

# **Kaua`i Seabird Habitat Conservation Plan**

**DRAFT August 2019**

## Executive Summary

Three listed seabird species breed seasonally in Hawai'i: the Newell's Shearwater (*Puffinus auricularis newelli*, Hawaiian name: 'a'o), the Hawaiian Petrel (*Pterodroma sandwichensis*, Hawaiian name: 'ua'u), and the Hawai'i distinct population segment (DPS) of the band-rumped storm-petrel (*Oceanodroma castro*, Hawaiian name: 'akē'akē, hereafter band-rumped storm-petrel), making the islands essential to the conservation of these species. These species are part of the unique natural and cultural heritage of Hawai'i, and the island of Kaua'i provides important breeding habitat for all three species. Protecting and managing that habitat to support viable populations of these species is critical for their long-term survival.

Among the threats known to impact the listed seabird species is attraction to artificial lights, which has been observed and documented on Kaua'i for decades. The Kaua'i Seabird Habitat Conservation Plan (KSHCP) has been developed to address light attraction impacts to the listed seabirds on the island of Kaua'i. The KSHCP also addresses the impacts of lights on the Central North Pacific distinct population segment (DPS) of the green sea turtle (*Chelonia mydas*, Hawaiian name: honu, hereafter honu). The proposed duration of the KSHCP is for 30 years and the geographic scope of the KSHCP coverage is the island of Kaua'i.

Seabird attraction to artificial lights is a commonly-observed phenomenon affecting petrel and shearwater species around the world, in many cases negatively altering their behavior. Fledgling seabirds are more affected by light attraction than adult seabirds, although adult birds also demonstrate altered behavior in the presence of unshielded lights, particularly near breeding colonies. At night, as the fledglings make their first flight from nesting sites to the sea, artificial lights degrade and impact their migratory corridor habitat. In the presence of light, the seabirds circle repeatedly and can become exhausted and often grounded as a result (commonly termed "fallout") or collide with structures in the process. Once grounded, the seabirds experience difficulty in resuming flight, and are vulnerable to introduced predators and vehicle traffic, such that unless rescued, they are assumed to have died, based on decades of seabird observations and reports. On Kaua'i, birds that are rescued are sent to the Save Our Shearwaters program for rehabilitation and released back into the wild where possible.

Light attraction fallout on the island of Kaua'i occurs in a widespread manner, with certain geographic areas having concentrated, higher amounts of observed fallout. Seasonally, most fallout occurs in the autumn months, coinciding with the seabird fledgling season. Many different entities on Kaua'i (resorts, businesses, and governmental agencies) have documented seabird fallout on their property and at their facilities resulting from the effects of light attraction. Light attraction on Kaua'i is an island-wide problem that negatively impacts the listed seabird species and is collectively attributable to many different entities.

Of the three listed seabird species, the 'a'o is the species most impacted by light attraction. The 'ua'u and the 'akē'akē are impacted to a much lesser degree.

The KSHCP relies on a unique structure to best meet the need for an effective and efficient response to the widespread nature of light attraction impacts on Kauaʻi. The structure of the KSHCP enables multiple individual entities on Kauaʻi to each apply for take authorization for light attraction impacts to the listed seabird species under one coordinated framework. This framework takes advantage of economies of scale and enables a pooling of resources to collectively achieve conservation goals. The requirements of the KSHCP, and the enrollment and approval process for listed species take authorization are defined in the KSHCP and consist of two parts: 1. the KSHCP document with associated appendices and 2. materials submitted by each Applicant which provide detailed descriptions of on-site minimization measures, covered activities, a monitoring plan, and the amount of take authorization being requested.

Applicants to the KSHCP are seeking an Incidental Take Permit (ITP) from the U. S. Fish & Wildlife service (USFWS) and an Incidental Take License (ITL) from the State of Hawaiʻi Department of Land and Natural Resources (DLNR). The mitigation and minimization measures contained in the KSHCP have been developed to inform the preparation of individual applications for listed seabird take authorization permits.

The KSHCP defines a set of actions to minimize and mitigate the effects of light attraction on the listed seabirds and to meet conservation goals. The KSHCP provides a suite of minimization actions and requires that each Applicant to the KSHCP implement all of the measures that are applicable to their facility and operational needs. Minimization measures emphasize reducing the amount of light that shines upward and reducing the amount of light output or intensity, which have been shown to reduce the effects of light attraction. Under the KSHCP, the minimization measures include:

- Deactivation of unnecessary lights;
- Use of full cut-off light fixtures (or their functional equivalent);
- Shielding existing light fixtures;
- Angling lights downward;
- Lowering the light output or intensity;
- Use of motion sensor light fixtures; and
- Decreasing the visibility of interior lights.

Under the KSHCP, mitigation actions are designed to be commensurate with the degree of impact caused by the taking of a listed seabird. Because some seabirds grounded by light attraction are found alive and deemed healthy, or are able to be rehabilitated, those birds will be released back into the wild. For seabirds that are found dead, those not found but assumed to have been impacted by light attraction, and for those birds that could not be released back into the wild, light attraction is considered to have caused the mortality of the affected birds. For impacts to those birds, mitigation will consist of predator control and the creation of a fenced seabird preserve in the northwest region of Kauaʻi. In this preserve, predators will be removed and seabirds will be lured to the site via social attraction, a well-established conservation technique for the creation of new seabird colonies. The absence of predators will enable the seabirds to breed more successfully and with higher reproduction rates than in

areas outside the preserve, thereby providing a conservation benefit to the seabird populations. The preserve site is located in Kōkeʻe State Park along the Kalalau rim. Predator control will be conducted in the vicinity of the preserve to reduce the impacts of predation on seabirds breeding nearby.

The funding design of the KSHCP features a cost-sharing structure. Total costs of the KSHCP, including implementation, mitigation, monitoring, Adaptive Management as needed and reporting, will be shared amongst the permit recipients according to the relative amounts of take authorized.

Compliance and effectiveness monitoring will be conducted to ensure that authorized amounts of take are not exceeded and to enable the wildlife agencies to determine that mitigation actions are meeting conservation goals. In response to monitoring results, Adaptive Management will be implemented in the event that mitigation actions require changes to meet conservation goals as new information is obtained during implementation of the KSHCP.

## Acronyms for this Document and all Associated Appendices

BLNR	Board of Land and Natural Resources
DAR	Division of Aquatic Resources
DLNR	Department of Land and Natural Resources
DOFAW	Division of Forestry and Wildlife
EA	Environmental Assessment
EIS	Environmental Impact Statement
ESA	Endangered Species Act
ESRC	Endangered Species Recovery Committee (State of Hawai'i)
FFS	French Frigate Shoals
GIS	Geographic Information Systems
ha	hectare
HAPE	Abbreviation for Hawaiian Petrel
HCP	Habitat Conservation Plan
HNP	Hono O Nā Pali
HNP NARS	Hono O Nā Pali Natural Area Reserve System
HRS	Hawai'i Revised Statutes
IA	Implementing Agreement
IE	Implementing Entity
ITL	Incidental Take License
ITP	Incidental Take Permit
IUCN	International Union for Conservation of Nature
KESRP	Kaua'i Endangered Seabird Recovery Project
KISC	Kaua'i Invasive Species Committee
KIUC	Kaua'i Island Utility Cooperative
Km	Kilometer
KPNWR	Kilauea Point National Wildlife Refuge
KSHCP	Kaua'i Seabird Habitat Conservation Plan
KWA	Kaua'i Watershed Alliance
mya	Million years ago
MBTA	Migratory Bird Treaty Act
MHI	Main Hawaiian Islands
NARS	Natural Area Reserve System
NEPA	National Environmental Policy Act
NESH	Abbreviation for Newell's Shearwater
NHPA	National Historic Preservation Act
NLCZ	No Light Conservation Zone
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NPS	National Park Service
NTBG	National Tropical Botanical Garden
NWHI	Northwest Hawaiian Islands
OEQC	Office of Environmental Quality Control

PCSU	Pacific Cooperative Studies Unit
PIP	Participant Inclusion Plan
RCUH	Research Corporation at the University of Hawai'i
SHPO	State Historic Preservation Officer
SOS	Save Our Shearwaters
SST	Surface Seawater Temperature
TMK	Tax Map Key
TNC	The Nature Conservancy
ULP	Upper Limahuli Preserve
UMP	Underline Monitoring Program
USDA	U.S. Department of Agriculture
USGS-PIERC	U.S. Geologic Survey Pacific Island Environmental Research Center
USFWS	U.S. Fish and Wildlife Service
WSART	Worker Seabird Awareness and Response Training

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## 1. INTRODUCTION

Nighttime lighting is an essential activity in most homes, businesses and industry centers. The Kaua'i Seabird Habitat Conservation Plan (hereinafter referred to as "KSHCP" or "Plan") was developed to provide an island-wide conservation program to support the use of wildlife-friendly nighttime lights; to mitigate for unavoidable incidental take impacts<sup>1</sup> to listed seabirds caused by nighttime lighting; to avoid and minimize take, and to facilitate the regulatory processes for Applicants to obtain authorization, as appropriate; to incidentally take listed seabirds (**Table 1-1**). The KSHCP was developed by the State of Hawai'i, Department of Land and Natural Resources (DLNR) with technical assistance from the U.S. Fish and Wildlife Service (USFWS), and in consultation with various scientific experts in the field of seabird and turtle biology.

The KSHCP is similar to a general conservation plan (GCP) as described in USFWS policy (USFWS 2007) except that it is being prepared by DLNR rather than USFWS; this approach is further discussed in Chapter 3. It was developed to support incidental take permit (ITP) and incidental take license (ITL) applications from multiple, qualifying non-Federal entities that have the potential for causing unavoidable take of Kaua'i's listed seabirds or honu. The seabirds covered in the KSHCP are the 'a'o, 'ua'u and the 'akē'akē, collectively referred to as "Covered Seabirds". The honu is also covered under this HCP. All of these species are collectively referred to as the "Covered Species" (**Table 1-1**).

Based on the potential for incidental take of these Covered Seabirds, Applicants may request an ITL under §195D-4(g) of the Hawai'i Revised Statutes (HRS), and an ITP pursuant to Section 10(a)(1)(B) of the Endangered Species Act (ESA) of 1973, as amended. It is anticipated that take of honu will be avoided through monitoring and measures to protect turtle nests. Federal agencies have a separate process to address take and other impacts to listed species, as provided for under the consultation processes of Section 7 of the ESA.

**Table 1-1. KSHCP Covered Species.**

Hawaiian name	Common Name	Latin Name	Conservation Status
'a'o*	Newell's shearwater	<i>Puffinus auricularis newelli</i>	Federally Threatened State Threatened IUCN Red List Endangered
'ua'u	Hawaiian petrel	<i>Pterodroma sandwichensis</i>	Federally Endangered State Endangered IUCN Red List Vulnerable
'akē'akē	band-rumped storm-petrel	<i>Oceanodroma castro</i>	Federally Endangered State Endangered IUCN Red List Least Concern
honu	green sea turtle	<i>Chelonia mydas</i>	Federally Threatened State Threatened IUCN Red List Endangered

\*Throughout the KSHCP Hawaiian names of Covered Species are used.

Non-Federal entities or Applicants seeking ITLs and ITPs (also collectively referred to below as a “permit” or “permits”) under the KSHCP would be seeking authorization for incidental take of the Covered Seabirds under specific terms and conditions defined by the Plan. Under the KSHCP, the impacts of any authorized incidental taking of the Covered Seabirds would be minimized and mitigated to the maximum extent practicable and offset with a net recovery benefit for the species affected. The duration of the Plan is 30 years; however, the term of individual permits under the Plan may vary within that 30-year KSHCP period. Other components of the HCP specific to individual Applicants include minimization and monitoring at Applicant facilities.

Covered Activities addressed under the KSHCP are: (1) the placement and operation of light structures that can cause disorientation of fledgling and adult seabirds, and hatchlings of the honu; (2) the placement and operation of new or future lights that have similar effects; and (3) conservation measures to mitigate the impacts of the taking on the Covered Species. The location of Covered Activities encompasses anywhere on the island of Kaua’i where light structures may occur, and State Lands where mitigation will occur.

## 1.1 PLANNING BACKGROUND OF THE KSHCP

The KSHCP is an atypical HCP and unique in several important respects. Planning for and development of the KSHCP was influenced by the following factors described below.

First, on the island of Kauaʻi, interactions of listed seabird species with existing lights has been a longstanding issue impacting the species. For the last three decades, as development on Kauaʻi has steadily increased, take of listed seabirds by their attraction to artificial lighting has been documented (Ainley et al. 1995, 2001). Island-wide estimates point to high amounts of incidental take occurring (involving hundreds of individuals of the covered listed seabird annually), that are negatively impacting the Covered Species (especially the ʻaʻo) and presenting challenges for achieving seabird conservation on Kauaʻi. The creation of the KSHCP was viewed as a critical tool to minimize and mitigate the effects of lighting on the Covered Species. The annual, ongoing nature of the take impacts on Kauaʻi contrasts with typical HCPs where the impacts of the taking on listed species are likely to occur *after* approval of an HCP and issuance of an ITP or ITL.

Second, the distribution of light attraction-related impacts to listed seabirds is widespread across the island. Downed birds are found wherever there is concentrated use of artificial outdoor lighting. Thus, the incidental take of Covered Seabirds involves multiple entities across different sectors, including private businesses and resorts as well as public agencies. Individual Applicants to the KSHCP will have differing take levels due to site-specific factors such as the specific location and extent of their facilities.

Third, conducting conservation actions to mitigate for the effects of unavoidable take of Covered Seabirds is difficult and costly due to the low reproductive capacity of the Covered Seabirds, their cryptic nature, the remote and rugged terrain on Kauaʻi in which they now breed and other factors. The challenging conditions for implementing actions in and near seabird colonies on Kauaʻi make it especially important to coordinate conservation efforts under the KSHCP to achieve the most cost-effective mitigation.

Another unique aspect of the KSHCP is its extended planning history. The concept of an island-wide HCP was developed, and initial outreach to potential Applicants began in 2005. Over 100 businesses and other entities were contacted, resulting in many voluntary changes at facilities to avoid and minimize take of the Covered Seabirds by installation of seabird friendly lighting and an overall reduction in the number of lights of Kauaʻi. Changes to lighting at some specific facilities were the result of litigation and settlement agreements. During the subsequent decade-long development process, some entities have determined that minimization alone will not completely avoid incidental take, and these entities are the expected pool of Applicants under the KSHCP.

## **1.2 REGULATORY FRAMEWORK**

### **1.2.1 FEDERAL ENDANGERED SPECIES ACT (ESA)**

The purpose of the ESA is to protect and recover endangered and threatened species and the ecosystems upon which they depend. Section 9 of the ESA and Federal regulation pursuant to Section 4(d) of the ESA prohibit the “take” of endangered and threatened species without special exemption. Under the ESA, “take” is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct (16 USC § 1532(19)). “Harm” is further defined by the USFWS to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering (50 CFR 17.3). “Incidental take” is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity.

Pursuant to Section 11(a) and (b) of the ESA, any person who knowingly violates Section 9 of the ESA or any permit, certificate, or regulation related to Section 9, may be subject to civil penalties of up to \$25,000 for each violation or criminal penalties up to \$50,000 and/or imprisonment of up to one year for each violation.

Individuals and State and local agencies proposing an action that is expected to result in the incidental take of Federally listed species are encouraged to apply for an incidental take permit (ITP) under Section 10(a)(1)(B) of the ESA to be in compliance with the law. Such permits are issued by USFWS when take is not the purpose of the action and is incidental to otherwise lawful activities. An application for an ITP must be accompanied by a habitat conservation plan, commonly referred to as an HCP. The regulatory standard for an ITP under Section 10(a)(1)(B) of the ESA requires that the applicant’s HCP minimize and mitigate the impacts of take on the listed species to the maximum extent practicable; not appreciably reduce the likelihood of the survival and recovery of the affected listed species in the wild; and provide adequate funding for its implementation and provide procedures to deal with unforeseen circumstances.

Section 7(a)(2) of the ESA requires Federal agencies to ensure that their actions, including the issuance of permits, do not jeopardize the continued existence of listed species or destroy or adversely modify listed species’ designated critical habitat. “Jeopardize the continued existence of...” pursuant to 50 CFR 402.2, means to engage in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species. Therefore the proposed issuance of an ITP under Section 10(a)(1)(B) of the ESA by the USFWS is a Federal action subject to Section 7 of the ESA. On that basis, the USFWS is required to conduct an internal consultation to affirm compliance with the requirements of Section 7(a)(2).

### **1.2.2 NATIONAL ENVIRONMENTAL POLICY ACT**

The purpose of the National Environmental Policy Act (NEPA) of 1969, as amended (42 U.S.C. § 4321 *et seq.*) is to ensure that, before Federal agencies make decisions (in this case deciding

whether to issue an ITP), they consider the effects of their actions on the human environment. NEPA serves as an analytical tool to assess direct, indirect, and cumulative impacts of a proposed action and alternatives. The USFWS must comply with NEPA before it makes an ITP decision. The USFWS is preparing a programmatic NEPA compliance document on the KSHCP with the intent of streamlining NEPA compliance for individual permit decisions.

### **1.2.3 NATIONAL HISTORIC PRESERVATION ACT**

The National Historic Preservation Act (NHPA) of 1966 (54 U.S.C. 300101 *et seq.*) established a comprehensive program to preserve the historical and cultural foundations of the nation as a living part of community life. Section 106 of the NHPA requires Federal agencies to consider the effects of projects they carry out, approve, or fund on historic properties included on or eligible for inclusion on the National Register of Historic Places. Historic properties also include properties of traditional religious and cultural importance to an Indian tribe or Native Hawaiian organization, so long as that property also meets the criteria for listing in the National Register. The issuance of ITPs is considered a Federal undertaking under Section 106 of the NHPA. Section 106 requires that the USFWS assess and determine if the undertaking has the potential to impact historic properties. This assessment may require consultation with the State Historic Preservation Office (SHPO) and appropriate Native Hawaiian groups and other affected parties.

### **1.2.4 FEDERAL MIGRATORY BIRD TREATY ACT**

The Migratory Bird Treaty Act (MBTA) of 1918, as amended (16 USC § 703-712), prohibits the take of migratory birds and makes it unlawful to pursue, hunt, take, capture, kill, possess, offer to or sell, barter, purchase, deliver or cause to be shipped, exported, imported, transported, carried or received any migratory bird, part, nest, egg or product without proper authorization. The avian Covered Seabird Species are protected under the MBTA. Pursuant to USFWS policy, an ITP also constitutes a Special Purpose Permit under 50 CFR § 21.27 for the take of ESA-listed migratory bird species (in this case, the ‘ua‘u, ‘a‘o and ‘akē‘akē), as long as the permit holder maintains compliance with the ITP terms and conditions. Under those circumstances, the take of ESA-listed migratory birds will not be considered a violation of the MBTA.

USFWS regulations require a permit for the banding or marking of migratory birds protected under the MBTA. Any bird banding conducted as part of the KSHCP conservation program will be conducted by persons with Federal and State banding permits.

### **1.2.5 HAWAI‘I REVISED STATUTES, CHAPTER 195D**

Chapter 195D of the HRS defines the State’s responsibilities with respect to species listed as endangered or threatened to protect and conserve native wildlife and their habitats, including species Federally listed as endangered or threatened. Under the provisions of HRS § 195D, species listed as endangered or threatened pursuant to the ESA are also listed as an endangered or threatened species by the State of Hawai‘i law (HRS §195D-4). Section 195D-2 defines “take” similarly to the Federal ESA. Section 195D-3 expressly prohibits, except as permitted by rules, any person to take, possess, transport, transplant, export, process, sell,

offer for sale, or ship any species that the DLNR has determined to be in need of conservation (see also §195D-4(e)).

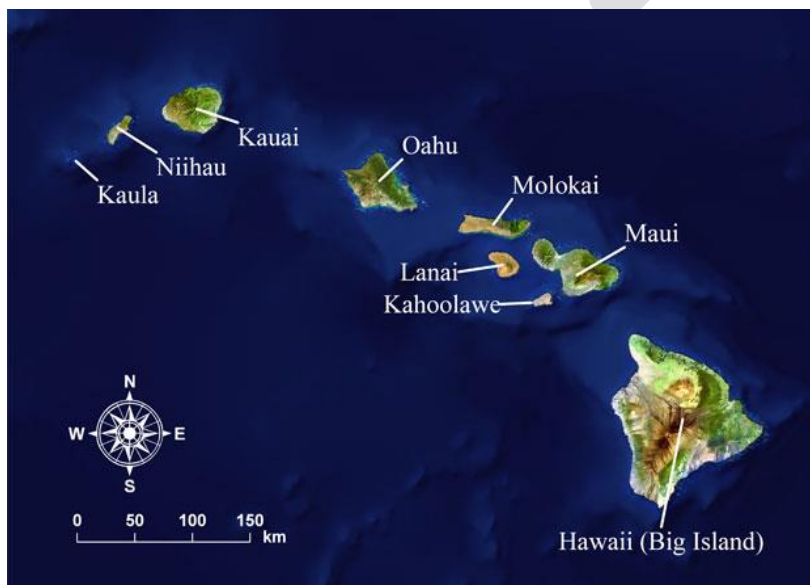
Section 195D-21 states that the State of Hawai'i may enter into an HCP if standards are met as defined in the statute. Section 195D-25 defines the composition and role of the Endangered Species Recovery Committee (ESRC) to provide guidance to the DLNR and the Board of Land and Natural Resources (BLNR) on matters relating to endangered, threatened, proposed, and candidate species. The ESRC is comprised of biological experts, representatives of relevant Federal and State agencies (e.g., USFWS, United States Geologic Survey (USGS), DLNR), and other appropriate governmental and non-governmental members. The ESRC reviews all HCP permit applications and makes recommendations to the BLNR on whether they should be approved, amended, or rejected. The ESRC also reviews all existing HCPs and ITLs annually to ensure compliance, and recommend any necessary changes to HCPs. Chapter 343 of the HRS and its implementing regulations (HAR §11-200) establish a system of environmental review to ensure that environmental concerns are given appropriate consideration in decision-making along with economic and technical considerations. The Hawai'i Office of Environmental Quality Control (OEQC) is responsible for environmental oversight and review under Chapter 343. Section 343-5 mandates the preparation of an Environmental Assessment (EA) or an Environmental Impact Statement (EIS) for activities by agencies [§343-5(a)] or applicants [§343-5(b)] meeting certain conditions.

