei var. *latius*	End	P
		Panicum pellitum	End	P
		Panicum torridum	End	P
		Setaria verticillata	Nat	P
Pterido-phytes	Dryopteridaceae	*Nephrolepis multiflora*	Nat	P
	Pteridaceae	*Doryopteris decipiens*	End	P

Table 4. Preliminary Checklist of Lehua's Marine Algae (adapted from Wood *et al*. 2004)**.**

Order	Family	Species
Cyanophyta	Oscillatoriaceae	*Lyngbya majuscule*
		Lyngbya semiplena
Chlorophyta	Anadyomenaceae	*Microdictyon setchellianum*
	Caulerpaceae	*Caulerpa racemosa* var. *peltata*
	Cladophoraceae	*Cladophora laetevirens*
	Codiaceae	*Codium edule*
	Dasycladaceae	*Neomeris vanbosseae*
Phaeophyta	Chordariaceae	*Chonospora minima*
		Hydroclathrus clathratus
	Dictyotaceae	*Dictyota bartayresiana*
		Dictyota sandvicensis
		Lobophora variegate
		Padina sanctae-crucis
		Padina sp.
	Sargassaceae	*Sargassum echinocarpim*
		Turbinaria ornate
	Scytosiphonaceae	*Colpomenia sinuosa*
	Scytothamnaceae	*Asteronema breviarticulatum*
	Sphacelariaceae	*Sphacelaria tribuloides*
Rhodophyta	Bonnemaisoniaceae	*Asparagopsis taxiformis*
		Falkenbergia hillebrandii
	Ceramiaceae	*Aglaothamnion boergesenii*
		Antithamnion antillanum
		Ceramium fimbriatum
		Ceramium flaccidum
		Griffithsia subcylindrica
		Gymnothamnion elegans
	Champiaceae	*Champia parvula*
	Corallinaceae	*Amphiroa rigida*
		Jania sp.
	Dasyaceae	*Dasya iridescens*
		Dasya murrayana
	Faucheaceae	*Halichrysis coalescens*
	Gelidiellaceae	*Gelidiella machrisiana*
	Phyllophoraceae	*Ahnfeltiopsis concinna*
	Plocamiaceae	*Plocamium sandvicense*
	Rhodomelaceae	*Amansia glomerata*
		Herposiphonia variabilis
		Laurencia sp.
	Rhodymeniaceae	*Botryocladia skottsbergii*
		Chrysymenia sp.

Table 5. Preliminary Checklist of Lehua's Terrestrial Arthropoda (adapted from Wood *et al*. 2004)**.**

Symbols: End=Endemic Ind=Indigenous Adv=Adventitious Unk=Unknown

Order: Family	Species	Common Name	Status
Araneae: Clubionidae	*Chiracanthium mordax*		Adv
Araneae: Lycosidae	*Lycos sp.*	Lycosid spider	End
Blattodea: Blattellidae	*Simploce pallens*		Adv
Collembola: Entomobryidae	*Entomobrya marginata*		Adv
Collembola: Caribidae	*Aephinidius opaculus*		Adv
Collembola: Caribidae	*Gnathaphanus picipes*		Adv
Collembola: Coccinellidae	*Cryptolamus montrouzier*		Adv
Collembola: Chrysomelidae	*Systena blanda*		Adv
Coleoptera: Curculionidae	*Hypurus bertrandi*		Adv
Coleoptera: Dermestidae	*Dermestes frischi*	carnivorous beetle	Adv
Coleoptera: Dytiscidae	*Rhantus psuedopacificus*		End
Coleoptera: Phalacridae	*Phalacrus sp.*		Adv
Coleoptera: Scarabeidae	*Adoretus sinicus*		Adv
Coleoptera: Scarabeidae	*Aphodius lividus*		Adv
Coleoptera: Scarabeidae	*Protaetia fusca*	pollen beetle	Adv
Coleoptera: Tenebrionidae	*Gonocephalum adpressiforme*		Adv
Dermaptera: Carcinophoridae	*Euborellia eteronoma*		Adv
Diptera: Chloropidae	*Siphunculina striolata*		Adv
Diptera: Ephydridae	*Hecamede granifera*	shore fly	Adv
Diptera: Ephydridae	*Ephydra gracilis*	shore fly	Adv
Diptera: Ephydridae	*Scatella sexnotata*	shore fly	Ind
Diptera: Dolichopodidae	*Hydrophorus pacificus*	long-legged fly	End
Diptera: Canacidae	*Canaceoides hawaiiensis*	beach fly	End
Diptera: Canacidae	*Canaceoides angulatus*	beach fly	Adv
Diptera: Canacidae	*Canaceoides sp.*	beach fly	Unk
Heteroptera: Anthocoridae	*Orius sp.*		Adv
Heteroptera: Lygaeidae	*Graptostethus manillensis*		Adv
Heteroptera: Lygaeidae	*Nysius kinbergi*	seed bug	End
Heteroptera: Nabidae	*Nabis capisiformis*		Adv
Homoptera: Cicadellidae	*Acinopterus angulatus*		Adv
Homoptera: Cicadellidae	*Balclutha sp.*		Unk
Homoptera: Delphacidae	*Perkinsiella saccharicida*		Adv
Homoptera: Membracidae	*Vanduzeea segmentata*		Adv
Hymoneptera: Braconidae	*Chelonus blackburni*		Adv
Hymenoptera: Colletidae	*Hylaeus flavifrons*	yellow-faced bee	End
Hymenoptera: Vespidae	*Pachyodynerus nasidens*	potter wasp	Adv
Hymenoptera: Formicidae	*Camponotus variegatus*		Adv
Hymenoptera: Formicidae	*Ochetellus glaber*		Adv
Hymenoptera: Formicidae	*Pheidole megacephala*	big headed ant	Adv
Hymenoptera: Formicidae	*Tetramorium simillimum*		Adv
Lepidoptera: Carmbidae	*Omiodes localis*		End
Lepidoptera: Crambidae	*Salbia haemorrhoidalis*		Adv
Lepidoptera: Crambidae	*Spoladea recurvalis*		Adv
Lepidoptera: Crambidae	*Tamsica floricolens*		End