The KSHCP proposes use of State lands as part of its conservation program and the potential use of State and County of Kaua'i funds, both of which trigger the need for compliance with HRS 343. KSHCP compliance with Chapter 343 will be satisfied by a joint document prepared for NEPA and HEPA compliance.

## 2. ENVIRONMENTAL SETTING

### 2.1 ISLAND OF KAUA'I

The island of Kaua'i lies at the northernmost end (22°03'N, 159°30'W) of the Main Hawaiian Islands (MHI) and is the oldest of the eight main islands (**Figure 2-1**). Measuring 884km<sup>2</sup> - 51km east-west and 35km north-south - Kaua'i is the fourth largest of the main islands in the Hawaiian archipelago. The island is characterized by steep cliffs and deeply eroded canyons and valleys. The north and east coasts receive wind and moisture carried on the trade winds and support lush vegetation, streams, and waterfalls, while the south and west coasts receive minimal moisture and are typically hot and arid. The island supports many valuable natural plant and animal communities including montane bogs, montane wet forest, lowland mesic forest, lava tube caves, long stretches of sandy beach, and many streams and rivers. Because of the age of the island and its relative isolation, Kaua'i contains higher levels of endemism than elsewhere in the State (Mitchell et al. 2005).

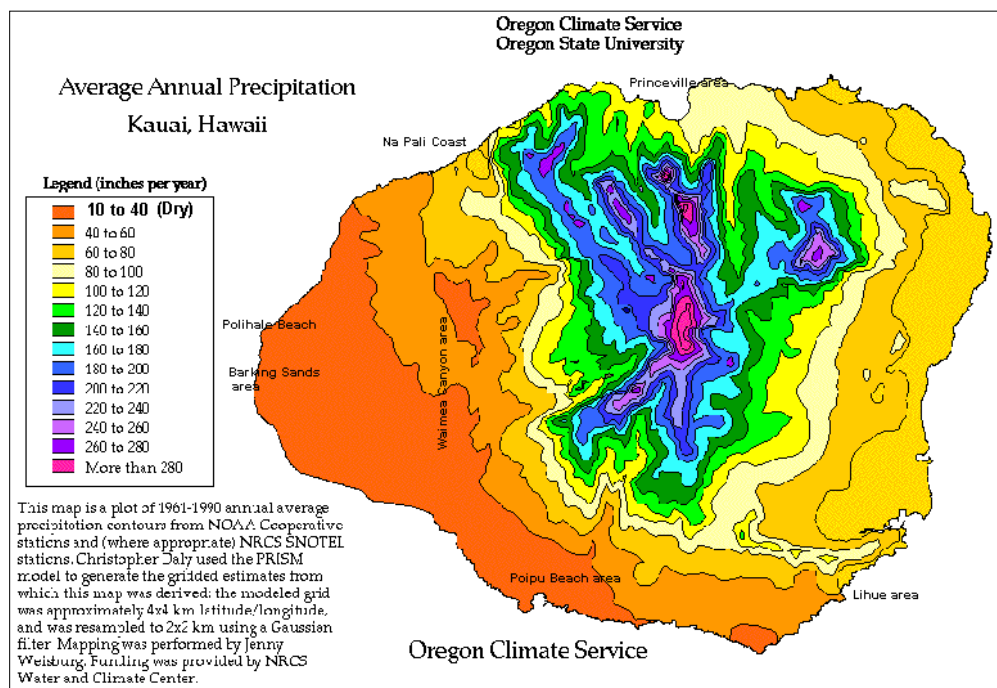


**Figure 2-1. Map of the southeastern Hawaiian Islands, also referred to as the Main Hawaiian Islands (MHI). Source [ccma.nos.noaa.gov](http://ccma.nos.noaa.gov)**

#### 2.1.1 CLIMATE

The climate and weather of Kaua'i is a function of isolation and its location in the tropical North Pacific Ocean, approximately 3540km from the nearest continent. There are significant contrasts in average precipitation and temperatures in different locations on the island. Like the other MHI, the climate varies around the island based on elevation above sea level, altitude-related temperature changes, topography, relative exposure to sunlight, and prevailing winds, especially the trade winds originating from the northeast (NOAA 1985). Trade winds are prominent drivers of climate and weather from May through September when the trades are prevalent 80 to 95% of the time. From October through April, the effects of the trade winds are less prominent across the island (NOAA 1985).

Kaua'i receives varied amounts of annual rainfall at different locations on the island (**Figure 2-2**). Mount Wai'ale'ale is one of the wettest spots on earth receiving an average of more than 1117cm of rain a year (State of Hawai'i 2010). As a whole, the island of Kaua'i receives an average of over 100cm of rainfall. Three-quarters of this total, on average, falls during the seven-month wet season, from October through April. Average precipitation in January, the wettest month, is over 15cm; June, the driest month, receives only about 9.66cm of rain.



**Figure 2-2. Average annual participation on Kaua'i. Source: Oregon Climate Service (August, 1998).**

Hurricanes, (storms with winds in excess of 120km/h) have occurred in the MHI five times over a 62-year period (State of Hawai'i 2010). Tropical storms caused by low pressure systems are more frequent and may be similar to hurricanes but with more modest winds, below 120km/h. Studies based on weather satellite photographs suggest that tropical storms affect areas within the State of Hawai'i every year or two (NOAA 1985). Hurricanes and tropical storms are most likely to occur during the last half of the year, from July through December.

In the past 50 years, strong winds, heavy rains and storm surges caused by periodic hurricanes have resulted in devastating effects (**Table 2-1**). Hurricanes 'Iwa (1982) and 'Iniki (1992) caused extensive damage to native plant communities and 'Iniki also damaged buildings, roadways, utility structures and outdoor lighting.

**Table 2-1. Major hurricanes affecting Kaua'i, 1950-2016**

Name	Date	Maximum winds recorded onshore (km/h)	Saffir-Simpson	Deaths	
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		<b>Sustained</b>	<b>Peak gusts</b>	<b>Hurricane Scale</b>		<b>Property Damage (mil. \$)</b>
Hiki	Aug. 15-17, 1950	109	(NA)	Tropical Storm	1	0.2
Niña	Dec. 1-2, 1957	(NA)	148	1	1	0.1
Dot	Aug. 6, 1959	130	165	2	-	5.5+
‘Iwa	Nov. 23, 1982	104	188	3	1	234
‘Iniki	Sept. 11, 1992	148	230	4	8	1,900

Source: Adapted from Table 5.45 in State of Hawai‘i (2010)

### 2.1.2 TOPOGRAPHY/GEOLGY

Kaua‘i, as well as Ni‘ihau and Ka‘ula, are the eroded emergent remains of three shield volcanoes that stand in over 3600m of water. Kaua‘i was formed during two periods of volcanism between 5.6 million and 3.6 million years ago (mya) (Blay and Siemers 2004). Originally a broad basaltic shield volcano, Kaua‘i was formed by thin sheets of lava gently sloping from the summit. Following the initial period of volcanism, rain, streams, and waves eroded more than 143,226 ha of the island creating: steep sea cliffs; deep canyons and valleys that extend from the interior of the island to the coast; a mountainous interior; a broad coastal plain with deep soil; and extensive beaches (Blay and Siemers 2004).

Roughly circular in shape, Kaua‘i contains striking physiographic features: a high central plateau topping out at over 1500m at the summits of Wai‘ale‘ale (1570m) and Kawaikini (1600m); steep cliffs and deeply incised valleys along the northern Nā Pali coast; the 1100m deep Waimea Canyon; the broad Līhu‘e Basin on the southeastern quadrant of the island; and the extensive coastal dunes of Polihale.

The northern area of the island extends from Kalihiwai to Hā‘ena, where the Nā Pali coast begins, the roads end, and the landscape transitions to regions of incised valleys and steep sea cliffs (300-600m tall). The north shore valleys include Hanalei, Lumaha‘i, Wainiha, Hanakāpī‘ai, Hanakoa, Kalalau, Honopū, Nu‘alolo, and Miloli‘i. The area around Līhu‘e has a low, sloping topography flanked by the Hā‘upu Ridge to the south.

### 2.1.3 HYDROLOGY/STREAMS, RIVERS, DRAINAGES

Kaua‘i’s hydrology is dominated by 61 streams that radiate out from the Wai‘ale‘ale-Kawaikini massif in all directions, 45 of which are perennial (State of Hawai‘i 2010). All significant slopes on Kaua‘i, except the west slope, carry these perennial streams.

#### **2.1.4 EXISTING LAND USE**

In recent history, the economy of Kauaʻi has been a blend of agriculture, tourism and military sectors. Today, the service sectors provide most of the jobs on Kauaʻi, in particular tourism. For most of the past decade, the annual visitor count for Kauaʻi was approximately 1 million people (DBEDT 2016).

The 2010 Census counted the Kauaʻi total population at 67,091 persons (U.S. Census Bureau 2011). Concentrations of development and human populations occur primarily in the coastal areas of the west, south, east and north shores, excluding the undeveloped and rugged Nā Pali Coast in the northwest. The west side of Kauaʻi is sparsely populated. The highest human population densities exist in the towns of Līhuʻe and Kapaʻa on the east coast while the rest of the island features smaller towns and resort areas along the coast.

Kauaʻi has experienced a conversion of land use from agriculture to residences, with many subdivisions featuring large-scale estates. For seabirds, this pattern may have potential to result in increased light attraction effects from lights encroaching into previously dark areas.

### 3. PLAN DESCRIPTION

The KSHCP is an island-wide conservation plan under which each individual Applicant may receive a separate ITP and ITL authorizing incidental take of the Covered Species. The intent in developing the KSHCP was to make it similar to a GCP as described in USFWS policy (USFWS 2007) for streamlining the regulatory processes associated with developing HCPs under Section 10(a)(1)(B) of the ESA. This approach allows for the development of a programmatic HCP suitable to meet the needs of a local area (e.g., the island of Kauaʻi) that will streamline NEPA and other requirements and allow issuance of individual ITPs and ITLs to landowners who apply for such permits and demonstrate compliance with the terms and conditions of the GCP.

The GCP-level approach allows coordinated, cost-efficient and effective conservation actions ([Section 5.4](#)) to occur under the KSHCP to achieve long-term biological goals and objectives ([Sections 5.1 & 5.2](#)) needed to offset incidental take impacts by individual applicants, and to provide a net benefit to the Covered Species as required by State of Hawaiʻi law (HRS § 195D-30). The KSHCP involves multiple Participants (entities that receive an ITP and ITL) under one plan, and recognizes that many entities on Kauaʻi have a desire to comply with Federal and State endangered species statutes, and to adequately address the adverse effects of light attraction on the Covered Species. This sentiment reflects the fact that lights are widespread on Kauaʻi and involve nearly all sectors of industry. By creating the KSHCP to meet the requirements of ITP/ITL issuance criteria, it eliminates the need for each non-Federal entity on Kauaʻi to develop their own HCP for the purposes of receiving an ITP and ITL addressing take of the Covered Species.

Under the KSHCP, private businesses, landowners, cruise ships that dock at Kauaʻi ports, and non-Federal public agencies on Kauaʻi that conduct actions with the potential to cause incidental take of the Covered Species may submit an application for an ITP and an ITL and request incidental take authorization as appropriate to their site-specific situation. The application will be in the form of a Participant Inclusion Plan (PIP) specific to Applicant facilities (see [Section 6.2.2](#) for details on PIPs). The KSHCP defines acceptable scientific approaches for estimating an Applicant's anticipated level of take, for monitoring the effect of the applicant-authorized taking, and for establishing minimization measures and mitigation actions, including long-term management, monitoring and reporting responsibilities to adaptively manage and implement the KSHCP. Evaluation of permit issuance criteria for individual permit applications will be based on adherence to the standards and actions delineated in the KSHCP, and acceptable minimization actions for individual applicants as outlined in PIPs.

Participation in the KSHCP is voluntary and is based on individual Applicant's risk assessments, which in turn are based on records of take of listed seabirds at their facilities. The conservation program under the KSHCP was designed to offset anticipated take impacts of listed seabirds based on pre-application PIPs submitted to the USFWS and DLNR by prospective participants. The location of Covered Activities encompasses light attraction anywhere on the island of Kauaʻi where light structures may occur, and State Lands where mitigation will occur.

### **3.1 ACTIVITIES COVERED BY THE PERMITS**

Two primary categories of Covered Activities likely to cause take of Covered Seabirds are addressed under the: (1) artificial nighttime lighting; and (2) conservation program activities. Each of these categories is discussed below. The mechanism and effects of each of the Covered Activities are described in Chapter 4 ([Section 4.2](#)).

#### **3.1.1 ARTIFICIAL LIGHTING**

The KSHCP covers incidental take requests involving a full range of lighting types present on Kaua'i. Kaua'i contains a variety of lighting types, the specific type and intensity of which depend upon the purpose for the lighting. Under the KSHCP, all types of artificial lighting including land-based lights found at parks, retail stores, resorts, condominium complexes, agribusiness and industrial facilities, as well as lighting on ocean-going vessels such as cruise ships, can be addressed in PIPs. Artificial lighting includes the placement and operation of current light structures, as well as the placement and operation of new or future lights that have similar effects.

Outdoor lighting fixtures may include, but are not limited to:

- Street lights;
- Parking lot lights;
- Security lights;
- Searchlights, spotlights and floodlights;
- Building and structural or architectural lights;
- Building overhang and canopy lights;
- Landscape lights;
- Recreational lights;
- Signage lights; and
- Product display area lights.

Applicants to the KSHCP must submit a PIP, which provides detailed information on outdoor lighting, such as:

- Light type
- Make & model
- Light output (e.g. lumens) & bulb type
- Bulb color
- Quantity (number of fixtures)
- Location
- Purpose of the lights
- Direction of light angle (e.g. up, down, out)
- Full cut-off/shielded fixture (yes/no)
- Time on/Time off

In addition, PIPs must describe any lighting standards required for facility operations or other requirements that necessitate the use of lighting (e.g., required for security, safety, operations) and any plans for future lights.

### **3.1.2 CONSERVATION PROGRAM ACTIVITIES**

The KSHCP conservation program, described in detail in *Appendix A: Kahuama'a Seabird Preserve Management Plan*, is comprised of several activities that collectively may have the potential to “take” individuals of the Covered Seabirds. These mitigation activities include establishment of a seabird social attraction site (SAS) and construction of a predator-proof fence (PPF) enclosing approximately 2ha of suitable seabird breeding habitat.

Comprehensive take-avoidance measures and protocols have been developed to prevent adverse impacts to the Covered Seabirds as a result of these mitigation activities. The specific mitigation activities are summarized below. A complete description of these mitigation actions is provided in the Management Plan (*Appendix A*).

- Construction and long-term maintenance of the 2ha PPF enclosure;
- Installation and long-term maintenance of social attraction equipment (speakers, solar panels, artificial burrows) within the 2ha PPF enclosure;
- Eradication of predators from within the 2ha PPF enclosure and implementation of long-term predator control at the site;
- Monitoring for predator incursions within the 2ha PPF enclosure;
- Barn owl control around the preserve and in the surrounding Kalalau Valley area;
- Feral cat control at ingress points to the SAS and neighboring source colonies in the Kalalau Valley;
- Invasive plant control and vegetation control within the 2ha PPF enclosure and along a 50m ‘predator defense zone’ outside the fence;
- Monitoring of the Covered Seabirds and their burrows/artificial nest boxes, including the physical handling and banding of birds by trained, federally permitted staff;
- Monitoring of other listed species (plants, forest birds, etc.) within the 2ha PPF enclosure; and
- Downed seabird recovery, evaluation, rehabilitation and release to sea.

KSHCP biologists, contractors and technicians implementing mitigation activities will be required to adhere to the take-avoidance measures and protocols referred to as Best Management Practices (BMPs) in the Management Plan (*Appendix A*). The KSHCP Prime Contractor will ensure that all individuals with 1) a designated role to perform research or any handling of listed species necessary for mitigation monitoring activities and/or 2) a designated role to conduct removal of barn owls protected under the MBTA, shall have the necessary required qualifications and permits in advance of doing the work.

The KSHCP Prime Contractor will also ensure that all BMPs are followed and when necessary recommend changes or additions to these BMPs that will be included in the annual KSHCP reports to the USFWS and DLNR for approval and implementation.

### 3.2 COVERED WILDLIFE SPECIES

As discussed above, the KSHCP addresses: the ‘a‘o (*Puffinus auricularis newelli*), the ‘ua‘u (*Pterodroma sandwichensis*) and the ‘akē‘akē (*Oceanodroma castro*). Each of these birds is vulnerable to light attraction, particularly during their post-fledging departure from the breeding colony site, but also as adults. The distribution, abundance, population trends, life history, habitat selection and threats for each of these species are described in detail in *Appendix B: Covered Species Biological Details*.

The KSHCP primarily addresses the effects of light attraction on the Covered Seabirds, but also addresses the effects of artificial lighting on the honu (*Chelonia mydas*). Honu also breed on Kaua‘i, and hatchlings may become disoriented by artificial night time lighting (one of the Covered Activities, [Section 3.1](#)). No take of honu is anticipated under the KSHCP due to take avoidance and minimization provisions under the Plan. All relevant turtle information that was relied upon in the KSHCP (e.g. see the sections on effects of Covered Activities, estimating take, monitoring and minimization) is presented in [Chapter 9](#). Information on honu distribution, abundance, population trends, life history, habitat selection and threats on Kaua‘i is described in detail in *Appendix B: Covered Species Biological Details*.

### 3.3 WHAT IS NOT COVERED IN THE KSHCP

The KSHCP does not address incidental take of any other listed species, including plants<sup>1</sup> or invertebrates, resulting from any of the Covered Activities, including installation of new lights. The maintenance and operation of all facilities and other structures covered under an ITL or ITP in association with the KSHCP shall avoid take of other listed species. If incidental take of species not covered under the KSHCP is likely to occur in conjunction with a specific ongoing or proposed Covered Activity, the Applicant would be ineligible to participate in the KSHCP (unless this take was covered under a separate HCP or through a similar regulatory process). Under those circumstances, the Applicant would need to obtain take authorization for all requested activities and species through a separate ITL and ITP, as appropriate.

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<sup>1</sup> While the ESA does not prohibit take of listed plants, the State of Hawai‘i under HRS 195D-4 does prohibit take of listed plants and may issue temporary incidental take licenses under its provisions.

#### **4. EFFECTS OF THE KSHCP COVERED ACTIVITIES ON THE COVERED SEABIRDS**

This chapter describes the effects of KSHCP Covered Activities (artificial lighting and the KSHCP conservation program) on the Covered Seabirds. The effects of KSHCP Covered Activities on honu are discussed in Chapter 9.

##### **4.1 EFFECTS OF THE KSHCP CONSERVATION PROGRAM**

The KSHCP conservation program includes a social attraction project to establish an ‘a’o population within a 2ha fenced area. Predator fencing, predator removal and invasive plant species management are proposed as part of the social attraction project to protect seabird breeding habitat from degradation and non-native terrestrial predators which prey on seabird eggs, chicks, juveniles and adults. The KSHCP conservation program also includes barn owl and feral cat management activities to protect populations of the ‘a’o, ‘ua’u and 'akē'akē from these predator species. The social attraction project and barn owl and feral cat management activities will be conducted to facilitate successful seabird reproduction and survival to an extent that provides a net conservation benefit over the 30-year duration of the Plan relative to the number of Covered Seabirds that are likely to be subject to take due to nighttime lighting activities on Kaua’i. As noted above in Chapter 2, the KSHCP conservation program also includes recovery, evaluation, rehabilitation and release to sea of “downed” (i.e. those who land from exhaustion after being attracted to artificial lights) Covered Seabirds.

##### **4.1.1 SEABIRD SOCIAL ATTRACTION PROJECT - KAHUAMA‘A SEABIRD PRESERVE**

Implementation of the seabird social attraction project at the Kahuama‘a Seabird Preserve is expected to benefit the ‘a’o. These benefits were estimated in terms of the increase in protected habitat as well as enhancement of the reproduction, numbers and distribution within the Preserve compared to existing baseline conditions for the species in this region of Kaua’i.

The 2ha mitigation/social attraction site is located on Kalalau Rim in northwestern Kaua’i at approximately 1,050m in elevation (i.e. mid- to high-elevation) at a similar elevation to occupied ‘a’o nesting colonies in that region of the island. The habitat and topography were determined to be suitable for predator-proof fencing (L. Young, 2017, pers. comm.). Construction of a predator-proof fence around the native plant dominated habitat at the site will create a montane ecological system closed to terrestrial predators. Within the fenced site, breeding pairs will be attracted using a sound system after eradication of feral cats, rats, and ungulates (pigs, goats, and deer) is implemented. A cat and rodent control grid will also extend 50m around the outside perimeter of the fence to minimize or avoid future terrestrial predator invasion into the fenced site. Barn owl trapping and shooting will be carried out around the perimeter of the fence to protect seabirds recruited to and breeding within the preserve. Non-native, invasive weeds will also be removed within the fenced site to protect existing, native-dominated vegetation and prevent degradation of suitable seabird habitat.

Given the close proximity of known ‘a’o breeding colonies to the social attraction site and the estimated flight paths of shearwaters using this area (USFWS 2017c, a) there is a high likelihood

that prospecting shearwater adults and sub-adults will visit the site and be exposed to social attraction cues. The social attraction site will be managed for the 30-year term of the KSHCP. Therefore, benefits to the 'a'o population on Kaua'i are anticipated to occur until the end of the 30 year period, once the predator-proof fence is completed, predators are removed from the fenced area, and the social attraction is initiated and successful in establishing breeding seabirds within the fenced area.

The long-term management of the 2ha site, which currently contains high quality breeding habitat for seabirds at a level that may support large numbers of nesting seabirds, is critical to support recovery of the 'a'o. This will establish a new breeding colony within a fully protected, terrestrial predator-free area in a native-plant dominated montane ecosystem on the island of Kaua'i. Predation and light impacts contribute to the range-wide endangerment of the 'a'o (USFWS 2017c). The KSHCP conservation program will support the recovery needs of the 'a'o as those needs are described in the Newell's Shearwater Landscape Strategy (USFWS 2017c), by creating and managing a new colony through social attraction in an area with minimal light impacts while mitigating threats at the colony.

Population modeling was used to calculate the anticipated increase in 'a'o reproduction of the population that will be recruited to and breed within the protected, fenced and managed site (*Appendix C: Social Attraction Benefit Estimator*). 'A'o reproduction and survival are impacted by predation at nesting colonies, from late March/early April through mid-November (Raine et al. 2017h). Thus, the beneficial effects for individual shearwaters are anticipated to occur during the breeding season. The beneficial effect on reproduction can be expressed as a change in the number of fledglings produced by the 'a'o pairs anticipated to breed within the fenced site compared to the existing condition for pairs breeding outside the fence. Based on surveys conducted at the site, there may already be some level of on-site breeding activity (*Appendix A: Kahuama'a Seabird Preserve Management Plan*). Between May 31 and June 3, 2016 and August 28-30, 2017, KSHCP staff conducted auditory surveys at the site and observed 'a'o transiting over the site, circling, and possibly calling from the ground on more than one occasion. However, because breeding is unconfirmed, the modeling of population change within the fence is assumed to have a starting population size of zero.

Based on the results of the population modeling, implementation of the seabird social attraction project over a 30 year period is anticipated to provide a reproductive benefit of 697 fledglings to the Kaua'i 'a'o population (*Appendix C: Social Attraction Benefit Estimator*, Table 7). This benefit relies on the following assumptions: (1) completion of a predator exclusion fence protecting 2ha of native habitat by Year 2 of the KSHCP, (2) eradication of terrestrial predators within the fence (100% efficacy of removing feral cats, rats and ungulates) by Year 2, (3) initiation of social attraction in Year 2, (4) initiation of barn owl control around the perimeter of the fence in Year 1 (80% efficacy, discussed in [Section 4.1.2](#)), and (5) 10% of prospecting sub-adult birds are available for recruitment to the site (i.e., sub-adults, ages 2-5 years old, returning to Kaua'i during the breeding season to prospect for nest sites and potential breeding partners). The 100% efficacy in terrestrial predators (ungulates, cats, rats) removal was considered achievable based on the successful eradication of these species in

densely forested habitat within the Nihoku predator exclusion fence located at the Kīlauea Point National Wildlife Refuge (PRC 2017). Additional information on ‘a’o modeling assumptions for site fidelity, flight paths, burrow density and Kaua’i population size are provided in *Appendix C: Social Attraction Benefit Estimator*. Although model outputs indicate the social attraction project could provide a reproductive benefit up to a maximum of 1,045 fledglings, the conservative estimate of 697 fledglings (*Appendix C: Social Attraction Benefit Estimator*, Table 7) was selected to provide a very high level of confidence and certainty in the reproductive outcome that will result from implementation of the project.

Establishing a seabird breeding colony in a terrestrial predator-free enclosure through the broadcasting of breeding calls is an effective and proven conservation tool (Gummer 2003, Sawyer and Fogle 2010, McIver et al. 2016). Jones and Kress (2012) evaluated 128 seabird restoration projects implemented to protect 47 seabird species in 100 locales in 14 countries worldwide. Many of the projects (73 of the 128) used either only acoustic playback or a combination of decoys and acoustics to attract seabirds. Thirty-four percent (16 of 47) of those projects aimed to restore threatened or critically endangered seabird species populations. The most successful seabird restoration projects worldwide (83% of successful projects) involved seabird species in the taxonomic family *Procellariidae*, in which the ‘a’o belongs, demonstrating the high level of confidence in this restoration approach for the ‘a’o.

#### **4.1.2 BARN OWL AND FERAL CAT CONTROL IN KALALAU VALLEY**

The benefits to the Covered Seabird populations from implementation of barn owl control and feral cat control in Kalalau Valley were estimated in terms of seabird distribution, reproduction, and numbers. Barn owl control will consist of trapping and shooting, carried out monthly, or as-needed, in identified territories of barn owls within Kalalau Valley. Observations by DLNR-DOFAW avian predator control technicians on Kaua’i suggest a continuing invasion every 3 to 12 months of new individual barn owls, into territories where control efforts are carried out (G Reid 2017, pers. comm.). Feral cat control will consist of regular trapping, along the rim of the Kalalau Valley, an area where cats have been observed on a near-weekly basis (K Pias 2016, pers. comm.). The trapping and shooting of barn owls and feral cats will benefit existing nesting colonies of Covered Seabirds in Kalalau Valley throughout the term of the 30-Year plan duration. The effects of the barn owl and feral cat control in Kalalau Valley on the Covered Seabirds discussed in this section are in addition to the effects of the barn owl and feral cat control around the perimeter of the fence at the Kahuama’a Seabird Preserve on ‘a’o (discussed above).

The breeding phenology and susceptibility of the Covered Seabirds to predation by barn owls and feral cats suggest that barn owl and feral cat control will result in an increase in the reproduction and numbers of seabirds breeding in Kalalau Valley outside of the 2ha Preserve site. According to population distribution models and data collected on seabird occurrence and threats, seabird predation by non-native barn owls and feral cats during the breeding season contributes to limiting the distribution of Covered Seabirds on the island of Kaua’i (Troy et al. 2014, Raine et al. 2017e, USFWS 2017c). The Covered Seabirds are primarily susceptible to predation by barn owls and feral cats during the 6-9 months following breeding periods when

they are present at nesting colonies. The specific period is species dependent: ‘a’o, late March/early April through mid-November (Raine et al. 2017i); ‘ua’u, early April through end December (Raine et al. 2017i); and ‘akē’akē, late May through mid -October (Raine et al. 2017c).

Immediate actions in Year 1 of the KSHCP to protect occupied breeding habitat of the Covered Seabirds from barn owls and feral cats, will address an important component of the survival and recovery needs of these species within the Kalalau Valley. The control of barn owls and feral cats will enhance adult survivorship and reproductive success of pairs breeding in the affected area (USFWS 2017b).

#### 4.1.2.1 Benefits to the ‘A’o from Barn Owl and Feral Cat Control

The ‘a’o population in Kalalau Valley that will be protected is estimated at 2,700 birds, using statistical methods employed in USFWS (2017a). This meta-population size was projected by USFWS, based on statistical analyses of ‘a’o calling data from auditory surveys conducted by the Kaua’i Endangered Seabird Recovery Project (KESRP). The KESRP calling data was compiled by USFWS in Geographic Information Systems (GIS) that allows mapping of numbers of calls and their locations relative to specific areas on Kaua’i. This information is packaged into separate polygons (i.e., shapes linked to geographic areas). As the data contained in KESRP polygons do not have an estimate of colony size, a statistically rigorous assessment relating calling data to information on environmental variables (e.g., slope, aspect) collected at known seabird breeding burrows was developed to proportion out the ‘a’o population estimate into each polygon, allowing for meta-population estimates (Joyce (2013). The subset of the ‘a’o meta-population within Kalalau Valley that is breeding outside the proposed 2ha fenced site is estimated to include 2,700 individuals.

The benefit of barn owl and feral cat control on ‘a’o reproduction was estimated using a mitigation efficacy calculator (USFWS 2017a) and adjusted based on additional information on adult and chick distributions across the populations projected in the models, provided by the USFWS in May 2017. The effect on reproduction was expressed as a change in the number of fledglings produced by the breeding pairs estimated to breed in Kalalau Valley (outside of the 2ha Preserve site) compared to the existing condition. Implementation of barn owl control is anticipated to provide a reproductive benefit of five ‘a’o fledglings per year and 150 fledglings over the 30-year duration of the KSHCP, based on the following assumptions: 80% decrease in barn owl predation of ‘a’o in the Kalalau Valley; beginning barn owl control in Year 1 of the KSHCP; and otherwise low ‘a’o predation levels within the Kalalau Valley (as defined in *Appendix C: Social Attraction Benefit Estimator*). These results (as well as the estimated benefit of feral cat control below) rely on the assumption that breeding adults protected by predator control (above the baseline level) will contribute to the anticipated fledglings increase in reproduction annually. Model estimates will be updated as needed with results of monitoring data, as described in Section 12.1.3 of *Appendix A: Kahuama’a Seabird Preserve Management Plan*.

The effectiveness of barn owl control in the Kalalau Valley will likely be limited by the level of barn owl detection, which is influenced by a frequency of monitoring and control activities. Therefore, the KSHCP estimates assume an 80% reduction in the number of shearwaters predated by barn owls. For example, in 2015 in an area which has received intensive predator control since 2011 (Upper Limahuli), an adult 'a'o was found predated by a barn owl and at least one barn owl was observed hunting on multiple occasions (Raine et al. 2016b).

Implementation of feral cat control is expected to provide a reproductive benefit of ten 'a'o fledglings per year and 300 fledglings over the 30-year duration of the Plan. This is based on the following assumptions: 30% decrease feral cat predation of 'a'o in the Kalalau Valley; beginning feral cat control in Year 1 of the KSHCP; and otherwise low 'a'o predation levels within the Kalalau Valley (as defined in *Appendix C: Social Attraction Benefit Estimator*). This predation level is described in USFWS (2017a), and is consistent with modeling for the social attraction project (discussed above).

The spatial coverage of feral cat trapping will likely limit effectiveness of the feral cat control in the Kalalau Valley. Under the KSHCP, the feral cat control will suppress the ingress of feral cats via the rim of the valley (a known movement corridor of feral cats) into 'a'o breeding sites. The control is not expected to stem the influx of feral cats from the valley floor, where feral cats occur in high numbers (Pias 2016, pers. comm.). Further surveys are needed to evaluate the movement patterns of cats in the valley to determine the extent of primary cat corridors up valley walls to breeding sites. At nearby 'a'o nesting colonies within Hono o Nā Pali Natural Area Reserve (NAR), at least 11 'a'o (8 adults and 3 chicks) were predated by feral cats over the two year period, 2014 -2015. During this same time cat control was ongoing in montane areas within the NAR (Raine and Banfield 2015a, Raine and Banfield 2015b, c, Raine et al. 2016a, Raine et al. 2016d, Raine et al. 2016e). Based on the above and the locations of 'a'o breeding colonies within the Kalalau Valley (Section 5.4, Figure 5-1 and *Appendix A: Kahuama'a Seabird Preserve Management Plan*), efficacy estimates are conservative and assume that trapping along the rim of Kalalau Valley will achieve a 30% reduction in the number of shearwaters predated by feral cats.

In addition, the estimated 'a'o reproductive benefit of predator control was based on the 2018 projected 'a'o population size. This estimate did not take into account the changes to the population in the valley throughout the Plan term from 1) ongoing impacts of remaining predation (rats, cats, pigs and barn owls) or 2) beneficial effects of establishing a breeding colony of 'a'o within the fully protected, terrestrial predator-free, fenced social attraction site ([Section 4.1.1](#)).

#### *4.1.2.2 Benefits to the 'Ua'u and 'Akē'akē from Barn Owl and Feral Cat Control*

Due to the low amount of 'ua'u and 'akē'akē take anticipated to be covered under the KSHCP (described in [Section 4.2.1](#)), no modeling of these species populations was conducted to estimate the potential increase in their reproduction due to mitigation measures, inclusive of

barn owl and feral cat control. However, these species are expected to experience some benefits from these mitigation measures.

One of the largest 'ua'u populations outside of the Haleakalā colony on the island of Maui breeds in Kaua'i at Hono o Nā Pali NAR, adjacent to Kalalau Valley. In Hono o Nā Pali NAR, a minimum of 240 burrows were documented across several colonies, including the Pihea, Pohakea, and North Bog colonies (Raine et al. 2017h, f, g). The 'ua'u population breeding in native-dominated forest on the southwestern rim of Kalalau Valley is likely an extension of the Pihea colony.

Song meters and auditory surveys have been used to monitor the populations in this area because the terrain is often too steep to allow safe searching for burrows (Raine et al. 2017h). The same song meters monitored populations of both 'a'o and 'ua'u in this area, on 450 total nights and 501 total hours (Raine et al. 2017h). The song meters in this study were programmed to record 1 out of every 5 minutes, for 5 hours starting at sunset, then record 1 out of every 10 minutes for the 5 hours preceding sunrise.

In 2015, the highest number of calls detected by these song meters in the Kalalau rim area equaled approximately six 'a'o calls per minute ( $6.37 \pm 6.56$  calls/minute  $\pm$  sd) and five 'ua'u calls per minute ( $4.77 \pm 4.24$  calls/minute  $\pm$  sd) (Raine et al. 2016a). These sites were also surveyed in 2013 and 2014, and no significant differences were found between years for all three years of both 'a'o and 'ua'u monitoring (Raine et al. 2016a). Barn owls and feral cats regularly predate 'ua'u at their nesting colonies. For example, the carcasses of adult 'ua'u depredated by barn owls were found in the Upper Limahuli colony in 2011 (n=2) and in the Pohakea colony in 2013 (n=1) (Raine et al. 2017f). In Hono o Nā Pali NAR over the two year period (2014-2015) at least 36 seabirds were predated by feral cats of which seven carcasses were confirmed to be 'ua'u (4 adults and 3 chicks), 11 confirmed to be 'a'o, and the rest (n=18) could not be identified to species (Raine and Banfield 2015a, Raine and Banfield 2015b, c, Raine et al. 2016a, Raine et al. 2016d, Raine et al. 2016e).

Evidence of an 'akē'akē population in Kalalau Valley is based on detections of 'akē'akē vocalizations during their breeding season (Wood et al. 2002, Raine et al. 2017c). Additional ground and auditory surveys are needed to estimate the population of 'akē'akē in Kalalau Valley; however, auditory detections of high rates of calling indicate that 'akē'akē is likely breeding throughout the valley ([Section 5.4](#), Figure 5-1 and *Appendix A: Kahuama'a Seabird Preserve Management Plan*). Raine et al. (2017c) reported that 'akē'akē calling rates in this area, detected during auditory surveys (conducted in 2006-2015), exceed 128 calls per hour. The carcass of a depredated 'akē'akē found on the Nā Pali Coast and observations of barn owls attracted to broadcast calls of 'akē'akē during banding sessions (Raine et al. 2017c) suggest barn owls regularly hunt this species. Feral cats are known to occur on the rim above the valley, between Honopū Valley and Kalalau Valley (Banfield et al. 2014), and are likely also preying on 'akē'akē breeding near the top of walls of Kalalau Valley (where calling has been heard, see [Section 5.4](#), Figure 5-1 and *Appendix A: Kahuama'a Seabird Preserve Management Plan*).

It is reasonable to assume that the barn owl and feral cat control will provide an annual benefit of at least 2 fledglings and 2 adult or sub-adult 'ua'u and at least 1 fledgling and 1 adult 'akē'akē on Kaua'i. This is based on known breeding activity of 'ua'u and 'akē'akē (discussed further below) in the Kalalau Valley, records of predation by barn owls and feral cats of these species in nearby colonies, and the anticipated increase in reproduction and adult survival resulting from barn owl and feral cat control. Over the 30-year term of the KSHCP, this benefit totals 60 fledglings and 60 adults or sub-adults of 'ua'u as well as 30 fledglings and 30 adults or sub-adults of 'akē'akē.

#### **4.1.3 RECOVERY AND RELEASE OF DOWNED SEABIRDS**

Reducing mortality of fledglings and adult seabirds that have been grounded (i.e. those that have landed and cannot regain flight from fatigue due to attraction to artificial lights) will contribute toward recovery of the Covered Seabird populations on Kaua'i. All three of the Covered Seabirds are impacted by light attraction on Kaua'i, although at different rates based on the Save our Shearwaters (SOS) program recovery data (Reed et al. 1985, Harrison et al. 1990, Cooper and Day 1998, DLNR 2016). The SOS is a nonprofit that collects, treats, and releases all native Hawaiian wildlife as well as grounded birds on Kaua'i.

Research comparing the survival of SOS-released 'a'o fledglings to survival of fledglings that naturally disperse out to sea from montane breeding colonies (i.e., naturally-fledged) was carried out over 3 seabird fledging seasons (2014, 2016, and 2017). The research relied on tracking birds using satellite tags and comparing their survival rates over time.

The objective of the 2014 study was to evaluate attachment technique and tagging technology. The study selected only the healthiest SOS birds that were most likely to survive; birds deemed suitable for *immediate release* (within 1-2 days). The study found that all 'a'o fledglings in the study travelled to an area 2km southwest of the Hawaiian Islands. The tags transmitted location data for an average of 20-days (min = 11 d, max = 31 d, median = 18.5 d) (Raine et al. 2015, p. 6). All birds ceased to transmit movement activity within 2-weeks, based on an activity sensor in the tag that measures the animal's head tilt. The 2014 study demonstrated that SOS-released 'a'o fledglings were able to successfully travel to their pelagic foraging areas, however, the degree to which fitness levels of individuals of the Covered Species are improved by the SOS program after an injury, was unclear.

Therefore, research was conducted again in 2016 and 2017 to compare the survivability of birds beyond 14 days of SOS-released 'a'o fledglings to the survival of naturally fledged shearwaters. Fourteen days is expected to be the maximum time period in which a hatch-year bird would need to learn how to feed itself or succumb to starvation (Mougin et al. 2000), and is the time period in which we would expect the hatch-year bird to succumb to any unknown injuries from being grounded, if those injuries were present but not observed prior to release (Raine et al. 2017a). The 2016 study included individuals submitted to SOS and deemed healthy (e.g. good release weight, plumage, body condition, and lack of physical injuries) and suitable for immediate release (within 1-2 days). Data from 2016 resulted in 83% of both naturally fledged (from Upper Limahuli) and SOS-retrieved fledglings (n=12) that survived beyond 14-days. The

2017 tagging study used both SOS-birds suitable for immediate release and SOS-birds that had spent up to 14 days in rehabilitation to compare with naturally-fledged birds (Raine et al. 2018). The 2017 study used only the individuals that met SOS standard release requirements<sup>2</sup>. One-hundred percent of SOS birds suitable for immediate release (n=4); 77% of SOS-rehabilitated birds (n=13); and 100% of a naturally fledged bird (n=1) survived at-sea beyond the two week threshold.

All SOS-released and naturally fledged hatch-year birds in the 2014, 2016, and 2017 studies, successfully traveled to foraging grounds at-sea southwest of the Hawaiian Islands and exhibited normal movement patterns as indicated from tagging data (Raine et al. 2015, Raine et al. 2017a, Raine et al. 2018). The length of time tags transmitted in 2016 and 2017 suggest that the 2014 cohort of tagged birds likely suffered due to weather or climatic conditions affecting food availability (Raine et al. 2016, Raine et al. 2017, p. 21) rather than effects from the tagging.

Additionally, in 2016, an adult ‘ua’u that had collided with a powerline and was recovered and tagged with a satellite transmitter by KESRP and subsequently flew just under 50,000 km to foraging sites, transmitting for 159 days until the tag battery fell off (Raine et al. 2017b). The distance and time traveled by this ‘ua’u suggests that some seabirds discovered and collected under powerlines following a serious injury (collision), and rehabilitated for a period of more than two days, may also experience the same foraging and movement patterns as a seabird that did not collide. However, the Hawaiian petrel, which was a breeding adult, did not return to its burrow that year and thus was a failed breeder. Nonetheless, it is important to note that without recovery and rehabilitation of downed birds, the potential for rehabilitation and survivability would not be possible.

## **4.2 IMPACT OF TAKING ON THE COVERED SPECIES**

### **4.2.1 TAKE DUE TO ARTIFICIAL LIGHTING**

Artificial lights affect the Covered Seabirds by degrading the transitory habitat for movement of fledglings in particular from the breeding colonies to the ocean. Fledgling seabirds may become confused or disoriented and suffer extreme fatigue when attracted to artificial lights. Seabirds affected by light attraction exhibit the following typical sequence of behaviors. Seabirds initially approach light sources from higher altitudes and exhibit a period of rapid flight and circling of lit areas. This is followed by descent and slowing of flight, and ultimately “fallout” by landing on the ground at locations where they normally would not have landed (Reed et al. 1985, Telfer et al. 1987) or colliding during flight with artificial structures such as wires, poles, or buildings (Ainley et al. 2001, Travers et al. 2016). Grounded seabirds can suffer injury, starvation,

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<sup>2</sup> The SOS standard release requirements include no apparent injuries, good body condition (at least a 2 on a 3-point scale), normal mentation, good flap test, and non-damaged/non-contaminated plumage. Waterproofing also needs to be demonstrated for birds spending time in rehab (Raine et al. 2018). This group does not include birds which SOS consider ‘marginal’ releases (e.g., compromised due to feather condition).

predation, or collision (e.g., with vehicles). Seabirds that collide in flight with artificial structures are commonly injured or killed.

Grounding Covered Seabirds due to light attraction is considered “take” in the form of ‘harm and harass’ under the ESA and State of Hawai‘i laws; however, not all grounded seabirds experience the same level of injury. The KSHCP conservation measure of recovering, evaluating, rehabilitating (if needed), and releasing Covered Seabirds in adequate condition is anticipated to mitigate the injury or harm of the affected individual caused by light attraction when the individual released meets the SOS release standard and is released within 48 hours (2 days) of being grounded (see [Section 4.1.3](#)). Therefore, seabirds that receive this treatment are considered “non-lethal” take. Grounded seabirds that are not recovered (i.e., undiscovered seabirds) are considered to have been taken in the form of harm, however, these undiscovered seabirds are anticipated to eventually suffer mortality due to predation, vehicle collision, or starvation and dehydration. Therefore, seabirds that are killed due to collisions or other factors related to a grounding event, and grounded seabirds that are not recovered are referred to hereinafter as “lethal take”.