Lepidoptera: Gelechiidae	*Dichomeris acuminata*		Adv
Lepidoptera: Geometridae	*Anacamptodes fragilaria*		Adv
Lepidoptera: Lycaenidae	*Lampides boeticus*		Adv
Lepidoptera: Noctuiidae	*Amyna natalis*		Adv
Lepidoptera: Noctuiidae	*Eublemma accedens*		Adv
Lepidoptera: Noctuiidae	*Heliothis virescens*		Adv
Lepidoptera: Oecophoridae	*Thyrocopa sp.*		End
Lepidoptera: Olethreutidae	*Crocidosema sp.*		End
Lepidoptera: Sphingidae	*Hipotion rosetta*		Adv
Mantodea: Mantidae	*Heirodula patellifera*	mantis	Adv
Orthoptera: Acrididae	*Schistocerca nitens*	grasshopper	Adv
Orthoptera: Gryllidae	*Gryllodes signallatus*	grasshopper	Adv
Orthoptera: Gryllidae	*Caconemobius sp.*		End
Othroptera: Gryllidae	*Trigonidomorpha sjostedti*		Adv
Orthoptera: Tettigoniidae	*Conocephalus saltator*		Adv
Orhtoptera: Tettigoniidae	*Euconocephalus nasutus*		Adv

Table 6. Checklist of bird species on Lehua (Adapted from Wood *et al*. 2004).

Symbols: End=Endemic SoC=Species of Concern P=Present on Lehua
Ind=Indigenous T=Threatened H=Historical [no longer present]
WV=Winter visitor E=Endangered
A=Alien C=Critically endangered

Species	Status	Presence
Black-footed Albatross (*Phoebastria nigripes*)	Ind, SoC	P
Laysan Albatross (*Phoebastria immutabilis*)	Ind, SoC	P
Wedge-tailed shearwater (*Puffinus pacificus*)	Ind	P
Christmas Shearwater (*Puffinus nativitatus*)	Ind, SoC	P
Newell's Shearwater (*Puffinus auricularis newelli*)	End, T	P
Bulwer's Petrel (*Bulweria bulwerii*)	Ind	P
Band-rumped Storm-petrel (*Oceanodroma castro*)	Ind, C	P
Red-tailed Tropicbird (*Phaethon rubricauda*)	Ind	P
White-tailed Tropicbird (*Phaethon lepturus*)	Ind	H
Masked Booby (*Sula dactylatra*)	Ind	H
Brown Booby (*Sula leucogaster*)	Ind	P
Red-footed Booby (*Sula sula*)	Ind	P
Great Frigatebird (*Fregata minor*)	Ind	P
Cattle Egret (*Bubulcus ibis*)	A	P
Peregrine Falcon (*Falco peregrinus*)	WV, SoC	P
Hawaiian Petrel (*Pterodroma sandwichensis*)	End, E	P
Pacific Golden-plover (*Pluvialis fulva*)	WV, SoC	P
Wandering Tattler (*Heteroscelus incanus*)	WV	P
Ruddy Turnstone (*Arenaria interpres*)	WV	P
Glaucous-winged Gull (*Larus glaucescens*)	WV	P
Gray-backed Tern (*Sterna lunata*)	Ind	P
Sooty Tern (*Sterna fuscata*)	Ind	P
Brown Noddy (*Anous stolidus*)	Ind	P
Hawaiian Black Noddy (*Anous minutus melanogenys*)	End	P
Rock Dove (*Columba livia*)	A	P
Zebra Dove (*Geopelia striata*)	A	P
Sky Lark (*Alauda arvensis*)	A	H
Northern Cardinal (*Cardinalis cardinalis*)	A	H
House Finch (*Carpodacus mexicanus*)	A	P
Nutmeg Mannikin (*Lonchura punctulata*)	A	P
House Sparrow (*Passer domesticus*)	A	H

Table 7. Preliminary checklist of Lehua nearshore fish (USFWS unpubl. data 2004)**.**