Covered Seabirds turned into SOS that cannot be rehabilitated and released (e.g. due to severe injury or poor body condition) are euthanized. These seabirds and those that die under rehabilitation are also considered to be taken in the form of harm, and referred to hereinafter as “lethal take”. Of the ‘a’o recovered by SOS in the ten-year period (2006-2016), an 88% average were deemed to be in good condition and released back into the wild (SOS, unpublished data). The remaining average 12% resulted in mortality of downed ‘a’o (i.e. seabirds turned in dead, those that died while in care, and those deemed unfit for release back into the wild (i.e. euthanized)).

This statistic is generalized for all birds turned in to SOS, and does not account for site-specific circumstances at each Applicant’s facility. Each Applicant will review their individual SOS records to make a determination on the anticipated number of seabird injuries or mortalities that will result from their Covered Activities. The methods for KSHCP Applicants to determine the amount of take of Covered Seabirds at their facilities and to account for estimated injuries or mortalities are described in [Section 6.2.2](#), which specifies the requirements for preparing a PIP. Rapid discovery of Covered Seabirds, proper handling, as well as awareness and education of seabird fallout is expected at a Participant facility(s) as part of minimization efforts required under the KSHCP (see [Section 5.3](#)). If carried out diligently, rapid discovery will contribute towards lower seabird mortality rates, and thus overall lower levels of lethal take at a Participant facility(s).

The timing of take of fledgling Covered Seabirds is primarily during the period when they leave their natal colony (the fledging period) from September 15 - December 15 each year. Adult Covered Seabirds may also be attracted to lights while transiting to and from their nesting colony, during the species’ specific nesting periods (i.e. ‘a’o, late March/early April through mid-November (Raine et al. 2017h); ‘ua’u, early April to end December (Raine et al. 2017i); and ‘akē’akē, late May through mid-October (Raine et al. 2017c)). Higher levels of seabird fledgling

take are expected during new moon periods than during full moon periods, likely because the moon is one of the visual clues seabirds use for first time navigation to the sea (Telfer et al. 1987).

It is anticipated that the annual take of Covered Seabirds will remain constant over the 30-year duration of the KSHCP and its associated ITPs and ITLs, based on recent trends of SOS recoveries island-wide in Kaua'i ('a'o, years 2011-2015; 'ua'u, 2000-2015). Over these years, SOS island-wide recoveries of the 'a'o and the 'ua'u have been stable (DLNR 2016), indicating a stable/consistent rate of threats to the current populations. It is important to note this stable annual downed rate of seabird recovery is at the latter half of the total time durations since first documentation of these threats occurred and after a ten year period (1993-2013) when the populations of 'a'o and 'ua'u were estimated to have declined by 94% and 78% respectively (average annual rate of ~13% and 6% respectively) (Raine et al. 2017d). One exception to the steady annual recovery rate during this period was a large fallout event in 2015 at the Kōke'e Air Force base near 'a'o breeding colonies. Significant modifications to the light regime have since been made to minimize fallout threats at the base (USAF 2016). This indicates that even though development on the island of Kaua'i may have increased lighting levels during these respective periods of time, island-wide, the threat of fallout of 'a'o and 'ua'u have been stable.

Because the KSHCP functions as a plan under which multiple entities may apply for incidental take authorization, it cannot be known exactly how much take will be covered under the KSHCP until potential permit recipients submit take requests and receive permits from the regulatory agencies. Therefore, estimates summarized in this section are considered the maximum take amounts that could be permitted under the KSHCP. An amendment to the KSHCP would be necessary if take requests exceed these maximum take amounts (see [Section 6.13.1](#) and [6.13.2](#) on minor and major amendments). Individual take requests of entities participating in the KSHCP will be presented in PIPs and not described in this section.

#### *4.2.1.1 Direct Take of Fledglings, Adults, and Sub-adults*

The amount of take anticipated under the Plan, including annual and 30-year take amounts, is based on analyses of available data provided by DOFAW, USFWS, and prospective Applicants for an ITP and ITL under the KSHCP. During the development of the KSHCP, prospective Applicants were identified, contacted and encouraged to join the KSHCP. DOFAW provided pre-application technical assistance to interested parties using data analyses of SOS recovery records of the Covered Seabirds.

The annual take amounts under the KSHCP are totals of specific estimates derived using methodologies to estimate Applicant take as described in [Section 6.2.2](#). The five-year average (2011-2015) of SOS recoveries at an Applicant's facility(s) was used to estimate take amounts for 'a'o for individual Applicants. A 15-year period (2000-2015) of SOS recoveries was used to estimate take of the 'ua'u and 'akē'akē for individual Applicants because fallout of these species is a much rarer occurrence. Considerably fewer 'ua'u, and even less 'akē'akē, are grounded by light attraction according to recent SOS program recovery records (DLNR 2016). Of the total

SOS recoveries of the Covered Seabirds in the years 2011 to 2015 (n=853, including fledglings, adults, and sub-adults), 5% were 'ua'u (n=43) and 0.6% were 'akē'akē (n=5).

The majority of the light attraction take on the island of Kaua'i involves fledgling seabirds. Adults and sub-adults are occasionally found in association with bright lights, usually near breeding colonies (e.g. northern region of the island of Kaua'i). The percentage of adult 'ua'u and 'akē'akē (~20%) of the total for each species, is higher than 'a'o (~5%) in island-wide SOS recoveries of the Covered Seabirds. Less is known of the likelihood of adult take of petrels occurring at prospective Applicant facilities.

The background information described above on island-wide SOS recoveries, pertaining to the species composition, the percentage of seabirds deemed to be in good condition and released, and the likelihood of adult take per species, is not necessarily reflective of the fallout records of prospective Applicants. However, fallout of the prospective Applicants is expected to be stable, consistent with the recent, island-wide fallout trend. Table 4-1 describes the take anticipated under the KSHCP, including lighting impacts to Covered Seabirds resulting in mortality (lethal take) and impacts resulting in injury or harm with subsequent recovery, evaluation, rehabilitation (if needed) and release to sea (non-lethal take). In addition, take estimates assume implementation of ongoing lighting modifications (see [Section 5.3](#)) which may reduce impacts to seabirds, but do not completely eliminate lighting threats.

#### 4.2.1.2 Indirect Take of Dependent Eggs or Chicks

The numbers of Covered Seabird chicks or eggs that are likely to be killed as a result of its parent's death) due to light attraction were estimated (Table 4-1) using information on population demographics. Based on this information, up to two 'a'o chicks or eggs (1.75 rounded to 2) are likely to be killed over the 30-year KSHCP duration. This assumes 70% of adults killed due to light attraction would have been breeding and 50% of breeding attempts would have resulted in a chick fledging the nest (i.e. breeding probability of 70% and reproductive success of 50%) (Griesemer and Holmes 2011). Also, based on this information, up to 10 'ua'u chicks or eggs (9.6 rounded) are likely to be killed over the 30-year term of the KSHCP, assuming a breeding probability of 89% (Simons 1984) and reproductive success of 72% (Simons 1985).

No data exists on the population demographics of 'akē'akē in the Hawaiian Archipelago. However, breeding probability and reproductive success of adult pairs in the European storm-petrel (*Hydrobates pelagicus*), a similar sized small seabird (Dunning 2008) in the same family (*Hydrobatidae*; order *Procellariiformes*) as the 'akē'akē, was estimated at 69% (Hemery et al. 1986 in Mougins et al. (1997)) and 53% to 63%. This range is from four studies, 1980 to 2001, in Cadiou (2001) and consistent with Sanz-Aguilar et al. (2008). Based on these data from an analogous species, three 'akē'akē chicks or eggs are likely to be killed over the 30-year Plan duration, assuming 69% breeding probability and 58% reproductive success (mid-point of above range).

An injury of a parent Covered Seabird and its subsequent rehabilitation and release of an adult (its survival) may disrupt incubation or provisioning patterns, and result in the loss of a chick or egg. Both ‘a’o and ‘ua’u parents take turns incubating the egg and provisioning the chick. Therefore, the number of Covered Seabird chicks or eggs that are likely to be killed as a result of this disruption of adult care was estimated using the population demographic information explained in the previous paragraph (Table 4-1).

**Table 4-1. Maximum anticipated take amounts for the ‘a’o, ‘ua’u, and ‘akē’akē under the KSHCP.**

	Total Annual		Total 30-year	
	Mortality (Lethal)	Injury (Non-lethal)	Mortality (Lethal)	Injury (Non-lethal)
<b>‘a’o</b>				
Fledglings	30	45	900	1,350
Adults or sub-adults	0.33	0.33	10	10
Eggs/chicks	<0.1	<0.1	2	2
<b>‘ua’u</b>				
Fledglings, adults, or sub-adults	1	1	30	30
Eggs/chicks	0.33	0.33	10	10
<b>‘akē’akē</b>				
Fledglings, adults or sub-adults	0.5	0.5	15	15
Eggs/chicks	0.1	0.1	3	3

#### 4.2.2 TAKE IMPACTS IN RELATION TO COVERED SEABIRD POPULATION SIZE AND REPRODUCTION

To provide perspective on the impact to the affected Covered Seabirds’ adult population and reproduction, the estimated take is expressed as a proportion of the adult population size and the number of fledglings produced annually for the Covered Seabirds’ Kaua’i populations. This value was calculated using the reproductive rates described in [Section 4.1](#) and population estimates in *Appendix C: Social Attraction Benefit Estimator*.

In the Kaua’i population of ‘a’o, the annual mortality of 30 fledglings and less than 0.1 eggs or chicks (Table 4-1) represents 1.44% of the total fledglings produced or 2,086 fledglings. This assumes 63.7% of the population is adults, the reproductive rates are as described above, and a Year 1 population of 18,720 birds (*Appendix C: Social Attraction Benefit Estimator*, Table 3; 80% of this population in flight path estimates equals 14,976 birds). The mortality of 0.33 adult ‘a’o per year represents less than 0.01% of the total estimated Kaua’i adult population (11,925 adults).

The ‘ua’u population residing on the island of Kaua’i is estimated at 1,200 to 1,600 pairs (Ainley et al. 1997a, Pyle and Pyle 2009). At this level, the mortality of one adult per year due to light

attraction would represent up to 0.03% to 0.04% of the Kaua'i adult 'ua'u. In comparison, the mortality of one fledgling and 0.33 eggs or chicks of the 'ua'u per year equals 0.13% to 0.17% of the total fledglings produced on Kaua'i (an estimated population of 769 - 1,025 fledglings given the Kaua'i breeding adult population range and reproductive rates as described above).

Based on the estimated Kaua'i population of 'akē'akē of 171-221 breeding pairs, (Wood et al. 2002) and reproductive data of European storm petrel discussed above, the mortality of 0.5 fledglings and 0.1 eggs or chicks of the 'akē'akē per year represents 0.68% to 0.88% of the estimated total fledglings produced annually by this species (68 – 88 fledglings). Comparatively, the mortality of 0.5 adult 'akē'akē per year equals 0.11% to 0.15% of the Kaua'i adult population of this species.

#### 4.2.3 PROPORTION OF ISLAND-WIDE LIGHT ATTRACTION EFFECTS COVERED UNDER KSHCP

The total amount of take potentially covered under the KSHCP will be less than the total island-wide light attraction effects to the Covered Seabirds. Approximately 50% of the total downed birds recovered by SOS are not attributable to any specific, consistent, or known source of light attraction. For this portion of light attraction impact, there is no identifiable entity to apply for take authorization. Additionally, there are several entities with identified ongoing take that will be mitigated through other means (e.g., federal entities, KIUC, etc.). Finally, not all of the identified, eligible entities expressed interest in participating in the KSHCP.

Of the total island-wide light attraction fallout of the Covered Seabirds, the following is expected to be covered and mitigated for directly by the KSHCP (Table 4-2): about 23.5% of 'a'o take, 11.6% of 'ua'u take, and 50% of 'akē'akē take. Annual island-wide take estimates (rounded to whole numbers), denoted by the asterisk (\*) in Table 4-2, are calculated from average SOS recoveries (2011–2015) with a 50% searcher efficiency rate to account for grounded birds present but not found (Ainley et al. 1995). Estimates of island-wide take and total amount addressed under the KSHCP do not include indirect effects to chicks or eggs.

**Table 4-2. Proportion of island-wide light attraction take impacts covered under the KSHCP.**

'A'o	Annual	30-year	'Ua'u	Annual	30-year	'Akē'akē	Annual	30-year
Total island-wide take estimate	322*	9,660	Total island-wide take estimate	17*	516	Total island-wide take estimate	2*	60
Total amount addressed under KSHCP	75.66	2,270	Total amount addressed under KSHCP	2	60	Total amount addressed under KSHCP	1	30
Proportion addressed	23.5%		Proportion addressed	11.6%		Proportion addressed	50%	

under KSHCP		under KSHCP		under KSHCP	
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#### 4.2.4 TIMING OF KSHCP - IMPACT OF DELAY IN MITIGATION BENEFITS IN RELATION TO TAKE IMPACTS

As discussed in [Section 4.1.3](#) above, under the KSHCP, light attraction-related take of fledgling, sub-adult, or adult Covered Seabirds resulting in injury (but not mortality), is likely to be offset in the same year (i.e., in-year) by mitigation consisting of recovery, evaluation, rehabilitation (if necessary), and release to sea of downed seabirds. Seabird recovery and rehabilitation services will be provided throughout the duration of the Plan, either through the SOS program, or another rehabilitation provider (see Chapter 7 - Funding).

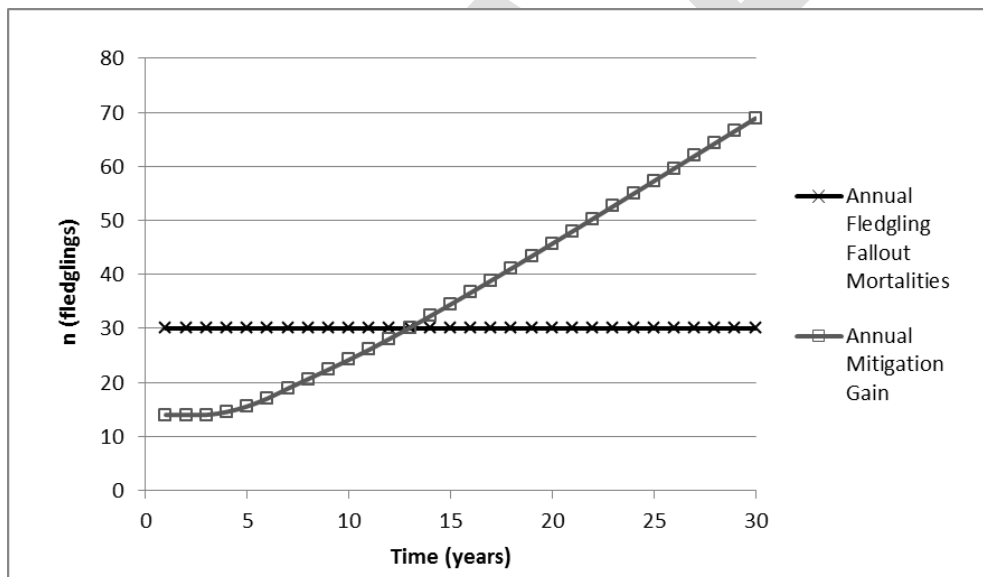
Barn owl control and feral cat control in the Kalalau Valley to be implemented under the KSHCP is anticipated to provide a complete, possibly greater than in-year offset of the total anticipated lethal take of 'ua'u and 'akē'akē proposed under the KSHCP ([Section 4.1.3](#)). Therefore, no delay in accruing reproductive benefits for these species is anticipated. However, given the estimated level of take of the 'a'o as a result of light attraction and the delay in accruing benefits to 'a'o reproduction from the seabird social attraction project, only a partial in-year offset of 'a'o take is anticipated in the first 12 years of the KSHCP implementation.

'A'o reproductive benefits (i.e., via an increase in fledgling production) being provided by the seabird social attraction project are expected to be delayed due to a combination of factors. These primarily include: (1) the conservative estimate of the starting population within the fenced 2-ha site (zero); (2) the several years to recruit breeding adults and increase breeding adult numbers at the social attraction site; and (3) the time delay to breeding age (6 years old) of fledgling birds that return to breed at the site. This is not the case for anticipated reproductive benefits from barn owl and feral cat control in the Kalalau Valley, for which the increase in 'a'o reproduction (15 fledglings) begins in the first year of the KSHCP.

Under the KSHCP, the standard for mitigating take of the 'a'o resulting in mortality will be as follows: increasing 'a'o reproduction by one fledgling will be necessary to offset each fledgling or egg/chick mortality, and by 3 fledglings to offset the mortality of one adult, given an juvenile/sub-adult survivorship of 0.33 (Ainley et al. 2001). One out of the 15 'a'o fledglings produced annually as a result of barn owl and feral cat control provides for a complete in-year offset for the adult 'a'o mortalities anticipated to be covered under the KSHCP (1 adult every 3 years or 0.33 annually). This means the reproductive benefits of the seabird social attraction project increases each year beginning in year 4 (*Appendix C: Social Attraction Benefit Estimator*). When these benefits are added to the remaining benefits of the barn owl and feral cat control (14 fledglings annually), there is a partial in-year offset of fledgling mortalities in Years 1 to 12 of the KSHCP, a complete in-year offset in Year 13, followed by a greater than in-year offset in Years 14-30 (Figure 4-1).

The delay in achieving mitigation benefits for the ‘a’o as a result of the seabird social attraction project (*Appendix C: Social Attraction Benefit Estimator*) and the partial in-year offset of ‘a’o fledgling take in Years 1 to 12 results in a loss of ‘a’o productivity over the term of the KSHCP. Because of the delay, the Kaua’i ‘a’o population is likely to experience a loss in breeding productivity due to the mortality of fledglings that would have returned to breed as adults and the loss of productivity of their progeny and subsequent progeny. The number of ‘a’o fledglings subject to take impacts that are not mitigated for in the same year as the take impact is shown in Figure 4-1, including 16 fledglings in Year 1, with a decreasing, in-year mitigation deficit from Years 4 until Year 12.

The loss in ‘a’o reproduction represented by these impacts that are not mitigated in-year, represents progeny that would have survived to breeding as well as the loss in reproduction of their progeny and subsequent progeny. These effects were calculated for each year of the 30-year KSHCP, based on an ‘a’o juvenile to adult survival of 0.28, breeding probability of 70%, and reproductive success of 50% (*Appendix C: Social Attraction Benefit Estimator*; Griesemer and Holmes (2011) low predation). The number of ‘a’o fledglings that the surviving breeding adults, their progeny, would have produced is equal to 81 fledglings over 30 years.



**Figure 4-1. Annual take of fledgling ‘a’o and annual increase in ‘a’o fledglings (i.e. annual mitigation gain) likely to result from KSHCP conservation program\***

\*Note: An annual increase of one out of the 15 fledgling ‘a’o is not included in the annual mitigation gain, because the one ‘a’o fledgling is anticipated to mitigate the proposed annual adult take of 0.33.

#### 4.3 NET EFFECTS OF ANTICIPATED TAKE IMPACTS AND THE KSHCP CONSERVATION PROGRAM

Over the 30-year term of the KSHCP, the seabird social attraction project, the barn owl control, and feral cat control are likely to result in a positive 'a'o reproduction output trajectory relative to the fledgling take impacts covered by the KSHCP. Due to the expected delay in productivity at the social attraction site, the Kaua'i 'a'o population is likely to decrease by ~25 breeding adults (0.21% of the Kaua'i adult population in 2018?) by Year 16 of the KSHCP. However, in Year 27 of the KSHCP, the cumulative 'a'o fledglings produced by the conservation program (fledglings produced at the social attraction site plus by nesting 'a'o in areas subject to barn owl and feral cat control) is likely to exceed the total fledgling take and total loss of productivity in fledglings from the delay in mitigation (980.7) (Figure 4-2).

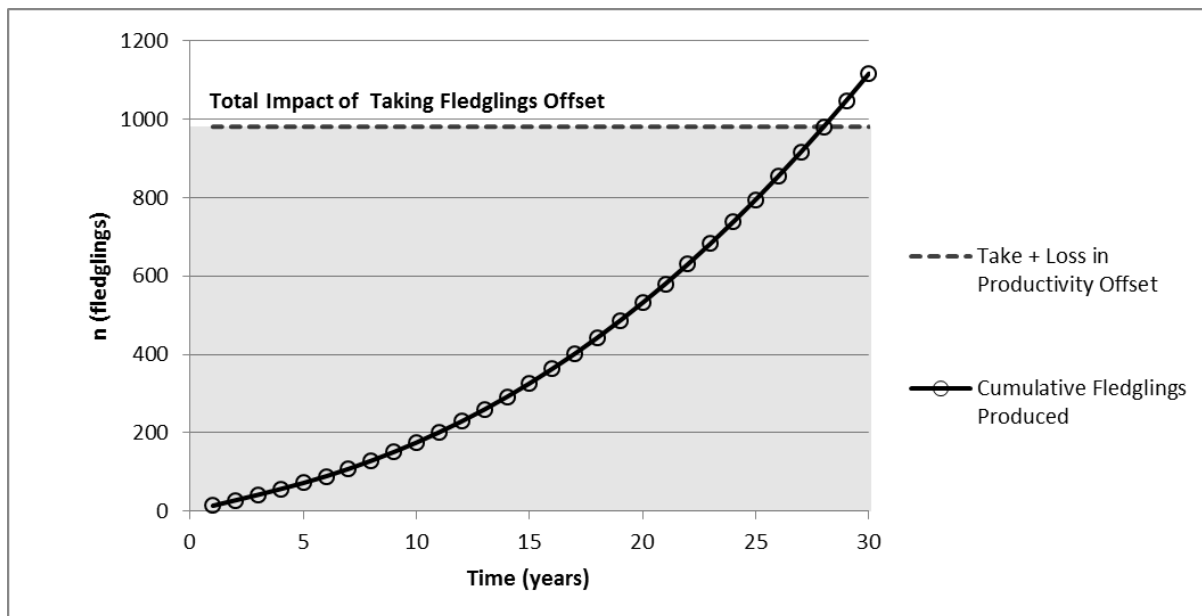
From Year 27 through Year 30, the KSHCP conservation program is likely to provide a net benefit to the 'a'o population of 136 fledglings (Figure 4-2). Note: if the requested take amount by KSHCP Participants is below the maximum level of take anticipated under the KSHCP (see Table 4-2), the conservation program would likely offset the take impacts more quickly than Year 27. Subtracting the 2 fledglings required to offset the chick/egg loss from mortality of 10 adult 'a'o over the 30-year term of the KSHCP results in a total net benefit of 134 fledglings. The resulting 'a'o fledgling mitigation replacement ratio (fledgling mortalities: fledglings produced) therefore would be 1:1.14 at the end of the plan term.

A complete in-year offset of adult 'a'o lethal take impacts covered under the KSHCP (an average of 1 adult every 3 years) is likely to be provided annually by the barn owl control and feral cat control along the rim of Kalalau Valley.

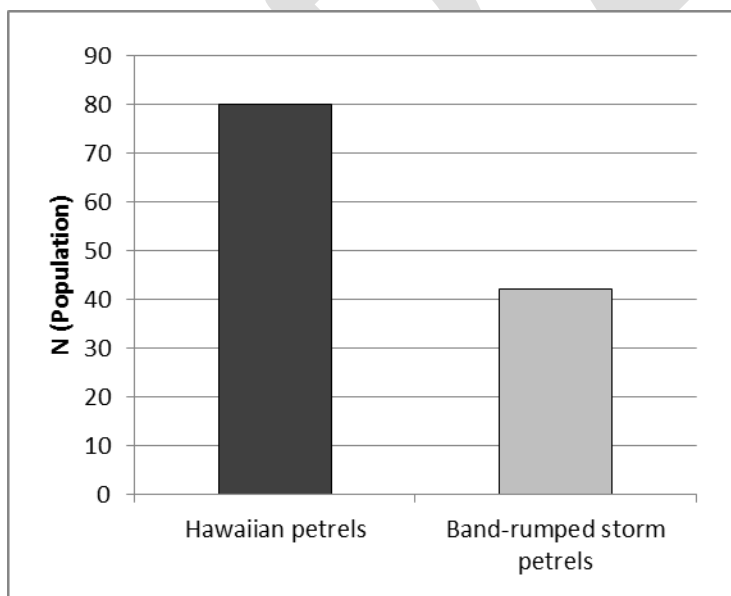
The net effect of the KSHCP is therefore predicted to be a positive impact on the range-wide population of the 'a'o by more than offsetting the adverse take impacts covered under the KSHCP. The overall effects of the take and the conservation program on the 'a'o population would result in a total net benefit of 134 fledglings. In Year 30, a population of ~372 shearwaters, growing at a rate of 8% per year ( $\lambda$  of 1.08), would reside within the protected fence site; this represents ~6% of the projected total Kaua'i 'a'o population at Year 30 (6,200 individuals; *Appendix C: Social Attraction Benefit Estimator*). While the annual level of 'a'o take under the KSHCP represents 1.44% of the anticipated total fledgling production and less than 0.01% of the Kaua'i adult population ([Section 4.2.1](#)), the conservation program would result in protection of ~6% of the Kaua'i population by year 30. This equals ~5.4% of the range-wide 'a'o population (6,888 individuals; 90% of 'a'o breed on Kaua'i (Ainley et al. 2001).

The barn owl and feral cat control in Kalalau Valley is also predicted to have a positive impact on the range-wide population of the 'ua'u and 'akē'akē. Beginning in the first year of the KSHCP, the fledglings, adults or sub-adults, and eggs/chicks produced will exceed the annual take of one 'ua'u and 0.5 'akē'akē. Thirty years of barn owl and feral cat control is likely to provide a total net benefit to the Kaua'i 'ua'u population of up to 80 individuals (Figure 4-3). This control will also provide, over the 30 years, a total net benefit to the Kaua'i 'akē'akē of up to 42 individuals (Figure 4-3). Although the magnitude of the range-wide beneficial effect of

KSHCP mitigation on the ‘ua‘u and the ‘akē‘akē is small, it is nevertheless positive and commensurate with the impact of the KSHCP on these species.



**Figure 4-2. Cumulative ‘a’o fledglings produced, in relation to the total fledgling production required to offset the total impact of the taking of the fledglings (including loss in productivity) in the KSHCP.**



**Figure 4-3. Total net benefit of 30 years of barn owl and feral cat control expressed in the number of individuals added to the Kaua’i ‘ua’u population and Kaua’i ‘akē’akē population.**

## 5. KSHCP CONSERVATION PROGRAM

This chapter identifies the KSHCP conservation goals and objectives and outlines the:

- Avoidance and minimization measures to reduce take of the Covered Species
- Conservation measures to mitigate for the unavoidable effects of authorized take of the Covered Seabirds

### 5.1 BIOLOGICAL GOALS

Section 10(a)(2)(AB) of the ESA requires that an HCP Participant specify the measures that the will be implemented to minimize and mitigate, to the maximum extent practicable, the impacts of the taking of any Federally listed animal species as a result of activities addressed by the plan.

As part of the “Five Point” Policy adopted by the USFWS and NMFS in 2000, HCPs must establish biological goals and objectives (65 *Federal Register* 35242, June 1, 2000). The purpose of the biological goals is to ensure that the operating conservation program in the HCP is consistent with the conservation and recovery goals established for the species. These goals are developed based on the species’ biology, threats to the species, the potential effects of the Covered Activities and the scope of the HCP.

The biological goals described below serve as the foundation for the conservation measures that will be undertaken as part of the KSHCP.

Goal 1: Under the KSHCP, avoid and minimize take impacts to the Covered Seabirds caused by nighttime lighting on Kaua’i to the maximum extent practicable for the 30-year term of the KSHCP. The effects of nighttime lighting on the Covered Seabirds represent a major threat to their survival and recovery.

Goal 2: Under the KSHCP, mitigate authorized take impacts of the Covered Seabirds by enhancing, protecting and managing suitable seabird breeding habitat on Kaua’i to facilitate successful fledgling production at a level that over the 30-year Plan term offsets or exceeds the take impacts caused by Covered Activities on the production of fledglings in the wild.

### 5.2 BIOLOGICAL OBJECTIVES

The biological objectives defined below are intended to **provide specific and measurable targets** for achieving the KSHCP goals. The regulatory requirements to minimize and mitigate the impacts of the taking of the Covered Species form the foundation for the goals and objectives described in **Table 5-1**. This table lists all goals and objectives relevant to the KSHCP; however, not all objectives are relevant to all Participants. The explicit responsibilities that each Participant must uphold in order to meet the objectives of the KSHCP are described in detail in the individual Participant Inclusion Plans (PIPs) (see *Appendix D: PIP Template*).

It is important to note that since ‘a’o take impacts comprise the majority of the take anticipated to be covered under the KSHCP, mitigation strategies under the KSHCP are primarily geared towards increasing productivity for this species. The minimization measures and conservation actions of the KSHCP will also serve to minimize the impacts on and offset requested take for the ‘ua’u and the ‘akē’akē.

Each PIP submitted in support of an ITP application must define the specific combination of minimization strategies to be implemented by the individual Participant (permittee) at their respective facility. The PIP must also define the level of funding that the Participant will provide to support implementation of KSHCP conservation measures to mitigate for the effects of their unavoidable take of the Covered Species. The proposed minimization plan should consider the needs and uses of lights, any regulations pertaining to the uses of lights, and the guidelines defined in [Section 5.3](#) (Avoidance and Minimization) below.

Under the KSHCP, conservation measures will be implemented to mitigate the impacts of authorized take on the Covered Seabirds by all Participants in the Plan. While the KSHCP conservation measures follow the goals and objectives of approved recovery plans for the Covered Species, the actions are not, in and of themselves, intended to achieve recovery of the Covered Species. State of Hawai‘i law (HRS Ch. 195D) requires that mitigation provide a net benefit to the Covered Species and the HCP shall “increase the likelihood that the species will survive and recover.”

Federal law requires that in order for an ITP to be issued, the taking will be minimized and mitigated to the maximum extent practicable and will not appreciably reduce the likelihood of survival and recovery of the listed species in the wild (16 USC 1539). In that regard, a combination of applicable minimization and mitigation measures in a PIP should be applied that are likely to avoid and/or minimize the impacts of the taking and mitigate unavoidable take impacts commensurate with the impact on the Covered Species. That determination will be made on an individual PIP basis according to the requirements for issuance of an ITP under Section 10(a)(2)(B) of the ESA.

Development of the conservation objectives (Table 5-1) for the KSHCP relied on various USFWS and DLNR recovery and management planning documents, including:

- USFWS Newell’s Shearwater Landscape Strategy (USFWS 2017c);
- USFWS Appendix II. Modelling Methods and Results used to Inform the Newell’s Shearwater Landscape Strategy (USFWS 2017a);
- Newell’s Shearwater and Hawaiian Petrel Recovery: Five-year Action Plan (Holmes et al. 2015);
- Newell’s Shearwater Population Modeling for HCP and Recovery Planning (Griesemer and Holmes 2011);
- USFWS Seabird Conservation Plan – Pacific Region (USFWS 2005);
- DLNR Hawai‘i’s Comprehensive Wildlife Conservation Strategy (Mitchell et al. 2005); and

- USFWS Recovery Plan for the Hawaiian Dark-rumped Petrel and the Manx Shearwater (USFWS 1983).

An emphasis was placed on considering most current available scientific information in developing the conservation objectives of the KSHCP relative to Covered Seabirds. Much of the current data (including the results of colony-based conservation and monitoring work) has been gathered by KESRP funded under the KIUC Short-term Seabird HCP (Raine et al. 2017h, f, i, g). Funding has also been provided by the National Fish and Wildlife Foundation (NFWF), St. Regis, and the State Wildlife Grant (SWG) program.

Table 5-1 lists the biological goals and objectives of the KSHCP. These are key to the KSHCP conservation framework. Objectives will be met annually if a year is not specified. Additional tables in subsequent sections and in *Appendix A: Kahuama'a Seabird Preserve Management Plan* detail how these objectives will be achieved and monitored, and how mitigation credit will be determined for each objective. Objectives 1.E and 2.I address honu; all other honu objectives are detailed in Chapter 9.

**Table 5-1. Biological goals and objectives of the KSHCP.**

Biological Goals	Biological Objectives
Goal 1: Under the KSHCP, avoid and minimize take impacts to the Covered Species caused by nighttime lighting on Kaua'i to the maximum extent practicable for the 30-year term of the KSHCP. The effects of nighttime lighting on the Covered Species represent a major threat to their survival and recovery.	1.A. Avoid and minimize the impacts of the taking of Covered Seabirds due to light attraction by removing or turning off lighting, and altering light structure and function by the end of Year 1, as specified in PIPs.
	1.B. Minimize mortality of Covered Seabirds downed due to light attraction by implementing actions to reduce presence of free-roaming seabird predators such as cats and dogs at Participant facilities, as specified in PIPs.
	1.C. Minimize mortality of Covered Seabirds downed due to light attraction by conducting annual Worker Seabird Awareness and Response Training (WSART), as specified in PIPs.
	1.D. Minimize mortality of Covered Seabirds downed due to light attraction by implementing seabird awareness outreach to the public, guests, and customers at Participant facilities as specified in PIPs.
	1.E. Avoid and minimize honu hatchling disorientation due to lighting at beachfront facilities by implementing best lighting practices as specified in PIPs, and protecting any nests at facilities via shielding as needed
	1.F. Implement recovery and release of Covered Seabirds downed due to light attraction through the Save Our Shearwaters (SOS) program or other certified rehabilitation facility.

<p>Goal 2: Under the KSHCP, mitigate authorized take impacts to the Covered Seabirds by enhancing, protecting and managing suitable seabird breeding habitat on Kaua'i to facilitate successful production of fledglings at a level that over the 30-year term of the Plan offsets or exceeds the impacts of light attraction take caused by Covered Activities on the production of fledglings in the wild.</p>	<p>2.A. Construct a predator-proof fence and install social attraction equipment (nest boxes, speakers) within the fenced area at the mitigation site in Year 1 of KSHCP implementation.</p>
	<p>2.B. Remove predators from within the fenced enclosure with monitoring confirmation of their absence, and activation of the social attraction equipment by Year 2; predator eradication within fenced enclosure maintained for the life of the project.</p>
	<p>2.C. Ground activity by Covered Seabirds documented at the mitigation site by Year 4 of KSHCP implementation.</p>
	<p>2.D. Breeding activity by Covered Seabirds documented at the mitigation site by Years 5-7 of KSHCP implementation.</p>
	<p>2.E. Cumulative upward trend in Covered Seabird breeding documented at the mitigation site by Year 10 of KSHCP implementation.</p>
	<p>2.F. Continued cumulative upward trend in Covered Seabird breeding documented at the mitigation site by Year 20 of KSHCP implementation.</p>
	<p>2.G. Maintain high quality seabird habitat at the mitigation site by removal of habitat modifying invasive plants in Year 1 and annually throughout the 30-year duration of the KSHCP.</p>
	<p>2.H. Protect nesting birds inside mitigation fence and in nearby source colonies by implementing predator control of 1) barn owls within the area surrounding the fenced enclosure and the Kalalau Valley, and 2) feral cats at ingress points to source colonies in the Kalalau Valley, beginning in year 1 and annually throughout the 30-year duration of the KSHCP.</p>
	<p>2.I. Annual protection of any honu nests adjacent to facilities via shielding or other measures to avoid light attraction take.</p>

### 5.3 MEASURES TO AVOID AND MINIMIZE TAKE IMPACTS (BIOLOGICAL GOAL 1)

Measures to avoid and minimize the impacts of light attraction on the Covered Species are an integral part of the KSHCP. Avoidance measures and minimization measures aim to reduce the potential for take of a Covered Species. The avoidance and minimization efforts outlined below, and detailed in *Appendix E: Guidelines for Adjusting Lighting at Facilities* reflect the best available science on seabird friendly lighting.

#### 5.3.1 ADJUSTING LIGHTING AT FACILITIES

*Appendix E: Guidelines for Adjusting Lighting at Facilities* includes the following measures to avoid and minimize take impacts to Covered Seabirds:

- Deactivate non-essential lights
- Install full cut-off light fixtures
- Shield light fixtures
- Angle lights downward
- Place lights under eaves
- Shift lighting according to moon phase (during the fall-out period)
- Install motion sensors for motion-activated lighting
- Decrease lighting levels
- Decrease visibility of interior lights
- Use light-less technologies
- Plant vegetation around lights to reduce light visibility
- Lower height of lights
- Use longer light wavelengths

These guidelines are intended to be used in individual PIPs submitted to the USFWS and DLNR as part of the application process. Under the KSHCP, all minimization measures must be implemented within Year 1 of an ITP/ITL and maintained throughout the life of the permit/license. Compliance with the avoidance and minimization measures in PIPs will be monitored and reported at the onset of the KSHCP, and annually thereafter (see [Section 6.8.1](#)). New facilities or expansion of existing facilities identified in PIPs shall use, as appropriate, the avoidance and minimization measures described in this section.

The installation of “new” lights (those that are proposed or planned but do not exist at the time of the application for take permit/license) has the potential to exacerbate existing adverse light attraction impacts on Covered Seabirds and cause fallout (i.e. take) of seabirds. Participants in the KSHCP shall consult with the USFWS and the DLNR in advance on their plans to install new lights at existing facilities or to construct new facilities to determine the required avoidance and minimization measures. Depending on their potential impact, installation of new lights at an existing Participant’s facility may require an amendment to a PIP and the permit that has been issued to a Participant.

### **5.3.2 REDUCING PREDATORS AT FACILITIES (OBJECTIVE 1.B)**

Where minimization measures are not likely to result in the avoidance of seabird take, minimizing mortality of downed seabirds is critical. Seabirds that are downed at Participant facilities are vulnerable to direct mortality from predation by free-roaming dogs, cats, rats, and other predators. Downed seabirds that subsequently become preyed are considered lethal take (see [Section 4.2.1](#)). In order to receive incidental take authorization from the USFWS and DLNR, Participants are required to reduce the presence of predators at their facilities.

The following measures are required, to reduce the potential for Covered Seabird predation at Participant facilities:

- 1) Prohibit loose, free-roaming cats and dogs (e.g. leash and/or restrain). This prohibition will be clearly communicated with appropriate signage; and
- 2) Conduct a trapping and removal program at the facility for feral cats and dogs; feral animals should be taken to the Humane Society and not returned to the facility even if neutered.

Minimization measures will be described in individual PIPs submitted to the USFWS and DLNR as part of the application process. All measures to reduce presence of predators must be implemented within Year 1 of an ITP/ITL, and as needed throughout the life of the permit/license, if predators are present at Participant facilities (see [Section 6.8.3](#) and requirement to record predator presence).

### **5.3.3 CONDUCTING SEABIRD AWARENESS TRAINING AND OUTREACH (OBJECTIVES 1.C & 1.D)**

An important step in reducing mortality of downed seabirds is quickly finding and recovering (i.e. capturing and turning birds in to the SOS facility for rehabilitation) them efficiently. This is most likely to occur when on-site staff and workers are properly able to identify Covered Seabirds, understand and fully implement the protocol for their detection and safe capture, and have a clear search strategy.

Under approved PIPs, each Participant is required to conduct annual outreach and training for workers at their facilities that is specific to Covered Seabirds, beginning in Year 1 of the KSHCP. A detailed slideshow presentation was developed on this subject will be provided by the Prime Contractor staff on request; handouts are also provided in this document under *Appendix F: Training and Outreach Materials*. Other presentations or programs could be developed to meet this objective, subject to approval by the Prime Contractor. The goal is to properly train workers who will be responsible for the monitoring of downed seabirds at facilities, and who may find a downed seabird incidentally while performing other duties.

Each Participant will also produce seabird outreach materials tailored to their customers, guests, or the public who may be present at their facilities during the seabird fallout season. These materials will supplement efforts of Participant staff members by encouraging more “eyes on the ground” to identify and recover downed seabirds. Outreach at facilities can also help increase general awareness of endangered species issues on Kauaʻi.

Outreach materials may include, but are not limited to:

- Making guests/residents aware of the requirement to close blinds/curtains during seabird fallout season to reduce light attraction caused by interior lights;
- Seabird identification information;
- Location of nearest SOS aid stations;
- Instructions for handling seabirds and notifying appropriate staff; and
- Coloring books, children’s activity books, cartoon depictions, or other means of educating young age groups.

### **5.3.4 RECOVERY AND RELEASE OF DOWNED SEABIRDS (OBJECTIVE 1.E)**

#### ***5.3.4.1 Recovery of Downed Seabirds***

To adequately achieve Objective 1.E, all Participants are required to strive to recover all downed birds at their facilities and to notify the SOS program and the wildlife agencies as soon as possible as to the location, time and condition of all Covered Seabirds found and recovered. This objective requires that PIPs include a formal, organized search strategy to find downed seabirds. Participant Monitoring Plans, included in PIPs are required to include details on the search strategy, including a map of search routes (which should vary), the frequency of searches, likely problem locations and how these locations will be searched, the personnel involved, time required to complete the searches, date(s) on which searching will be conducted and how data will be collected and presented. PIPs will also include specific procedures for handling downed seabirds that are found and recovered. See *Appendix D: PIP Template*.

#### ***5.3.4.2 Rehabilitation and Release of Downed Seabirds***

KSHCP Participants must submit downed seabirds to an appropriately permitted rehabilitation facility where the birds can be evaluated, treated as needed, and released if possible. Currently all downed birds on Kaua'i are turned into the SOS program. This program has been in existence since 1978, when the DLNR initiated this community-based conservation effort. Funding to perpetuate the SOS program has come from various sources, but has been primarily funded via the KIUC since 2005, initially as part of their Short Term HCP. KIUC has stated their intent to continue funding the SOS program for a portion of their long term HCP (i.e. the KIUC Long Term HCP, in prep). In the event that the SOS program is no longer available, a veterinarian with appropriate permits to handle listed species would be hired by the Prime Contractor to accomplish this minimization measure (see [Section 6.11.12](#)).

The SOS program facility is Federal and State licensed. SOS staff process all downed seabirds and rehabilitate those that require additional care to improve their health and overall condition before release. Downed seabirds are assumed to be able to contribute successfully to population productivity if they are deemed healthy and are successfully released in a timely manner. Through the SOS evaluation process, downed seabirds receive a thorough physical examination including testing of feather waterproofing and treatment of injuries as necessary. In addition, any downed seabirds found dead at a Participant facility property will be turned into the SOS program for research (autopsy, discovery of cause of death, stomach contents analysis) and record keeping purposes.