Symbols: End=Endemic Ind=Indigenous A=Alien

Common Name	Species	Status
Orangespine Unicornfish	*Naso literatus*	Ind
Convict Tang	*A. triostegus*	End subspecies
Whitebar Surgeonfish	*A. leucopareius*	Ind
Orangeband Surgeonfish	*A. olivaceous*	Ind
Achilles Tang	*A. Achilles*	Ind
Ringtail Surgeonfish	*A. blochii*	Ind
Eyestripe Surgeonfish	*A. dussumieri*	Ind
Lagoon Triggerfish	*Rhinecanthus aculeatus*	Ind
Reef Triggerfish	*R. rectangulus*	Ind
Black Durgon	*Melichthys niger*	Ind
Pinktail Durgon	*M. vidua*	Ind
Gray Chub	*Kyphosus biggibus*	Ind
Highfin Chub	*K. cinerascens*	Ind
Bigeye Emperor	*Monotaxis grandoculis*	Ind
Yellowstriped Coris	*Coris flavovittata*	End
Blacktail Wrasse	*Hinalea lauhine*	End
Christmas Wrasse	*Thalassoma lauhine*	Ind
Saddle Wrasse	*T. duperrey*	End
Hawaiian Hogfish	*Bodianus bilunulatus*	Ind
Moorish Idol	*Zanclus cornutus*	Ind
Ornate Butterflyfish	*Chaetodon ornatissimus*	Ind
Longnose Butterflyfish	*Forcipiger longirostris*	Ind
Cornetfish	*Fistularia commersonnii*	Ind
Manybar Goatfish	*Parupeneus multifasciatus*	Ind
Blue Goatfish	*P. cyclostomus*	Ind
Yellowstripe Goatfish	*Mulloidichthys flavolineatus*	Ind
Yellowfin Goatfish	*M. vanicolensis*	Ind
Manta Ray	*Manta birostris*	Ind
Gray Reef Shark	*Carcharhinus amblyrynchos*	Ind
Blackspot Seargant	*Abudefduf sordidus*	Ind
Bluefin Trevally	*Carynx melampygus*	Ind
Smalltooth Jobfish	*Aphareus furca*	Ind
Bluestripe Snapper	*Lutjanus kasmira*	A
Hawaiian Flagtail	*Kuhlia sandvicensis*	End
Parrotfish spp.	*Family Scaridae*	Ind or End

Appendix B. Phenology of Select Species of Sea Birds and Nest Content Data for Wedge tail Shearwater, Red tail Tropic Birds, and Bulwer's Petrels.

Figure 2. Breeding phenology of bird species on Lehua (Adapted from Wood *et al.* 2004)**.**

Dashed lines indicate eggs and solid line indicates chicks. Extent of each stage of the breeding cycle was extrapolated from survey dates based on incubation and fledging periods in other areas. Additional species suspected to nest on Lehua but for which there is insufficient information to determine breeding phenology include Christmas Shearwater, Newell's Shearwater, Hawaiian Petrel, and Band-rumped Storm-petrel.

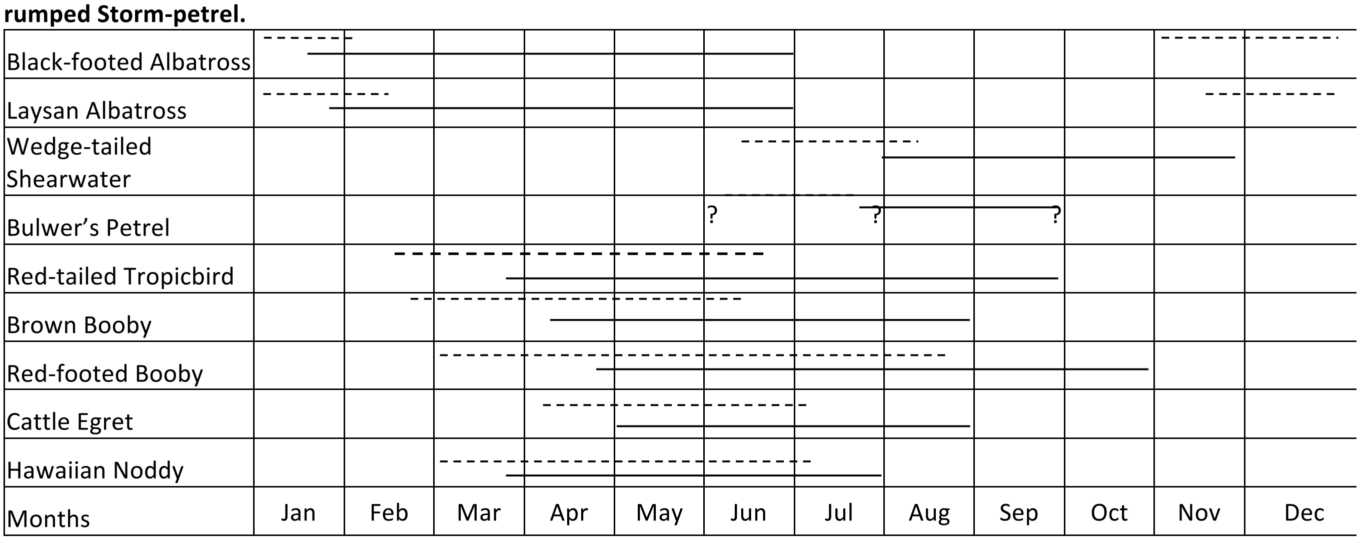

Table 13. Nest content data from Lehua Islet for three species of sea birds. The surveys were conducted in July, September and October of 2016 by Pacific Rim Conservation. WTSH = Wedge tail Shearwater, RTTR = Red tailed Tropic Bird, BUPE = Bulwer's Petrel