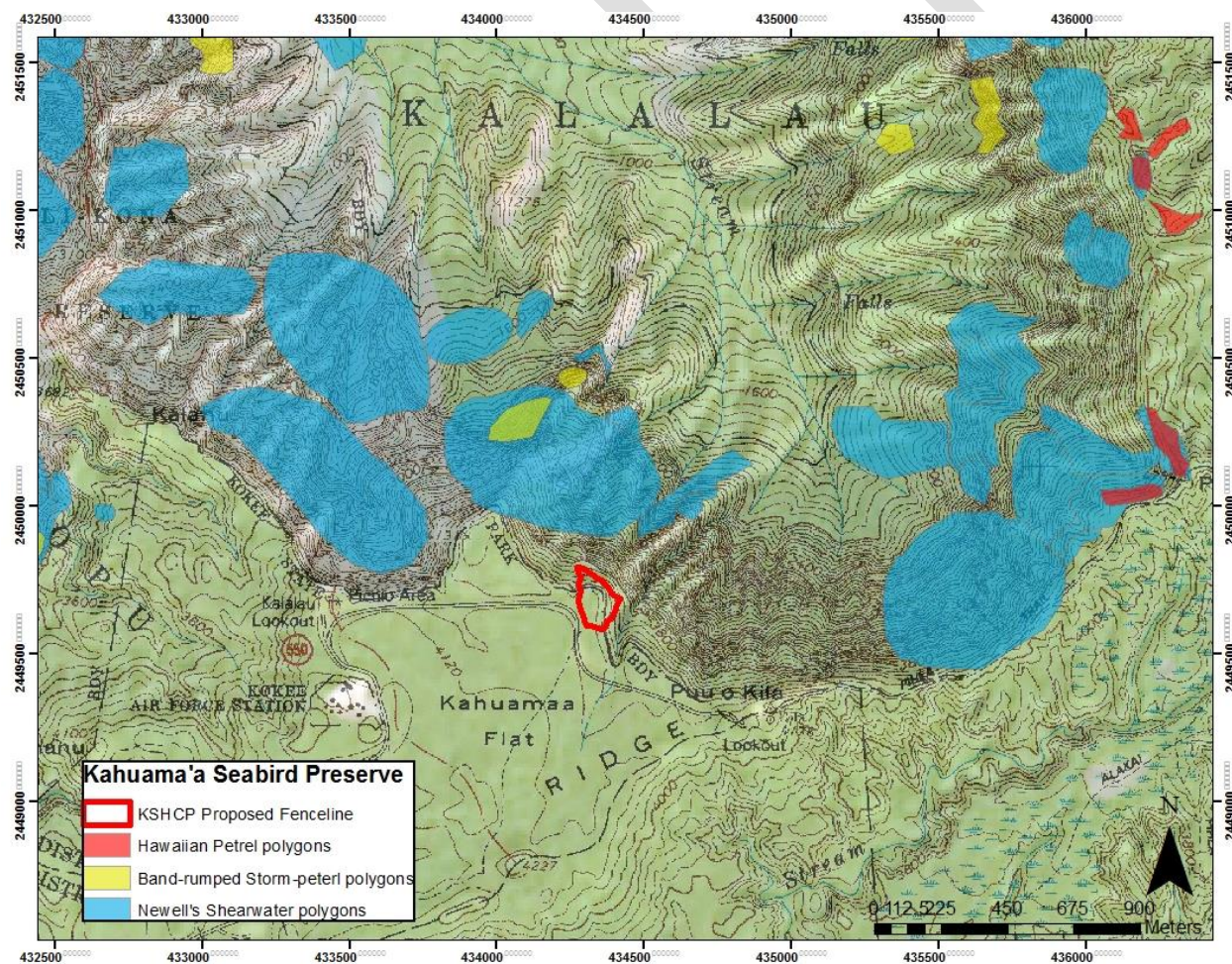
### **5.4 CONSERVATION MEASURES TO MITIGATE UNAVOIDABLE IMPACTS (BIOLOGICAL GOAL 2)**

Mitigation to offset authorized incidental take of the Covered Seabirds consists of conservation activities to increase breeding probability, breeding success and survival of the Covered Seabirds, and provide a net conservation benefit over the 30-year duration of the KSHCP.

To achieve this objective, a seabird preserve (the Kahuama'a Seabird Preserve) will be created. Conservation actions at this site will include terrestrial predator proof fencing, predator

eradication and the implementation of social attraction (playing Covered Seabird calls to attract birds on the flyway from neighboring colonies to breed inside the protected predator proof fence). Feral cat control will be conducted to prevent the ingress of cats into the Kalalau Valley colonies as well as keep cats away from the fenceline to prevent reinvasion inside the predator proof fence. Barn owl control will be conducted to further reduce the threat from predation.

Predation at breeding colonies is a primary threat to the survival of the Covered Seabirds (Ainley et al. 2001, Griesemer and Holmes 2011, Raine et al. 2017c, Raine et al. 2017e). Abating the threat of predation through fencing, predator removal, and social attraction is predicted to mitigate the effects of the take authorized under the KSHCP by increasing the breeding production of the Covered Seabirds from the baseline existing condition. The seabird preserve site is located in the north-west of Kaua'i, along the rim of the Kalalau Valley, straddling two State parks: Kōke'e and the Nā Pali Coast (Figure 5-1). The site is located in a geographic area known as Kahuama'a Flats. Full details on the creation and management of this seabird preserve are included in *Appendix A: Kahuama'a Seabird Preserve Management Plan*.



**Figure 5-1. Kahuama'a Seabird Preserve, located on the rim of the Kalalau Valley.**

‘A’o are the primary target of the conservation measures proposed at the Kahuama’a Seabird preserve because the amount of take is higher than the other Covered Species and therefore likely to be requested by the ITP/ITL Applicants in their respective permit/license requests. The lower levels of anticipated take of ‘ua’u and ‘akē’akē by Participants will be offset through active predator control for the introduced barn owl around the preserve and the Kalalau Valley, where both of these seabird species are known to nest (see Figure 5-1).

The selection of a site for a predator proof fence and social attraction project as the primary mitigation strategy to offset take impacts under the KSHCP was based on extensive consultation with conservation agencies and experts in seabird biology using the latest scientific information and analysis. Construction and maintenance of a fenced, predator free enclosure is a preferred conservation measure because it creates a sanctuary for seabird breeding, and is the only assured way to remove all predators. Predator control work alone (without a fence) is not sufficient to prevent all depredation of seabird eggs, chicks, and adults and guarantee a sufficient level of productivity to offset the take impacts anticipated under the KSHCP.

Table 5-2 lists the selection criteria that were used to evaluate the preserve site, how the site ranked in relation to these criteria, and the data source used for the evaluation. These criteria were adapted from an unpublished social attraction site ranking system that was developed by KESRP and a group of experts working on Hawaiian seabirds in 2014 (A. Raine, 2016, pers. comm. and Raine et al. 2014). Local experts, such as the KESRP Coordinator, fencing experts and other seabird biologists were consulted in the evaluation process. Through this process, it was clear that this site is ideal for the purposes of creating a mitigation site that is likely to contribute to the conservation of ‘a’o.

**Table 5-2. Ranking of mitigation site selection criteria.**

Criteria	Kahuama’a Seabird Preserve ranking	Data Source
Presence of breeding seabirds (at site, adjacent or transiting)	<b>Yes:</b> Adjacent and transiting	KESRP auditory surveys in surrounding area (2011_2016); song meter deployed at site in 2016; KSHCP auditory surveys on site (2016 & 2017)
Habitat Quality	<b>High</b> presence of native plant communities	Site visits; initial plant surveys
Line collision threat	<b>Low</b>	Powerline distribution maps
Light attraction threat	<b>Low</b>	No Light Conservation Zone (NLCZ) mapping (USFWS 2016)
Feasibility of predator removal	<b>High</b>	Expert opinion

Feasibility of fence construction	<b>High</b>	Expert opinion
Socio-political feasibility	<b>High</b>	Low hunting use; State Parks (land owner) willing
Site Access	<b>High</b>	Easy road access to site

The Kahuama‘a Seabird Preserve will enclose 2ha of high quality seabird breeding habitat and provides terrain desirable for nesting colonies in terms of slope, aspect and access. The proposed size of the preserve is consistent with other seabird social attraction sites in Hawai‘i (e.g. Makamaka‘ole on west Maui, Nihoku on Kaua‘i). An enclosure of this size allows for adequate space for both installation of artificial burrows, and also excavation of natural burrows.

A social attraction site has a lag time between the inception of seabird social attraction activities and the successful breeding of seabirds using the site. This is due to several factors, including seabird life history (birds usually begin breeding in year 6), and the time needed for the newly created colony to become established. In order to offset the seabird take impacts that will occur during this lag time, the KSHCP conservation program will provide immediate benefit to the Covered Seabirds via a barn owl and feral cat control in the Kalalau Valley.

Barn owls are a known predator of endangered seabirds on Kaua‘i (Raine et al. 2017e). They are aerial predators with a large home range of up to 31 km<sup>2</sup> (Martin et al. 2014) which makes multiple seabird colonies vulnerable to predation. In addition, when one barn owl is removed from its territory, others quickly move in to occupy the empty territory (G. Reid, 2016, pers. comm.), thus barn owl control needs to be ongoing in any given area. Barn owl control removal is likely to provide both immediate and ongoing benefit to seabirds that breed inside the fence site, in the area around the fence site, and in surrounding source colonies. In this way, this action is likely to offset the take impacts of ‘ua‘u and ‘akē‘akē and help offset the take impacts of the ‘a‘o covered under the KSHCP.

Feral cat removal is also key to fulfilling Biological Goal 2 as it provides direct benefit to ‘a‘o source populations by removing a significant predator of seabird colonies in the Kalalau Valley. It also provides secondary benefit to the Kahuama‘a Seabird Preserve by reducing the number of feral cats in the vicinity that might attempt to scale the fence.

Barn owl and feral cat control are components of the KSHCP mitigation package that have the potential to be scaled marginally as an Adaptive Management response ([Section 6.9.2](#)). For example, cat trapping lines could be extended into hanging valleys where topography allows or barn owl control could be conducted in smaller adjacent valleys. However, at this time, based on known information on breeding colonies, Covered Seabird life history and habitat, it is not anticipated that expanding predator control within Kalalau Valley alone would provide benefits to completely offset take impacts anticipated under the Plan.

If Covered Activities under an HCP cause take in the form of harm by permanently altering or destroying the habitat of a listed species, then permanent mitigation must occur to offset this impact. In the case of the KSHCP, the Covered Activities will impact individual birds, not habitat ([see Chapter 4](#)). Under these circumstances, the mitigation offset must occur for the duration of the period where the take impacts caused by the Covered Activities are expected, but not into perpetuity. For the KSHCP, it is expected that at the end of the 30 year term the social attraction site will be heavily colonized and productive for seabirds, and will be a desirable ongoing project for either extension of the KSHCP, or as mitigation for a different program that must offset take impacts on the 'a'o. In the latter case, implementation of management activities as the social attraction site would then transfer to the appropriate program. However, in the circumstance that there is no funding available to continue management at this site past the current KSHCP permit term, then funds for Changed Circumstances/Adaptive Management will be used for decommissioning of the fence (see Contingency Funding discussion in [Section 7.1](#)).

The details on how the fence and social attraction site will be implemented are presented in *Appendix A: Kahuama'a Seabird Preserve Management Plan*. This plan includes methods and protocols for specific tasks, timelines, work plans, expected staffing requirements, best management practices, as well as monitoring.

#### **5.4.1 CONSERVATION MEASURE ALTERNATIVES NOT SELECTED**

A larger predator proof fence enclosure was considered, but modeling results showed that due to expected high density of nesting, within the enclosure that will result from management at the site, even an enclosure larger than 2ha would not reach carrying capacity within the 30 year permit term. Thus expanding the size of the enclosure would not result in higher seabird production (see Discussion in *Appendix C: Social Attraction Estimator Model*).

The potential for a smaller predator proof fence enclosure was also considered, to determine if this could achieve necessary production of Covered Seabirds to offset the impacts of take under the KSHCP for a lower cost. It was determined that a minimum of approximately 2ha was necessary to allow for creation of a productive 'a'o colony and management of native vegetation for seabird habitat. Since the fence site needs to include sloped terrain to facilitate seabird takeoff, a 2ha site or larger minimizes the potential for fence collision during takeoffs and landings of seabirds and fledglings. A smaller unit would also not support enough suitable area for the installation of artificial burrows and habitat restoration for breeding birds to naturally create burrows and nest within the enclosure.

Another conservation measure alternative that was considered was translocation of Covered Seabird chicks to "jump start" the Preserve population within the social attraction site. This was considered not feasible for the following reasons. Considering the rarity of the 'a'o, the number of active and accessible source burrows is the primary limiting factor for translocation in any given year. Despite ongoing efforts to identify other breeding areas and locate active burrows, there are currently only five stable breeding colonies (Upper Limahuli Preserve, Pohakea, Hanakāpī'ai, Hanakoa, and Kīlauea Point National Wildlife Refuge) considered appropriate as a

source for chicks for translocation (due to existing predator control and colony monitoring). All available chicks from these colonies are already being considered for another existing long-term translocation effort (the Nihoku site within Kīlauea Point NWR).

In addition, translocation of chicks requires extensive monitoring of remote colonies to locate nest sites that may be available for chick removal, predator control in these remote locations to offset human traffic during monitoring, and an extended period of care for translocated chicks. All of the above are costly, time intensive, and not likely necessary given the proximity of source seabird colonies to the Kahuamaʻa Seabird Preserve. Finally, unlike the Nihoku site, the selected fence enclosure site is located adjacent to the highest concentration of ʻaʻo nesting colonies on the island of Kauaʻi, thus providing high confidence that social attraction alone will attract birds to nest within the fence site. It is anticipated that social attraction at the Preserve will provide beneficial seabird production earlier than translocation would, because it attracts juvenile and breeding birds to the site immediately, instead of waiting five to seven years for the translocated chicks to return to begin prospecting and breeding.

Other conservation measures that were considered but not selected include rodent and feral pig control in colonies; predator proof fencing an existing seabird breeding colony; and contributing to a large scale watershed protection project with the Kauaʻi Watershed Alliance (KWA) that is planning to construct ungulate fencing in areas with active seabird nesting. Each of these options was not selected for multiple reasons. Rodent and feral pig control alone, without a fence, requires constant removal of predators to maintain benefit to breeding seabirds, has a lower nesting productivity than a fenced site and creates long lasting human trails within breeding colonies that may facilitate ongoing and enhanced predator presence. Building a predator proof fence directly around existing seabird colonies would provide immediate benefits, however most of the seabird nesting colonies that remain on Kauaʻi are in areas that are difficult to access, are in terrain where fencing is not feasible, or are already targeted for other fencing projects. Contributing to the KWA fencing program was considered infeasible because it (1) targets only removal of ungulates, and does not address feral cats and rats, and (2) logistically, ungulate removal, would be carried out predominantly in areas with low endangered seabird numbers, and would have been very hard to quantify and monitor.

## **5.5 PERFORMANCE AND SUCCESS CRITERIA**

The performance and success criteria for achieving the Goals and Objectives of the KSHCP are provided in detail in Section 7.6 on Mitigation Credit.

## **6. PLAN IMPLEMENTATION**

This chapter discusses the implementation of the KSHCP and related aspects that reflect its programmatic structure and defines the roles, responsibilities, and obligations of all participating entities.

Each Participant in the KSHCP must submit a complete application for an ITP/ITL that will be processed by DLNR and USFWS. If applicable issuance requirements are met, an ITP/ITL will be issued to the Applicant. The ITP/ITL will authorize the Participant to incidentally take the Covered Seabirds in the course of implementing Covered Activities, provided all terms and conditions of the ITP/ITL are met.

Under the KSHCP, the Participants will oversee the implementation of the conservation and other plan-related actions and activities with the assistance of the National Fish and Wildlife Foundation (NFWF) and a Prime Contractor. NFWF will hold the funds received from the Participants for the term of the HCP and will make payments as described below to implement the conservation and other plan-related activities. A Prime Contractor selected by the Participants' Committee will implement the conservation and other plan-related activities.

### **6.1 ROLES AND RESPONSIBILITIES**

#### **6.1.1 PARTICIPANTS**

A Participant in the KSHCP is defined as a non-Federal entity that has been issued an ITP from USFWS and an ITL from the DLNR (collectively referred to as "permits") under the KSHCP. Each Participant is responsible for ensuring compliance with the terms and conditions of their individual permits, including required funding assurances, implementation of minimization measures, monitoring of take, and fulfilling reporting requirements.

Participant roles and responsibilities include:

- 1) Compliance with the terms and conditions of their ITP/ITL and Implementing Agreement (IA);
- 2) Ensuring KSHCP implementation by:
  - a. Funding and implementing all required site-specific minimization measures for Covered Activities as set forth in the PIP;
  - b. Funding implementation of KSHCP conservation measures commensurate with the amount of take authorized under their ITP/ITL;
  - c. Paying all applicable KSHCP-related fees according to the schedule;
  - d. Implementing incidental take monitoring for Covered Seabirds;
  - e. Monitoring for honu nests if Participant facilities are located on beachfront property(s) with suitable honu habitat and visible lights;
  - f. Implementing honu nest protection measures as set forth in the PIP if an active nest(s) is found;

- g. Submitting Annual Reports to the Prime Contractor, according to the schedule, that summarize all ITP/ITL related activities implemented, and results for that year;
- h. Participating in periodic reviews of their facilities.

Under the KSHCP, Participants will provide funding which will be held by the National Fish and Wildlife Foundation and which will be used to conduct Plan-level mitigation actions according to the schedule established in the KSHCP and in accordance with the provisions of an approved PIP. The Participants' Committee made up of representatives from each of the Participants will select and contract with a Prime Contractor to conduct the required work to meet mitigation obligations under the ITP/ITL. The Prime Contractor may choose to sub-contract specific work to another entity as appropriate. This arrangement is 'Participant-initiated' mitigation and Participants remain ultimately responsible for implementing mitigation (including actions that may be necessary in response to Adaptive Management provisions of the Plan and the PIP) as defined herein.

#### **6.1.2 NATIONAL FISH AND WILDLIFE FOUNDATION (NFWF) AND PRIME CONTRACTOR**

NFWF will establish two accounts in its fiduciary capacity to receive, manage and disburse certain funds to be deposited by the Participants for the purpose of implementing the KSHCP. The KSHCP Conservation Measures Implementation Funding Account will receive the annual payments from the Participants and act as the operating account of the KSHCP. Funds in this account will be used in the near term for mitigation (e.g. predator proof fence, seabird social attraction, barn owl and feral cat control, etc.) and project management (annual reports, coordination with agencies, etc.). The KSHCP Reserve Account will hold funds set aside for financial assurance, early withdrawal, and changed circumstances. NFWF will manage the accounts for the 30-year term of the KSHCP. NFWF will provide semi-annual accounting of the funds in its accounts to the Prime Contractor for use in the Annual Report to the agencies.<sup>3</sup>

NFWF will provide written notice to the wildlife agencies of its receipt of each of the payments required in Chapter 7, as represented in Table 7-2, from each Participant. Written notice may be provided by either U.S. mail or email to the addresses set forth in the Implementing Agreement, attached as Appendix G. The Participants will provide written notification to the wildlife agencies when disbursements are made from the Reserve Account.

The Participant will procure and enter into an agreement with a Prime Contractor to perform the mitigation and project management measures outlined in the KSHCP. The responsibilities include implementing the Management Plan for the Kahuama'a Seabird Preserve as well as other KSHCP duties. The Prime Contractor will have conservation biology and project

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<sup>3</sup> The Participants anticipate that NFWF will be the financial institution. If NFWF is not the financial institution, the replacement for NFWF shall be capable of performing duties similar to NFWF for the KSHCP as agreed with approval from USFWS and DLNR.

management experience and will hold recovery permits necessary to conduct its work under Section 10(a)(1)(A) of the Endangered Species Act and/or Sections 13-124-4 and 13-124-6 of the Hawaii Administrative Rules.<sup>4</sup> The Prime Contractor will compile data for the Annual Reports on project progress.

The Prime Contractor will compile, prepare, and submit necessary information to the USFWS and DLNR to enable the agencies to evaluate compliance with the terms and conditions of each ITP/ITL issued under the KSHCP. Table 6-1 below outlines the responsibilities of the Prime Contractor.

**Table 6-1. Duties and responsibilities for the Prime Contractor.**

<b>Responsibilities</b>	<b>Description of Duties</b>
Budget requirements for field work and administrative tasks	Provide annual budget and requests funds to be allocated as necessary to cover field and administrative tasks
Annual meeting to update Participants	Update Participants; receive feedback
Annual reporting	Compile, write, and submit Annual Report pertaining to mitigation actions
Attend ESRC meetings, as requested; Annual ESRC presentation	Submit documents; attend meetings
Serve as liaison between mitigation work and regulatory wildlife agencies	Data collation as requested; conference calls; meetings; arrange site visits as needed
Serve as liaison between Participants and regulatory wildlife agencies	Conference calls; meetings
Seabird social attraction / terrestrial predator proof fence project / feral cat & barn owl control / effectiveness monitoring	Manage field operations
Minimization monitoring	Compile Participant reports for Annual Report

<sup>4</sup> The Participants anticipate that the initial Prime Contractor will be Pacific Rim Conservation for the initial five years, with options to extend. If a Prime Contractor other than Pacific Rim Conservation is selected, Participants shall consult with USFWS and DLNR regarding selection of an alternate Prime Contractor. Participants shall not be required to obtain approval from USFWS and DLNR of an alternate Prime Contractor, provided that the alternate Prime Contractor has the qualifications stated above.

Seabird recovery and rehabilitation	Coordinate with SOS or contracted entity as needed; assist in coordination of Participant downed bird pick-ups
Take monitoring	Compile and review Participant reports and third-party facility monitoring reports
Adaptive management	Facilitate annual meetings; notify agencies of results and recommendations

Under the terms of the permits issued, the Participants will be responsible for ensuring that the actions and activities of the KSHCP are carried out properly and for selecting another Prime Contractor, if that becomes necessary.

### **6.1.3 STATE OF HAWAII DEPARTMENT OF LAND AND NATURAL RESOURCES (DLNR)**

#### ***6.1.3.1 Regulatory Role***

The DLNR provides regulatory oversight for the State of Hawai'i, as authorized by statute, to ensure that all HCPs and ITLs issued by the Board of Land and Natural Resources (BLNR) comply with the provisions of applicable State of Hawai'i regulations. This section briefly outlines the regulatory role of DLNR as it pertains to the KSHCP if the Plan is approved and ITL/ITPs are issued (Table 6-2).

In 2011, the State Legislature approved HRS 195D-23 allowing the DLNR to collect fees and payment for costs incurred for use of DOFAW's technical assistance program in the development, review, or monitoring of a specific HCP. This service was not applicable to the development of the KSHCP which was funded by a series of ESA Section 6 HCP planning assistance grants from the USFWS, which also supported application assistance to an initial set of Applicants that participated during the development of the KSHCP.

Section 195D-21(f) of the Hawai'i Revised Statutes requires that Participants in an HCP submit an Annual Report to the DLNR. The DLNR through the Division of Forestry & Wildlife will review KSHCP Annual Reports for thoroughness, compliance, and effectiveness to ensure that the KSHCP is meeting its objectives and that Participants are each complying with the terms and conditions of ITLs issued.

**Table 6-2. DLNR – DOFAW regulatory responsibilities and duties.**

<b>DLNR Regulatory Responsibilities</b>	<b>DOFAW ITL Section Duties</b>
Authorize, amend, or revoke ITLs (as approved by BLNR)	<ul style="list-style-type: none"> <li>Coordinate with Endangered Species Recovery Committee (ESRC) to recommend approval, major amendments, or revoking of an ITL</li> </ul>

Verification of compliance with each ITL issued under the KSHCP.	<ul style="list-style-type: none"> <li>• Coordinate and ensure DOFAW Administrator is aware of any compliance issues</li> </ul>
Funding and Mitigation Implementation Schedule	<ul style="list-style-type: none"> <li>• Verify that funding was provided and track funding assurances</li> <li>• Review mitigation reports and implementation schedule</li> <li>• Verify implementation of mitigation actions</li> </ul>
Effectiveness Monitoring	<ul style="list-style-type: none"> <li>• Communicate with Prime Contractor regarding effectiveness monitoring</li> <li>• Visit seabird mitigation site as needed</li> </ul>
Take Monitoring and Minimization Compliance	<ul style="list-style-type: none"> <li>• Review downed wildlife or observed take reports</li> </ul>
Adaptive Management	<ul style="list-style-type: none"> <li>• Review KSHCP Annual Reports to determine if Adaptive Management triggers have been met</li> <li>• Attend and arrange meetings as needed</li> <li>• With USFWS, make determinations on appropriate Adaptive Management measures if required.</li> </ul>
Consider recommendations from the ESRC	<ul style="list-style-type: none"> <li>• Ensure ESRC receives Annual Reports to provide adequate recommendations for Adaptive Management as needed.</li> </ul>
Submit for OEQC 60-day public comment period any new or significantly revised Participant Inclusion Plans (PIP)	<ul style="list-style-type: none"> <li>• Assist Applicants with new or revised PIP(s)</li> </ul>

#### **6.1.4 ENDANGERED SPECIES RECOVERY COMMITTEE (ESRC)**

As an advisory body to the Board of Land and Natural Resources (BLNR), the overall role of the ESRC is to make recommendations to the BLNR regarding issues relating to endangered species, including the adequacy of HCPs and the issuance of ITLs. The role of the ESRC as defined in statute is to review the KSHCP and any applications for an ITL and to make a recommendation to the Board for approval, disapproval, and recommendations for changes to the KSHCP and/or applications for ITLs. Under HRS §195D-25(b)(2) the ESRC shall also review the KSHCP annually to ensure compliance with the terms of the KSHCP and any ITLs issued and make recommendations for any necessary changes.

### **6.1.5 U. S. FISH AND WILDLIFE SERVICE (USFWS)**

The USFWS is the Federal agency responsible for determining whether an ITP associated with an HCP for listed species under its jurisdiction meets issuance criteria and for monitoring and enforcing compliance with issued permits. The following points further describe the roles of the USFWS in the KSHCP:

- 1) As feasible, provide technical assistance to potential Applicants seeking incidental take authorization from the KSHCP in the drafting of their PIPs.
- 2) Process applications for ITPs under the KSHCP including providing an opportunity for public review and comment and environmental compliance, as applicable;
- 3) After considering public comments and all relevant information, issue decisions for applications for ITPs under the KSHCP;
- 4) Review KSHCP reports, ensure compliance with terms and conditions of each Participants' ITP, determine the effectiveness of monitoring, minimization, and mitigation actions conducted under the KSHCP, and provide technical assistance to the Participants, and with DLNR, make determinations regarding appropriate Adaptive Management measures;
- 5) Participate to provide technical assistance at ESRC meetings and KSHCP annual review meetings as needed;
- 6) Review and process amendments to the KSHCP and to ITPs; and
- 7) Take enforcement action as necessary and appropriate.

## **6.2 ENROLLMENT AND APPROVAL PERMITTING PROCESS**

Enrollment refers to the process by which each Applicant applies for incidental take authorization under the KSHCP.

Each non-Federal entity requesting incidental take authorization will submit a PIP that incorporates the KSHCP by reference and addresses all criteria for permit/license issuance under both State and Federal regulations. The PIP demonstrates how each potential Participant will meet the terms and conditions set forth in the KSHCP. A PIP template is provided in the appendices (*Appendix D: PIP Template*) as a reference for future applicants. This PIP template is a suggested format. Applicants may, but are not required to, follow this suggested format.

The Applicant submits the following documents to USFWS and DLNR which together comprise a complete KSHCP "enrollment package":

- a. Written request (e.g. cover letter) from the landowner, facility operator, or other responsible party that the wildlife agencies formally process the KSHCP enrollment package;
- b. State and Federal application forms (with Federal application fee);
- c. A completed PIP
- d. The final KSHCP by reference.

The KSHCP "enrollment package" application will then be processed through the State and Federal approval processes, outlined below.

The initial enrollment period under the KSHCP will occur for Applicants who complete their enrollment packages prior to the start of the KSHCP public review process, and go through this process in conjunction with the KSHCP document. Going through public review in conjunction with the KSHCP minimizes the workload for initial Applicants, USFWS and DLNR. However, since each Applicant will be applying for a separate ITP/ITL, individual permits are not issued until each PIP has been accepted and approved.

If the BLNR and/or the USFWS issue an ITP/ITL to an entity, the Participant shall convey requisite funds for KSHCP fees to the designated NFWF accounts within 30 days of ITP/ITL issuance. Upon receipt of those funds, the effective date of the ITP/ITL will commence.

#### **6.2.1 PRE-APPLICATION PROCESS**

Applicants are encouraged to meet with DLNR and USFWS to discuss the requirements of the KSHCP and determine if enrollment application is advisable, including:

- Discuss the general effects of the Covered Activities on the Covered Species;
- Discuss measures to avoid take and determine if potential for take can be avoided or minimized as per guidelines in the KSHCP;
- For landowner or business Applicants considering new developments (or additions to existing facilities), the design of new developments offer opportunities to incorporate minimization measures that may be more difficult to implement after developments have been constructed. Those Applicants are encouraged to consult with the wildlife agencies early in the design process to:
  - Incorporate minimization measures in design of the development/facility addition;
  - Incorporate operational measures that minimizes the need for night lighting;
  - Consider other design options that would minimize or avoid potential for take of the Covered Species;
- Review terms and conditions of the KSHCP and the enrollment application process; and
- Review preparation of the PIP as well as the overall schedule for processing KSHCP applications through the State and Federal processes.

#### **6.2.2 COMPLETION OF A QUALIFYING PARTICIPANT INCLUSION PLAN (PIP)**

A qualifying PIP is prepared by each Applicant and reviewed by the USFWS, the DLNR, and the ESRC as part of the State and Federal approval processes. The following list summarizes the required content that must be included in an Applicant's PIP:

- Facility ownership and contact information;
- Maps and legal descriptions (such as Tax Map Key) of the property boundaries;
- Maps depicting the locations of the Covered Activities (lights and utilities);
- A thorough and complete description of the Covered Activities, both existing and proposed over the life of the 30 year KSHCP duration;

- A minimization plan for the Covered Activities to reduce the effects of the activities, based on KSHCP guidelines. This section of the PIP will also describe alternatives to the taking that were considered and the reasons these alternatives were not selected;
- Honu minimization and monitoring plan (if applicable);
- Description of training for staff, and any outreach for guests/clients/residents that will occur to maximize seabird recovery at the facility through increased awareness;
- Predator control plan;
- Incidental take estimates for the Covered Species (see methodology below);
- The amount of incidental take authorization requested by species class;
- An incidental take monitoring plan that is based on KSHCP guidelines; and
- A description of the mechanisms that will assure funding over the requested ITP/ITL term (see Chapter 7).

New facilities, whether additions to existing Covered Activities or entirely new facilities, should consult early in the project design phase to evaluate the potential risks of incidental take and to ensure that avoidance and minimization measures are factored into project design to the maximum extent practicable.

As noted above, the DLNR and the USFWS may be able to assist Applicants by providing technical assistance in the preparation of the PIP. Such technical assistance may include, but is not limited to:

- Assist with the description of existing and proposed facilities containing the Covered Activities;
- Site assessments for Covered Activities;
- Assistance with identifying appropriate light attraction minimization measures;
- Refinement of facility take estimates; and other topics as needed.

### **6.2.2.1 Methods for Determining the Amount of Take of Covered Seabirds**

#### **a. Data from the SOS Program**

The primary data source for determining annual take of Covered Seabirds is the Save our Shearwaters (SOS) program. This program has a long term and ongoing data set on downed seabirds. These data include information on species, age class, location where the bird was found, and the condition of the bird. Since SOS relies on the public to find and turn in downed birds, a system has been established to standardize collection and reporting. There are eleven SOS shearwater 'aid stations' located around the island. Each aid station contains individual cubbies to house birds, a whiteboard and instructions on recording relevant data for each bird. The aid stations are visited daily during the fledging season (September 15-December 15) by SOS staff. The SOS headquarters at the Kaua'i Humane Society is open year-round to accept any seabirds that might be downed outside of this time period. In addition, several of the potential Participants identified during development of the KSHCP have aid stations located at their facilities and have protocols in place to inform SOS when a downed seabird is found. The take

calculation for an individual application may also include consideration of other site specific monitoring collection data where available to refine the SOS numbers. The assessment of where a downed seabird should be attributed to an Applicant's facility will be based on the best available data.

### **b. Calculating the Amount of Light Attraction Take**

The calculation of light attraction take requires the following information:

1. The average number of downed birds on the Applicant's property that are found and turned into SOS;
2. The amount of "lethal" take calculated from the average number of downed birds that are found and turned into SOS ("observed lethal take");
3. The amount of "lethal" take attributable to downed birds that are not found on the property and assumed to be "lethal" take ("unobserved take");
4. The total estimated annual lethal take from light attraction; and
5. The Applicant's requested annual lethal take.

The sections below explain how each of these determinations is made.

#### **1. Determining the annual average number of downed birds.**

The first step is to determine the annual average number for downed birds. For the 'a'o (NESH), the annual average number of downed birds over the most recent 5-year period is used.

For the 'ua'u and 'akē'akē (HAPE and BRSP), the annual average number of downed birds over the most recent 15-year period is used. This longer period is used because the fallout of these species is a rarer occurrence.

In most instances an Applicant will choose to use SOS records to calculate its annual averages. However, the Agencies may permit an Applicant to use its own records of downed birds for this calculation if Applicant can demonstrate the reliability of those records.

#### **2. Determining the annual average of observed lethal take.**

All live birds discovered on an Applicant's property, whether they are discovered by Applicant or by another party, are turned in to SOS. For purposes of observed take estimation, an Applicant must account for the number of birds that are released to the wild by SOS and the number of birds that die in captivity. Of all discovered birds turned in to SOS (100 percent), 88 percent are released and 12 percent die in captivity (Unpublished SOS data, DOFAW 2018). Consequently, the Applicant multiplies its total observed take by 12% to determine its observed lethal take. The remaining 88% of the total is non-lethal take.

#### **3. Determining the annual average of unobserved lethal take.**

SOS data represents the “observed” take, i.e., the number of downed birds that are discovered annually on an Applicant’s property and turned in to SOS. Ainley et al. (1995) conducted surveys to locate downed birds and reported an average 50% discovery rate. In other words, ‘best available data,’ indicates that only half of the birds that fallout from the effects of light are actually found and turned in to SOS. In order to account for “unobserved” take, the Applicant must assume that an equal number of birds is not found. The undiscovered birds are considered lethal take as they are likely killed due to injury, starvation, predation or collision (e.g., with vehicles).

Applicants have the option of demonstrating that they have a better discovery rate than the 50% discovery rate found in the literature. For example, at a small facility, with highly trained staff and excellent searching conditions, an Applicant may be able to demonstrate a higher searcher efficiency rate. In order to do so, an Applicant must demonstrate with supporting information (1) that it has higher searcher efficiency than the 50 percent searcher efficiency found in the literature; and (2) that it has created a predator control program that sufficiently minimizes the chance that carcasses will be carried away by predators and not counted. If an applicant believes it has met these requirements it may request in its PIP the assignment of a higher discovery rate. The wildlife agencies will each determine whether they will grant an Applicant’s request to assign it a higher discovery rate which would reduce the unobserved lethal take.

#### **4. Determining the total estimated annual lethal take from light attraction.**

If the standard assumptions are used, the following formula summarizes the calculation of an annual estimate of lethal take:

*Lethal take = 100% undiscovered birds + 12% of birds that are discovered and turned into SOS*

#### **5. Determining the Applicant’s requested annual lethal take.**

After determining its estimated annual take from light attraction, the Applicant determines the annual take it will seek. An Applicant may wish to request additional take as a cushion so that it does not have unpermitted take over the life of the permit. Also, as set forth next, while most downed birds are fledglings, an Applicant may wish to increase its take request to account for an occasional downed adult.

The following table illustrates how take is calculated. In this scenario, the applicant’s SOS data shows an average of three Newell’s Shearwaters each year over the last five years, one-half a Hawaiian Petrel each year over the last fifteen years and one Band-rumped Storm Petrel each year over the last fifteen years. This applicant is unable to demonstrate better than 50% searcher efficiency.

### Annual Take Calculation

	Newell's Shearwater	Hawaiian Petrel	Band-Rumped Storm-Petrel
1. Annual average number of downed NESH (5 most recent years), HAPE or BRSP (15 most recent years)	3	.5	1
2. Annual observed lethal take estimate (12% of 1, all downed birds)	.36*	.06	.12
3. Annual unobserved lethal take estimate (e.g. 100% of 1, all downed birds if 50% searcher efficiency assumed)	3	.5	1
4. Total estimated annual lethal take from light attraction (2+3)	3.36**	.56	1.12
Requested Annual Lethal Take	4***	1***	1.12

\*  $3 \times .12 = .36$

\*\*  $3 + 0.36 = 3.36$

\*\*\* This applicant has elected to request more take than projected because it anticipates an occasional downed adult (see discussion in item 5, above) and to provide a cushion so that it does not have unpermitted take.

### c. Adult Light Attraction Take

Most downed seabirds, especially 'a'o, are fledglings (see [Section 4.2.1](#)); however, KSHCP Applicants may request incidental take coverage for adult/sub-adults due to light attraction. These take requests must also address indirect take of dependent eggs or chicks.<sup>5</sup> As described in section 4.2.1.1, an average take in total of all applicant take combined of 2 'a'o adult every 3 years (1 lethal and 1 non-lethal), 2 'ua'u every year (1 lethal and 1 non-lethal), and 1 'akē'akē (0.5 lethal and 0.5 non-lethal) are anticipated under the Plan. As described in Section 4.3, a complete in-year offset of adult lethal take impacts covered under the KSHCP is likely to be provided annually by the barn owl control and feral cat control at Kalalau Valley.

<sup>5</sup> Indirect impacts of covered activities are analyzed in the intra-Service section 7 consultation on ITP applications associated with an HCP (section 1.2.1 and 50 CFR 402.02). Indirect impacts are considered reasonably certain to occur when an adult(s) are attracted to artificial lighting (section 4.2.1.1). Therefore, applicants requesting coverage for direct take of adults must also request coverage of indirect take of eggs/chicks.

The number of adult age-class birds must be converted to the equivalent number of fledgling age-class birds because costs are shared and most Applicants' take is anticipated to be for fledgling age-class. For the purposes of this HCP, the take of one adult of any Covered Seabird will equal take of 3 fledglings, assuming juvenile/sub-adult survivorship (i.e., percentage surviving till age 6) of 0.33.<sup>6</sup> In addition, the amount of indirect take associated with each direct take of an adult, lethal or non-lethal<sup>7</sup>, will be as follows, assuming the reproductive information described in Section 4.2.1.2 (authorities for this information cited in parentheses):

- 0.18 chicks or eggs for each 'a'o take (Griesemer and Holmes 2011);
- 0.32 chicks or eggs for each 'ua'u take (Simons 1984, Simons 1985); and
- 0.20 chicks or eggs for each 'akē'akē take (Hemery et al. 1986 in Mougins et al. 1997, Cadiou 2001).

Consequently, the total fledgling offset for each direct adult take will equal 3.18 fledglings for each 'a'o take, 3.32 fledglings for each 'ua'u take, and 3.20 fledglings for each 'akē'akē take.

#### **d. Extrapolating 30-year Take Estimates**

The methods described above are used to determine estimates of annual lethal and non-lethal light attraction take for fledglings of each of the Covered Seabird species. For the purposes of the KSHCP, each Participant also needs to estimate a 30-year amount of fledgling light attraction take to determine overall take estimates for the permit term of the ITP and ITL. This is accomplished by simply multiplying the annual light attraction take estimates by 30.

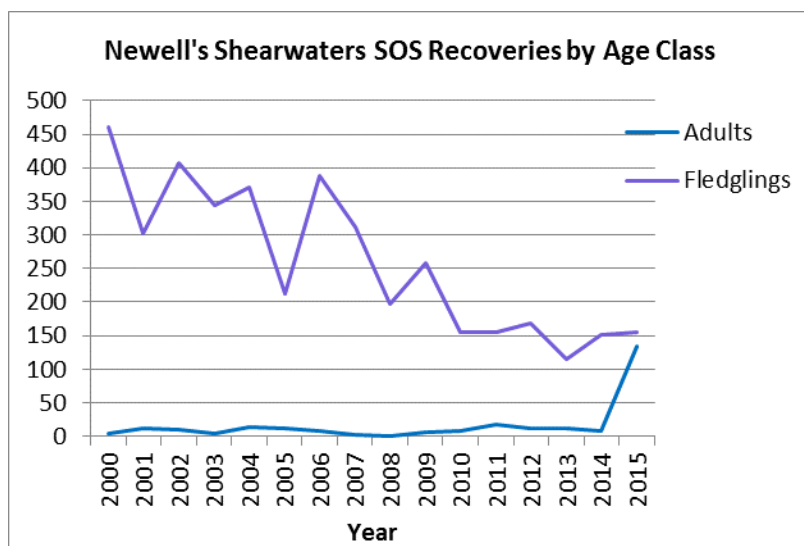
This method assumes that take due to the effects of light attraction will remain constant over the 30-year duration of the KSHCP and associated ITPs and ITLs. However, the population of 'a'o is estimated to have declined by 94% (at an average rate of ~13% per year) from 1993-2013 and is predicted to continue to decline (Raine et al. 2017d). Populations of 'ua'u are estimated to have declined by 78% (at an average rate of ~6% per year) during the same period (Raine et al. 2017d). Figures are not available for 'akē'akē. This would suggest a future decline in SOS program fallout numbers if fallout patterns track the overall population. However, between 2010 and 2015 fallout numbers have been stable for the 'a'o (Figure 6-1). Fallout numbers have been relatively constant for the 'ua'u since the year 2000. It is important to note that the up-tick in adult take numbers for 2015 represents one large fallout event that occurred at the Kōke'e Air Force base (see Raine et al. (2015) for details). Since this event, lights have been drastically reduced (or eliminated) to address this light attraction issue and KESRP surveys in 2016 found no downed birds when lights were turned off (Raine et al. 2016c, USFWS 2017b); new ground lighting is yet to be assessed.

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Indirect impacts of covered activities are analyzed in the intra-Service section 7 consultation on ITP applications associated with an HCP (section 1.2.1 and 50 CFR 402.02). Indirect impacts are considered reasonably certain to occur when a

n adult(s) are attracted to artificial lighting (section 4.2.1.1). Therefore, applicants requesting coverage for direct take of adults must also request coverage of indirect take of eggs/chicks. patterns, and result in the loss of a chick or egg.

Given this recent SOS program trend, the KSHCP assumes that light attraction take estimates will remain constant for the 30-year duration of the Program. This assumption, while conservative, also serves to ensure sufficient take coverage and mitigation are provided for KSHCP Participants. Recovery actions and conservation associated with this and other seabird HCPs may also contribute to significantly reducing the current declining population trends of the Covered Species.



**Figure 6-1: SOS program recoveries of ‘a‘o by age class 2000 -2015.**

### 6.2.3 STATE APPROVAL PROCESS

The State of Hawai‘i Board of Land and Natural Resources (BLNR) approval process of the KSHCP and ITL issuance decision process is outlined below. The process is separated into two steps: (a) approval of the KSHCP document and (b) approval of each PIP when submitted:

1. Review of the KSHCP document:
  - a. The DLNR reviews the KSHCP for consistency with State regulations on the take of a listed species (HRS § 195D);
  - b. The Office of Environmental Quality Control (OEQC) publishes in the periodic bulletin a notice of availability of the KSHCP document and associated PIPs for a 60-day (minimum) public comment period (HRS § 195D-21(6)); During the 60-day comment period:
  - c. The DEA will post for a 30-day comment period;
  - d. The Endangered Species Recovery Committee (ESRC) meets to review and comment on the KSHCP document;
  - e. DOFAW holds a public meeting on Kaua‘i (HRS § 195D-4(g)(9));
  - f. The ESRC conducts a public site visit/meeting;
  - g. DOFAW addresses comments received in coordination with USFWS;
  - h. ESRC meets to review the revisions resulting in the final draft and make a recommendation on the KSHCP package, to the BLNR;

- i. The BLNR issues a decision on the KSHCP and ITLs.
2. Review of each PIP when submitted for approval:
  - a. OEQC publishes in the periodic bulletin a notice of availability of each completed PIP for a 60-day (minimum) public comment period;
  - b. Endangered Species Recovery Committee (ESRC) reviews the PIPs, including take request and any staff recommendations, for consistency with the KSHCP terms and conditions and applicable State laws;
  - c. The Applicant responds to comments received and revises PIP, if needed;
  - d. The ESRC makes a recommendation to the BLNR on each PIP;
  - e. The BLNR holds a public hearing on each ITL application (HRS § 195D-4(g)(9));
  - f. BLNR Board Meeting to review applications;
  - g. The BLNR issues a separate issuance decision for each ITL.