Data Category	WTSH	RTTR	BUPE
Total # nests	127	157	7
# nests hatched	62	54	0
# nests not hatched	33	27	5
# nests fledged	46	69	0
# nests dead chick observed	17	25	2
# rat predated eggs	4	0	0
# owl predated chicks	3	4	0

Appendix C. Data on the Efficicacy and Preference of Bell Lab's Formula 4 Bait at 50 ppm and 100 ppm.

Table 14. Summary statistics for *Rattus exulans* 15-day 2-choice feeding trial results for Bell Labs (0.005% a.i. Diphacinone)

	50 ppm	**100 ppm**
Mortalities (% efficacy)	100%	96.10%
Mortality (days)	(4-14)	(4-17)
Bait consumption (g)	(5.7-30.3)	(1.2-41.2)
Bait acceptance2 (%)	(25.5-100)	(3.7-100)

(Siers, S.R. 2016. Efficacy and acceptance of 0.005% diphacinone experimental pellet bait on Polynesian rats (*Rattus exulans*). Unpublished Report. QA-2546. National Wildlife Research Center, Fort Collins, Colorado. 192p)

Appendix D. Bait Interactions Data from Studies Conducted at Lehua Islet.

Table 15. Attraction of nearshore marine fishes to placebo Ramik Green rat bait pellets (2-3 gram size) at Lehua Island, Hawai`i, September 18-19, 2004 (USFWS unpublished data)

Common English Name	Scientific Name	Total Number of Fish	Number of bait interactions observed (some individuals interacted multiple times)			Number of bait interactions per species
			Inspected Bait	Touched Bait	Consumed bait	
Orangespine Unicornfish	*Naso literatus*	13	10	8	0	18
Convict Tang	*Acanthurus triostegus*	8	0	0	0	0
Whitebar Surgeonfish	*Acanthurus leucopareius*	85	19	0	0	19
Orangeband Surgeonfish	*Acanthurus olivaceous*	7	3	5	0	8
Achilles Tang	*Acanthurus achilles*	2	0	0	0	0
Ringtail Surgeonfish	*Acanthurus blochii*	1	0	0	0	0
Eyestripe Surgeonfish	*Acanthurus dussumieri*	1	0	0	0	0
Lagoon Triggerfish	*Rhinecanthus aculeatus*	1	1	0	0	1
Black Durgon	*Melichthys niger*	6	21	13	0	34
Pinktail Durgon	*Melichthys vidua*	5	13	9	0	22
Moorish Idol	*Zanclus cornutus*	1	0	0	0	0
Ornate Butterflyfish	*Chaetodon ornatissimus*	1	0	0	0	0
Longnose Butterflyfish	*Forcipiger longirostris*	1	0	0	0	0
Cornetfish	*Fistularia commersonnii*	1	0	0	0	0
Gray Reef Shark (juv.)	*Carcharhinus amblyrynchos*	1	1	0	0	1
Blackspot Sergeant	*Abudefduf sordidus*	1	3	0	0	3
Manybar Goatfish	*Parupeneus multifasciatus*	2	0	0	0	0

Blue Goatfish	*Parupeneus cyclostomus*	3	0	0	0	0
Yellowstripe Goatfish	*Mulloidichthys flavolineatus*	1	0	0	0	0
Hawaiian Hogfish	*Bodianus bilunulatus*	1	1	1	0	2
Parrotfish spp.	Family *Scaridae*	2	0	0	0	0

Table 16. Common names, Order, Family, scientific names and observations of terrestrial species showing positive bait interactions as evidenced by pyranine exposure during nocturnal terrestrial inert bait interaction surveys on Lehua Island, September 2015.

Common Name	Order	Family	Scientific Name	Observation
American cockroach	Blattodea	Blattidae	*Periplaneta americana*	Carried bait, consumed ɨ
Beetle sp.	Coleoptera			Consumed
Big-headed ant	Hymenoptera	Formicidae	*Pheidole megacephala*	Carried bait, consumed
Centipede sp.	Chilopoda (Class)			Positive biomarker ɨ
Compost mite	Acrina			Consumed
Cricket sp. (large bodied)	Orthoptera			Consumed
Cricket sp. (small bodied)	Orthoptera			Consumed
Isopod sp.	Isopoda			Consumed
Oriental cockroach	Blattodea	Blattidae	*Blatta orientalis*	Consumed
Shore bird sp.				Feces positive biomarker
Silverfish	Thysanura	Lepismatidae	*Lepisma sacharina*	Consumed
Spider sp.	Araneae			Consumed ǂ
Unidentified guano				Positive biomarker ϖ

(ɨ positive biomarker in gut ǂ consuming glowing insect ϖ quarter-sized guano positive biomarker

Table 17. Common, Hawaiian, scientific names and observations of species interacting with inert pellet bait during marine surveys on Lehua Island, September 2015.

Common names followed by an asterisk denote species known to be collected for human consumption (Manuel Mejia pers. comm [The Nature Conservancy Honolulu])

Common Name	Hawaiian Name	Scientific Name	Observation
Achilles Tang*	Pākuiku`i	*Acanthurus achilles*	Contact
Black DurgonTriggerfish	Humuhumu`ele`ele	*Melichthys niger*	Consumed bait
Blackspot Sergeant/Damselfish	Kapapa	*Abudefduf sordidus*	Consumed bait
Bluestripe Snapper*	Taape	*Lutjanus fulvus*	Consumed bait
Boomerang /Whiteline/Scythe Triggerfish	Humuhumu lei	*Sufflamen bursa*	Consumed bait
Bright-eye Damselfish		*Plectroglyphidodon imparipennis*	Consumed bait
Butterfly fish sp.		Family Chaetodontidae	Contact
Christmas Wrasse	Awela	*Thalassoma trilobatum*	Consumed bait
Four-spotted Butterfly Fish	Lau hau	*Chaetodon quadrimaculatus*	Consumed bait
Hawaiian Hog Fish*	A`wa	*Bodianus albotaneniatus*	Consumed bait
Hawaiian Sergeant	Mamo	*Abudefduf abdominalis*	Consumed bait
Hawaiian Wrasse		*Labroides phthirophagus*	Consumed bait
Hermit Crab sp.		Superfamily Paguroidea	Contact
Indo-Pacific Sergeant	Mamo	*Abudefduf vaigiensis*	Consumed bait
Lowfin Chub	Nenue	*Kryphosus vaigiensis*	Consumed bait
Oblong Urchin	Wana	*Echinometra oblonga*	Contact
Orange-band Surgeonfish*	Na`ena`e	*Acanthurus olivaceous*	Contact
Ornate Wrasse	La`o	*Halichoeres ornatissimus*	Consumed bait
Pale Rock-boring Urchin	Wana	*Echinometra mathaei*	Contact
Pinktail Triggerfish	Humuhumu hi`ukole	*Melichthys vidua*	Consumed bait
Potter's Angelfish		*Centropyge potteri*	Consumed bait
Saddle Wrasse	Hinalea lau-wili	*Thalassoma duperrey*	Consumed bait
Spotted Boxfish	Moa	*Ostracion meleagris*	Contact
Stocky Hawkfish	Po`opa`a	*Cirrhitus pinnulatus*	Consumed bait
Surge Wrasse	Hou	*Thalassoma purpureum*	Consumed bait

Common Name	Hawaiian Name	Scientific Name	Observation
Triggerfish sp.		Family Balistidae	Consumed bait
Achilles Tang*	Pākuiku`i	*Acanthurus Achilles*	Contact
Black DurgonTriggerfish	Humuhumu`ele`ele	*Melichthys niger*	Consumed bait
Blackspot Sergeant/Damselfish	Kapapa	*Abudefduf sordidus*	Consumed bait
Bluestripe Snapper*	Taape	*Lutjanus fulvus*	Consumed bait
Boomerang /Whiteline/Scythe Triggerfish	Humuhumu lei	*Sufflamen bursa*	Consumed bait
Bright-eye Damselfish		*Plectroglyphidodon imparipennis*	Consumed bait
Butterfly fish sp.		Family Chaetodontidae	Contact
Christmas Wrasse	Awela	*Thalassoma trilobatum*	Consumed bait
Four-spotted Butterfly Fish	Lau hau	*Chaetodon quadrimaculatus*	Consumed bait
Hawaiian Hog Fish*	A`wa	*Bodianus albotaneniatus*	Consumed bait
Hawaiian Sergeant	Mamo	*Abudefduf abdominalis*	Consumed bait
Hawaiian Wrasse		*Labroides phthirophagus*	Consumed bait
Hermit Crab sp.		Superfamily Paguroidea	Contact
Indo-Pacific Sergeant	Mamo	*Abudefduf vaigiensis*	Consumed bait
Lowfin Chub	Nenue	*Kryphosus vaigiensis*	Consumed bait
Oblong Urchin	Wana	*Echinometra oblonga*	Contact
Orange-band Surgeonfish*	Na`ena`e	*Acanthurus olivaceous*	Contact
Ornate Wrasse	La`o	*Halichoeres ornatissimus*	Consumed bait
Pale Rock-boring Urchin	Wana	*Echinometra mathaei*	Contact
Pinktail Triggerfish	Humuhumu hi`ukole	*Melichthys vidua*	Consumed bait
Potter's Angelfish		*Centropyge potteri*	Consumed bait
Saddle Wrasse	Hinalea lau-wili	*Thalassoma duperrey*	Consumed bait
Spotted Boxfish	Moa	*Ostracion meleagris*	Contact
Stocky Hawkfish	Po`opa`a	*Cirrhitus pinnulatus*	Consumed bait
Surge Wrasse	Hou	*Thalassoma purpureum*	Consumed bait
Triggerfish sp.		Family Balistidae	Consumed bait

Table 18. Common names, Order/Hawaiian Names, Family, scientific names and observations of species negative for pyranine exposure and not observed interacting with bait during nocturnal terrestrial inert bait and marine bait interaction surveys on Lehua Island, September 2015. Common names followed by an asterisk denote species known to be collected for human consumption (Manuel Mejia pers. comm [The Nature Conservancy Honolulu]).

Common Name	Order/ Hawaiian Name	Family	Scientific Name	Observation
Common house gecko			*Hemidactylus frenatus*	Negative biomarker
Moth sp.	Lepidoptera			Negative biomarker
Red-footed Booby			*Sula sula*	Negative biomarker feces
Wedge-tailed Shearwater			*Puffinus pacificus*	Negative biomarker feces
Convict Tang*	Manini		*Acanthurus triostegus*	No interaction
Hawaiian Monk Seal	Ilio holo I ka uaua		*Neomonachus schauinslandi*	No interaction
Moorish Idol	Kihikihi		*Zanclus cornutus*	No interaction
Pacific Sailfin Tang	Mane`one`o		*Aebrasoma veliferum*	No interaction
Surgeon Fish sp.		Family Acanthuridae		No interaction
Unicorn Fish sp.*	Kala		*Naso* sp.	No interaction
Yellowstripe Goatfish*	Weke`a		*Mulloidchthys flavoineatus*	No interaction

Appendix E. Results of Laboratory Analysis of Marine Samples Collected after the 2008 Aerial Diphacinone Application to Mokapu Island, Molokai

The following six pages contain three reports from the National Wildlife Reserce Center showing the levels of diphacinone from in Fish, Limpets (opihi), and Ocean water respectively sampled after the 2008 application of diphacinone on Mokapu for the eradication of rats. Mokapu samples are compared with reference samples of other fish, limpets, and water found locally to determine the efficacy of the test.

Note that MLOD means "Mass Level of Detection" and where the results state "<MLOD" it means that for the given test done on the sample, the result was less than the level at which it could be detected. In essesence, a result of <MLOD means diphacinone could not be found in that sample.

Wildlife Services NWRC National Wildlife Research Center Analytical Services Report	United States Department of Agriculture Animal Plant Health Inspection Service Wildlife Services National Wildlife Research Center Invasive Species and Technology Development Research Program Analytical Chemistry Project	Invoice #: 08-025/2 Date: 04/03/2008 Page: 1 of 2

To: Chris Swenson
Pacific Islands Coastal Program
US Fish and Wildlife Service

Peter Dunlevy
Pacific Islands Fish and Wildlife Office
USDA – APHIS – Wildlife Services

Katie Swift
Ecological Services Office
US Fish and Wildlife Service

Subject: Determination of Diphacinone in Fish Tissue

Method: 159A - Modified

Analysis Date: 3/31/08

AC Notebook Reference: AC 137 pp. 171-173

QC Notebook Reference: QC 26 p. 67

Analyst: Chad Wermager, Tom Primus

Sample Description: Fish samples arrived 03/20/08 and were logged into our sample tracking system. Samples arrived in Ziploc bags according to sample number with fish fillet individually wrapped in aluminum foil. Each tissue sample was homogenized in a SPEX liquid nitrogen freezer mill. Each homogenized sample was placed in a labeled bag, vacuum sealed and frozen (-30 °C) until analyzed.

Additional Comments: The MLOD was determined to be 0.013 ppm Diphacinone and 0.003 ppm Chlorophacinone. Modifications to method 159A included the following. After evaporating the extraction solution, each sample residue was reconstituted with 2 mL chloroform and 3 mL hexanes. During filtering before cleanup, each sample tube was rinsed with 1 mL of both chloroform and hexanes. The solid phase extraction (SPE) cleanup procedure was completed with Phenomenex Strata X-AW 33 µm polymeric weak anion (200 mg) SPE columns conditioned with 0.5 mL methanol, 1.0 mL chloroform and 1.5 mL hexanes. After loading each SPE column with the sample extract, each column was washed with a solution used to rinse the sample tube consisting of 0.25 mL methanol, 0.5 mL chloroform and 0.75 mL hexanes. The analyte was eluted off each SPE column with 12 mL of 15 mM TBA in methanol and collected in a 10 mL screw top tube.

The mobile phase was replaced with 60% 5 mM TBA in Methanol : 40% Aqueous IPCA Solution with pH ~8.5. High performance liquid chromatograph used UV detection @ 325 nm for the analytical wavelength with 360 nm as the reference.

[signature]	4/18/08	[signature]	4/19/08	[signature]	4/19/08
Analyst	Date	QC Specialist	Date	Reviewer	Date

Invoice #: 08-025/2	Date: 04/03/08	Page: 2 of 2

Results:

Table 1. Diphacinone concentration in analyzed fish samples.

Sample Description	Lab ID	Diphacinone Conc. (ppm)
Oahu Fish Market Reference Fish	S080320-14	<MLOD
Mokapu 2/17 Fish 1	S080320-15	<MLOD
Mokapu 2/17 Fish 2	S080320-16	<MLOD
Mokapu 2/17 Fish 3	S080320-17	<MLOD
Mokapu 2/17 Fish 4	S080320-18	<MLOD
Mokapu 2/17 Fish 5	S080320-19	<MLOD
Mokapu 2/17 Fish 6	S080320-20	<MLOD

Table 2. Quality Control Recovery for Diphacinone (Surrogate Corrected).

ID	Fortification Level (ppm)	% Recovery (surrogate corrected)
QF 1	Blank	------
QF 2	Blank	------
QF 3	0.100	97.5
QF 4	0.0947	100
QF 5	0.237	103
QF 6	0.244	100
Mean		100 ± 2.3

Oahu Fish Market Reference Fish used for all QC samples (S080320-14)

Cc: Tom Primus
Doreen Griffin
John Johnston

Wildlife Services **NWRC** National Wildlife Research Center Analytical Services Report	United States Department of Agriculture Animal Plant Health Inspection Service Wildlife Services National Wildlife Research Center Invasive Species and Technology Development Research Program Analytical Chemistry Project	Invoice #: 08-025/3 Date: 04/21/2008 Page: 1 of 2

To: Chris Swenson
Pacific Islands Coastal Program
US Fish and Wildlife Service

Peter Dunlevy
Pacific Islands Fish and Wildlife Office
USDA – APHIS – Wildlife Services

Katie Swift
Ecological Services Office
US Fish and Wildlife Service

Subject: Determination of Diphacinone in Limpets

Method: 159A - Modified

Analysis Date: 4/14/08

AC Notebook Reference: AC 137 pp. 171, 175

QC Notebook Reference: QC 26 p. 71

Analyst: Chad Wermager, Tom Primus

Sample Description: Limpet samples arrived 03/20/08 and were logged into our sample tracking system. Samples arrived in Ziploc bags according to sample number with limpet soft tissue wrapped in aluminum foil. Samples had no shell. Reference limpets (S080320-21) required soft tissue to be removed from shell before homogenization. Each tissue sample was homogenized in a SPEX liquid nitrogen freezer mill. Each homogenized sample was placed in a labeled bag, vacuum sealed and frozen (-30 °C) until analyzed.

Additional Comments: The MLOD was determined to be 0.059 ppm Diphacinone. Modifications to method 159A included the following. Methanol was used as the extraction solution. After evaporating the extraction solution, each sample residue was reconstituted with 2 mL chloroform and 3 mL hexanes. During filtering before cleanup, each sample tube was rinsed with 1 mL of both chloroform and hexanes. The solid phase extraction (SPE) cleanup procedure was completed with Phenomenex Strata X-AW 33 µm polymeric weak anion (500 mg) SPE columns conditioned with 1.5 mL chloroform and 1.75 mL hexanes. After loading each SPE column with the sample extract, each column was washed with a solution used to rinse the sample tube consisting of 1.5 mL chloroform and 1.75 mL hexanes. The analyte was eluted off each SPE column with 12 mL of 15 mM TBA in methanol and collected in a 10 mL screw top tube.

The mobile phase was replaced with 60% 5 mM TBA in Methanol : 40% Aqueous IPCA Solution with pH ~8.5. High performance liquid chromatograph used UV detection @ 325 nm for the analytical wavelength with 360 nm as the reference.

[signature]	4/14/08	[signature]	4/19/08	[signature]	4/19/08
Analyst	Date	QC Specialist	Date	Reviewer	Date

Invoice #: 08-025/3	Date: 04/21/08	Page: 2 of 2

Results:

Table 1. Diphacinone concentration in analyzed limpet samples.

Sample Description	Lab ID	Diphacinone Conc. (ppm)
Kalaupapa Reference Limpets	S080320-21	<MLOD
Mokapu 2/17 Limpet 1	S080320-22	<MLOD
Mokapu 2/17 Limpet 2	S080320-23	<MLOD
Mokapu 2/17 Limpet 3	S080320-24	<MLOD

Table 2. Quality Control Recovery for Diphacinone.

ID	Fortification Level (ppm)	% Recovery
QL 1	Blank	------
QL 2	Blank	------
QL 3	0.195	113
QL 4	0.201	101
QL 5	0.965	90.3
QL 6	0.975	101
Mean		101 ± 9.3

Kalaupapa Reference Limpets used for all QC samples (S080320-21)

Cc: Tom Primus
Doreen Griffin
John Johnston

Wildlife Services NWRC National Wildlife Research Center Analytical Services Report	United States Department of Agriculture Animal Plant Health Inspection Service Wildlife Services National Wildlife Research Center Invasive Species and Technology Development Research Program Analytical Chemistry Project	Invoice #: 08-025/1 Date: 04/03/08 Page: 1 of 2

To: Chris Swenson
Pacific Islands Coastal Program
US Fish and Wildlife Service

Peter Dunlevy
Pacific Islands Fish and Wildlife Office
USDA – APHIS – Wildlife Services

Katie Swift
Ecological Services Office
US Fish and Wildlife Service

Subject: Determination of Diphacinone in Seawater

Method: 158A - Modified

Analysis Date: 03/27/08

AC Notebook Reference: AC 137 pp. 169-170

QC Notebook Reference: QC 26 pp. 66

Analyst: Chad Wermager, Tom Primus

Sample Description: Water samples arrived 03/20/2008 and were logged into our sample tracking system. Water samples were in 250 mL screw top jars. Water samples were stored in a refrigerator at 4 °C until analyzed. All samples were analyzed with a modified version of method 158A. The method uses 150 mL of sample. As specified 75 mL of each set of two replicates from each sample location (total of six) were composited into a 150 mL sample. The remaining water from each of 12 samples (two from each location) was composited after the final results were tabulated. This composited sample will be used for a storage stability study.

Additional Comments: The MLOD was 0.029 ppb Diphacinone and 0.058 ppb Chlorophacinone. Method 158A modifications included omitting step 3 (addition of salt to the sample to increase ionic strength of the sample) and replacing the mobile phase with 60% 5 mM TBA in Methanol : 40% Aqueous IPCA Solution with pH ~8.5. High performance liquid chromatograph used UV detection @ 325 nm for the analytical wavelength with 360 nm as the reference.

[signature]	4/19/08	[signature]	4/19/08	[signature]	4/19/08
Analyst	Date	QC Specialist	Date	Reviewer	Date

Invoice #: 08-025/1	Date: 04/03/08	Page: 2 of 2

Results:

Table 1. Diphacinone concentration in analyzed water samples.

Sample Description	Lab ID	Diphacinone Conc. (ppb)
Kalaupapa Reference Sea Water	S080320-01	<MLOD
Mokapu Sea Water 2/17 1A	S080320-02	<MLOD
Mokapu Sea Water 2/17 1B	S080320-03	
Mokapu Sea Water 2/17 2A	S080320-04	<MLOD
Mokapu Sea Water 2/17 2B	S080320-05	
Mokapu Sea Water 2/17 3A	S080320-06	<MLOD
Mokapu Sea Water 2/17 3B	S080320-07	
Mokapu Sea Water 2/17 4A	S080320-08	<MLOD
Mokapu Sea Water 2/17 4B	S080320-09	
Mokapu Sea Water 2/17 5A	S080320-10	<MLOD
Mokapu Sea Water 2/17 5B	S080320-11	
Mokapu Sea Water 2/17 6A	S080320-12	<MLOD
Mokapu Sea Water 2/17 6B	S080320-13	

75 mL of each sample designated as A and B were composited together for each 150 mL sample.

Table 2. Quality Control Recovery for Diphacinone (Surrogate Corrected).

ID	Fortification Level (ppb)	% Recovery (surrogate corrected)
QW 1	Blank	------
QW 2	Blank	------
QW 3	0.502	115
QW 4	0.500	114
QW 5	2.00	111
QW 6	2.00	103
Mean		111 ± 5.4

Kalaupapa Reference Sea Water used for all QC samples (S080320-01

Cc:
Tom Primus
Doreen Griffin

Appendix F. Lehua Island Protocols and Proceedures (LIPP)

Lehua Island Protocols and Procedures (Updated July 2008)

Trip Leader Responsibilities
Kauai DOFAW will designate a trip leader for every group who will inform the group about all island rules and procedures and will also be responsible for the following:

- Making sure that all necessary permits have been obtained and all island drop-off and pick-up arrangements have been made, including contingency plans for weather delays
- Ensuring that the group brings sufficient food and water, including extra for weather delays
- Ensuring that communications and emergency evacuation plans are in place
- Ensuring that the camp site is kept in good order and all garbage and used water jugs are removed
- As requested by DOFAW, conducting supply inventories at the camp
- Checking to make sure all alien species prevention measures have been implemented

Alien Species Prevention

- BRING NO RODENTS…. NO INSECTS….AND NO SEEDS!!
- Inspect all Lehua gear and make sure it's free of any rodents, insects, and seeds: this includes shoes, socks, clothing, other soft materials, camping gear, food and supplies
- Prior to helicopter take-off, inspect any slingload materials, including the nets, for alien species and minimize the amount of time slingloads and pallets are left out prior to transport to Lehua
- Use a paved area of the heliport for loading, take-off and gear storage
- Seal all packages and gear tightly, especially food containers, and don't leave them out where pests can get in
- If possible, pack on the day of departure to avoid bringing alien stowaways
- Do not bring fruits or vegetables with seeds (like tomatoes) to Lehua

Human Safety

- Be extremely careful where you walk and carry a cell phone or walkie-talkie
- Report violations of seabird sanctuary regulations to Kauai DOFAW at (808) 274-3433
- Document and photograph violations if possible, but do not attempt to enforce regulations

Monk Seal Avoidance

- Try to stay 100' away from monk seals
- If a seal reacts to you, leave the area

Seabird Avoidance

- Whenever possible, stay on established trails
- Avoid walking close to nesting birds and any actions that flush birds, especially when they are sitting on eggs or have young chicks
- Stay alert for bird burrows and avoid crushing them; May through November is the peak nesting season for burrow-nesting species

- If you crush a burrow, gently dig out the bird

Archaeological Site Avoidance

- Learn to recognize archaeological sites and the tags used to mark sites
- Never disturb any rock platform or rock pile, even small piles
- Avoid disturbing any marked site in any way
- Stay on established trails as much as possible
- If you find any artifacts or human remains, leave them alone and report the location and date of the discovery to Kauai DOFAW at (808) 274-3443

Trash Disposal

- Leave no trace of human presence – bring all trash off the island