#### **6.2.4 FEDERAL APPROVAL PROCESS**

The USFWS ITP issuance decision process for an ITP is outlined below.

1. To streamline review of individual permit applications, USFWS publishes a Notice of Availability of the KSHCP document, each PIP submitted as part of the enrollment process, and a draft environmental assessment on the potential issuance of incidental take permits based on the KSHCP in the *Federal Register* for a public comment period;
2. USFWS responds to public comments received, advises DLNR of revisions or additional measures it believes are necessary or appropriate for purposes of the KSHCP, works with each Applicant to revise the PIP(s), if needed, and revises the EA, as appropriate;
3. USFWS prepares a Biological Opinion in accordance with the requirements of ESA Section 7 on the KSHCP to evaluate whether implementation of the KSHCP is: (1) likely to jeopardize listed species or destroy or adversely modify critical habitat;
4. USFWS determines whether it is appropriate to issue a NEPA Finding of No Significant Impact (FONSI) based on information in the EA, or to prepare an Environmental Impact Statement (EIS);
5. If necessary, USFWS conducts scoping and prepares an EIS;
6. USFWS prepares findings on the proposed ITP request for each PIP application to inform the permit decision and makes a decision whether to issue the permit.

#### **6.3 LATE ENROLLMENT**

The KSHCP is designed to be available as a mechanism for all non-Federal entities with ongoing take of Covered Seabirds to obtain an ITL/ITP. Throughout the development of the KSHCP (~10 year period), there were many attempts to recruit eligible Applicants, and distribute information regarding this unique opportunity. These efforts have included: public meetings, visits to potential Applicant facilities, producing informational flyers, maintaining a KSHCP website, and presentations at conferences.

After the initial decisions on the applications of Applicants who have completed the public review process simultaneously with the review of the KSHCP itself, other Applicants may be

able to join the KSHCP during the 30 year term of the KSHCP provided that certain conditions, described below, are met. These Applicants must submit their PIPs to the Participants for review and concurrence, to the wildlife agencies for processing (which will include an opportunity for public review), and obtain permits. Permits issued would cover the added Participants' incidental take through the remaining duration of the KSHCP. For example, a new Applicant in the tenth year of implementation would request coverage for the remaining 20 years of the KSHCP. In the review of any Applicant's PIP, Participants may not engage in any discrimination that is prohibited by any applicable federal, state, or county law.

The KSHCP has been developed to accommodate a maximum annual and 30-year take number (see [Section 4.2](#)) for each of the Covered Seabirds. If the inclusion of additional Participants past the initial enrollment period does not exceed the maximum annual take threshold ([Table 4-1](#)), new Applicants may enroll as described above, and shared costs will be adjusted (see [Section 7.4](#)), provided however that such joinder shall not increase the costs to the Participants. If the addition of a new Applicant would exceed the maximum take number, then an amendment to the KSHCP would be required to revise the Plan as needed, provided however that such amendment shall not increase the costs to the Participants. Nothing in this section is intended to alter the changed circumstances and "no surprises" provisions of this KSHCP. If it is considered more cost effective for the Applicant seeking take coverage to initiate their own HCP, rather than amending the KSHCP, this will be recommended during pre-application discussions.

#### **6.4 EARLY WITHDRAWAL AND DISCONTINUANCE OF PERMITTED ACTIVITY**

Similarly, due to the unique nature of the KSHCP and the need to make it flexible to accommodate individual Participant needs, it is anticipated that some Participants may request Early Withdrawal. For this to occur, a Participant will need to provide written notice to the other Participants and the regulatory agencies sufficiently demonstrating: (1) that it has made all payments required up to the time of withdrawal and will pay any remaining funds required to ensure full mitigation for take that has occurred; and (2) why Covered Activities/incidental take will cease to occur at facilities. If, for example, all lights will be deactivated, then funds to cover requested take up to the point of Early Withdrawal will be collected, and the Financial Assurances and Changed Circumstances Payments will be retained in the NFWF accounts for use by the remaining Participants to defray KSHCP implementation costs (see [Section 7.4.2](#)). The Participants may elect to initiate a Major Amendment if there is a reduction of greater than 10% of the initial authorized take (see [Section 6.13.2](#)).

In addition, after surrendering the permit, the Participant will remain responsible for any outstanding minimization and mitigation measures required under terms of the permit for take that has occurred prior to surrender of the permit. Notice to USFWS must comply with the regulations applicable at the time of withdrawal (currently codified at 50 C.F.R. § 13.26.). Costs will be adjusted for remaining Participants as described in [Section 7.4](#).

## **6.5 REVISED INCIDENTAL TAKE REQUEST**

Another possibility is that Participants will wish to revise their initial incidental take requests. Take requests may be increased or decreased, depending on specific circumstances at facilities such as a need for additional lights, or in response to the results of take monitoring. Any proposed change to a Participant's take requests would require an amendment to the permit and PIP pursuant to regulations in effect at the time the Participant submits their request (as described in [Section 6.14](#)). If the incidental take request increases, the request will be evaluated to determine whether the conservation program can mitigate for additional take, and if so, the Participant will be responsible for increased funding to offset the additional take request, provided however that such take increase shall not increase the costs to the other Participants. If the incidental take request decreases, as described above with Early Withdrawal, Participants must ensure that their take amount is fully mitigated. Requests to amend take in PIPs should be submitted as part of Participant Annual Reports for review by regulatory agencies. Costs will be adjusted for remaining Participants as described in [Section 7.4](#).

## **6.6 REPORTING REQUIREMENTS**

Reporting is necessary to provide regular information and updates to the USFWS and the DLNR to ensure that the KSHCP is meeting its objectives and to demonstrate that each Participant is in compliance with the terms and conditions of its permit. Reporting will provide information to address compliance with the terms of the ITP/ITLs issued and effectiveness both of permits issued and of the KSHCP as a whole. This section outlines the reporting requirements of the responsible parties.

### **6.6.1 PARTICIPANTS' REPORTING REQUIREMENTS**

#### **6.6.1.1 Reporting Take of Covered Species**

Within 24 hours of discovery, any Participant shall submit notice of any incidental or other take of any of the Covered Species at the authorized covered facilities via phone, email, or other written form to the USFWS, DLNR, Kaua'i DOFAW and SOS, including date, time and exact location where found, species (if known), and condition of the animal. The agencies will provide names, phone, and email contact information to the participants on a regular and updated basis of those individuals to be contacted.

Within one week of discovery, any Participant shall provide USFWS and DLNR Honolulu the completed "KSHCP Downed Seabird Form" and a description of any further actions taken or considered to minimize fallout at the incident location.

In addition to reporting take as required by the above protocols, a full take monitoring report will be submitted annually as part of Participant Annual Report, following protocols from Participant Monitoring Plans, which will be described in PIPs. The Participant Annual Report should include information as described in the next Section.

#### *6.6.1.2 Participant Annual Reports*

KSHCP Participants shall provide annual status updates covering the preceding calendar year to the Prime Contractor no later than **Jan 15 of each year**. Photographs should be included in the Annual Report to illustrate any proposed changes to lighting, facility predator control programs, outreach and training or downed bird recovery protocols on site.

The status updates shall provide the following information:

- a. Facility name, ownership and contact details;
- b. Summary of any proposed changes to the facilities with potential to affect the Covered Species;
- c. Changes to facility management or other key personnel involved in the KSHCP;
- d. Request from a Participant to change minimization measures conducted at the facility and the reasons for the requested change (as needed);
- e. Summary of the results of self-monitoring of take of the Covered Seabirds and monitoring for honu nests, including:
  - i. Map of search route used for conducting searches;
  - ii. Frequency of searches conducted;
  - iii. Personnel involved in search efforts;
  - iv. A summary table of the search effort results to include: number of birds or honu nests found, the date, time, and exact location where each was found, disposition of the birds or nests (if known), including description of any honu nest protection efforts implemented;
  - v. A discussion of the efficacy of the current self-monitoring protocols and whether adjustments need to be made;
- f. Summary discussion of the results of on-site animal control efforts;
- g. Summary of worker training and outreach efforts;
- h. Other relevant information that the wildlife agencies may require to verify compliance with permit issued.

#### *6.6.1.3 Other Relevant Reporting*

Some changes at facilities may require immediate reporting outside of the Annual Report time window. Participants must inform USFWS and DLNR prior to any of the following changes:

1. Changes in property ownership (may require permit transfer or amendment), Participant must report:
  - a. New ownership name, company/organization;
  - b. Primary and alternate contact information;
  - c. Changes to property boundaries, planned or proposed, with updated map/survey of property.

Any transfer of the Federal permit must be accomplished in accordance with the applicable regulations in existence at the time of transfer (currently codified at 50 C.F.R. § 13.25.). If change in ownership involves discontinuance of permit activities or requests for changes in incidental take amounts, these changes must also be made in accordance

with federal regulations. See [Sections 6.4](#) and [6.5](#) above. In these cases, Participants should report any planned or proposed change in ownership well in advance of the change.

2. Changes to the permitted facility, both proposed and planned, with potential to affect the Covered Species (may require an amendment to the permit) including, but not limited to:
  - a. Expansions or additions to existing facilities;
  - b. New facilities and facility light changes;
  - c. Reasons why changes were made.

Any additional incidental take due to changes at a permitted facility will require an amendment to the permit in advance of the change occurring. Amendments to authorize additional take must comply with all applicable Federal and State requirements; therefore, it is important for Participants to report any planned or proposed change well in advance so that they can work with the wildlife agencies to determine if a permit amendment is possible.

3. Changes to take requests (increase or decrease). Any potential changes to take requests will require an amendment to the permit in advance of the change. Amendments to authorize additional take must comply with all applicable Federal and State requirements; therefore, it is important for Participants to report any planned or proposed change well in advance so that they can work with wildlife agencies to determine if a permit amendment is possible.
4. Any material changes in the Participant's financial ability to fulfill its obligations under the permit.

#### **6.6.1.4 Certification**

All reports will include the following certification from a responsible company official who supervised or directed preparation of the report:

I certify that to the best of my knowledge, after appropriate inquiries of all relevant persons involved in the preparation of this report, the information submitted is true, accurate, and complete.

#### **6.6.2 KSHCP ANNUAL REPORT**

The Prime Contractor shall prepare and submit to the DLNR and the USFWS an Annual Report on behalf of the Participants, according to the Annual Report requirements (Section 6.6.2.1 through 6.6.2.8) and Reporting Schedule detailed below ([Section 6.7](#)).

##### **6.6.2.1 General Topics**

- 1) Summary of any non-substantive changes made to the KSHCP Appendices in the preceding year (e.g., final Memorandums of Agreement(s), contracts, etc.);

- 2) Any changes in the reporting schedule for the KSHCP, as determined by the ESRC, the USFWS, and the DLNR;
- 3) Description of all amendments initiated, underway or completed during the preceding year and their status;
- 4) Any other pertinent information of a general nature that would illustrate the status of the KSHCP and compliance and effectiveness of the KSHCP.

#### **6.6.2.2 Summary of KSHCP Participants' Annual Reports**

The Annual report should provide a summary of the KSHCP Participants' Reports including:

- 1) Name, location, facility type, ownership, and permitted incidental take (by species) of existing Participants;
- 2) Summary of any changes to the facilities of existing Participants (may require permit amendment);
- 3) Any changes in ownership of existing Participants (may require permit amendment);
- 4) Summary of results of take monitoring at Participant facilities;
- 5) Summary of results of compliance monitoring of implementation of minimization measures at Participant facilities;
- 6) Summary of KSHCP financial status of existing Participants, including any KSHCP mitigation fees owed;
- 7) Any other information that would demonstrate compliance with the terms and conditions of permits issued;
- 8) The status of any KSHCP Applicants in process and anticipated take level by species and age class.

#### **6.6.2.3 KSHCP Finances**

The Financial status of the KSHCP should be provided to include:

- 1) An accounting of funds received to date and KSHCP fees paid by each Participant;
- 2) An accounting of funds expended;
- 3) Overall financial status of the KSHCP;
- 4) Any changes in anticipated budget expenditures (e.g., through Adaptive Management).

#### **6.6.2.4 Compliance and Effectiveness Monitoring of Mitigation**

- 1) Overall status of mitigation action including:
  - a. Progress towards KSHCP mitigation objectives;
  - b. Updates on schedule for the mitigation project;
  - c. Description of any issues encountered and successes towards implementing the project;
  - d. Recommendations to initiate any Adaptive Management as needed.
- 2) Evaluation of the effectiveness of conservation/mitigation projects including:
  - a. Summary of results from effectiveness monitoring to date;
  - b. Updates and status of any projects or components pending implementation; and

- c. Status of any anticipated plans for initiating projects during the upcoming year

#### **6.6.2.5 Compliance Monitoring of Take of the Covered Seabirds**

- 1) Status reports and an evaluation of take monitoring including:
  - a. Status of monitoring of take of the Covered Seabirds from light attraction, including self-monitoring conducted by Participants;
  - b. A summary of take to date, by species and age class, resulting from take monitoring.

#### **6.6.2.6 Honu Monitoring and Protection**

- 1) Status of honu nest monitoring and measures taken to avoid take of honu if nest(s) are found.

#### **6.6.2.7 Adaptive Management**

- 1) A summary of all changes made to date resulting from Adaptive Management, triggers encountered, and responses initiated;
- 2) Discussion of any proposed changes to management based on Adaptive Management framework.
- 3) Discussion of any issues encountered as part of implementing Adaptive Management.

#### **6.6.2.8 Additional Topics**

- 1) Descriptions of KSHCP-related public meetings held during the reporting period;
- 2) Areas of KSHCP implementation meriting technical and/or scientific review;
- 3) Summary of any new relevant findings, reports, or published studies that pertain to seabird and/or honu conservation;
- 4) Any other pertinent information that would demonstrate the compliance and effectiveness of the KSHCP and permits issued under the Plan.

### **6.7 KSHCP REPORTING SCHEDULE**

The KSHCP reporting schedule provides the anticipated due dates of reporting deliverables, responsible parties and review actions. The Annual Report shall consolidate all reports and updates of the KSHCP according to the reporting schedule (Table 6-3). In order to best use reports to make annual Adaptive Management changes to the minimization and mitigation, the season for reporting will fall during the interim season when seabirds are not present on the island (December-April). The Annual Report will be discussed at the KSHCP Annual Meeting mid-March.<sup>8</sup> At this meeting any changes in management, monitoring, or minimization actions at Participant facilities will be discussed (see [Section 6.9](#) for Adaptive Management process). A final version KSHCP Annual Report shall be submitted to the USFWS and the DLNR by April 15.

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<sup>8</sup> AG/AS will revisit report dates and suggest revisions.

If a Participant report is not submitted on time or is inadequate (e.g., missing information), the responsible party shall be notified by the wildlife agencies in writing and must demonstrate compliance with the reporting requirement within thirty (30) days. If a Participant fails to comply within the allotted time, the USFWS and the DLNR may initiate permit suspension procedures or revocation procedures (50 CFR 13.27 - 13.28)(HRS § 195D-21(d)).

**Table 6-3. KSHCP Reporting Schedule by Report Type, Responsible Party, and Due Dates.**

<b>Report Type/Action</b>	<b>Who</b>	<b>Due Date</b>
Submit draft Participant Annual Report to the Prime Contractor	Participants	Jan 15
Submit draft KSHCP Annual Report to USFWS and DLNR	Prime Contractor	Feb 28
Annual KSHCP Review meeting	Participants, Prime Contractor, USFWS, DLNR	March 15-21
Final KSHCP Annual Report	Prime Contractor	April 15
Final KSHCP Annual Report to State (legislative deadline)	Prime Contractor	Aug 1

## **6.8 MONITORING**

There are three types of monitoring addressed in the KSHCP: compliance, effectiveness, and take monitoring.

- “Compliance monitoring” verifies implementation of the HCP terms and conditions by the individual Participants and the Prime Contractor. Annual reports and reporting requirements (as outlined in Section 6.6) will be provided by each Participant and the Prime Contractor to document that the Participant has performed all of the required tasks and activities. (Actions on site to reduce/eliminate light attraction).
- “Effectiveness monitoring” evaluates the success of the HCP to minimize and mitigate take of listed species to the maximum extent practicable; evaluating whether minimization measures are effective and sufficient; and the extent to which mitigation measures are successful.
- “Take monitoring” determines when and where take of Covered Species occurs, and documents monitoring efforts.

### **6.8.1 COMPLIANCE MONITORING**

The KSHCP objectives delineate minimization and mitigation actions that will achieve specific desired outcomes for the Plan duration (see Table 5-1). Each individual PIP identifies actions specific to each Participant. Compliance monitoring evaluates whether those actions are being properly implemented and is used to ensure that each enrolled Participant meets its obligation under this HCP and the individual PIPs.

Monitoring compliance with minimization actions at Participant facilities will occur via agency review of Participant Annual Reports. As described in [Section 6.6.1](#), these reports will contain summaries, maps and photographic evidence of minimization actions that are implemented at facilities. Follow up visits by regulatory agency staff may occur as needed to validate compliance.

Monitoring compliance with mitigation actions will similarly occur via agency review of the KSHCP Annual Report. These reports will describe status of the mitigation project and progress towards meeting KSHCP objectives (see [Section 6.6.2](#)), including supporting data. Staff from regulatory agencies will also visit the mitigation site as needed.

### **6.8.2 EFFECTIVENESS MONITORING**

Effectiveness monitoring is necessary to review whether the measures being implemented as part of the HCP and associated PIPs are as effective as predicted at the time of development of this HCP. Effectiveness monitoring identifies if and when a specific measure is ineffective and provides information if the measure is ineffective, to ultimately support a determination on whether the proposed minimization or mitigation measures can be modified through Adaptive Management (see [Section 6.9](#)) or whether the HCP itself needs to be amended.

At Participant facilities the following will be evaluated: the efficacy of methods used to minimize instances of light attraction, the success of on-site predator control, training and outreach to increase the likelihood of finding downed birds. The evaluation will be based on Participant Reports (see details in [Section 6.6.1.2](#)). Additional effectiveness monitoring visits by the regulatory agencies may take place if necessary.

Protocols for effectiveness monitoring to evaluate progress and success are described in detail in *Appendix A: Kahuama'a Seabird Preserve Management Plan* for the KSHCP mitigation objectives. These objectives require three aspects of biological monitoring: monitoring of predator eradication/suppression, monitoring of vegetation (habitat) management, and monitoring of Covered Seabird response to management.

### **6.8.3 TAKE MONITORING**

Take monitoring to compare actual rates of take to requested amounts will also be conducted at Participant facilities. Each participant will provide a Covered Seabird Monitoring Plan in their PIP. The components that will be included, and the KSHCP guidelines/standards are presented in Table 6-4.

**Table 6-4. Take monitoring components for Participants and KSHCP guidelines.**

<b>Take monitoring component</b>	<b>KSHCP Guideline</b>
Detailed maps of the property indicating structures and property features (including all light sources); topography; any	All searchable areas must be covered in defined search routes (attach map). Justify "unsearchable areas".

unsearchable areas; and the proposed search route	
Description of annual training for searchers	Must cover seabird identification, seabird handling, appropriate downed birds search methods, and response procedures. Recommend training to occur immediately prior to Sept 15 (start of fallout season).
Time of Year of searches	Searching must occur twice daily between Sep 15 and Dec 15.
Frequency of searches	Minimum of twice daily (or more frequently if possible); searching should be intensified during the peak of fallout (Oct 1 – 15).
Time of day of searches	The peak of fallout generally occurs around 2 hours after sunset – <b>searches should therefore commence 2-3 hours after sunset.</b> An additional search should take place within <b>3 hours after sunrise</b> to find birds in the daylight which might have been missed the night before.
Search methods	Specify, e.g. vehicle versus walking; looking under and around objects as opposed to just patrolling; searching with flashlight, etc.
Record keeping method	Downed Wildlife Form and photographs required for each bird found.
Presence of seabird predators on site (cats, dogs, mongoose)	Record any predators seen during searches and inform management taking actions to reduce predators at facilities (actions described in <a href="#">Section 5.3.2</a> ), and what action(s) taken to remove predators from the area.
Number of searchers needed to cover area.	Depends on site conditions and safety considerations.

As provided in Section 6.2.2.1.1, the take calculation for an individual application may also include consideration of other site specific monitoring collection data where available to refine the SOS numbers. The assessment of where a downed seabird should be attributed to an Applicant's facility will be based on the best available data.

## 6.9 ADAPTIVE MANAGEMENT

USFWS policy defines Adaptive Management as “a formal structured approach for addressing uncertainty in natural resources management using the experience of management and the results of research as an ongoing feedback loop for continuous improvement” (USFWS and NMFS 1996). Uncertainties may include limited biological information for the Covered Species,

a lack of knowledge about the effectiveness of mitigation or management techniques, or doubt about the anticipated effects of Participants' facilities on Covered Species. Adaptive management recognizes that full information necessary to make decisions is often unavailable, and allows for change of management practices when supported by data or other information. It allows for the incorporation of new information into conservation and mitigation measures during KSHCP implementation.

#### **6.9.1 ADAPTIVE MANAGEMENT OF MINIMIZATION MEASURES**

Although KSHCP uses the best available information to evaluate measures to minimize incidental take of Covered Species, new or untested minimization measures to reduce incidental take of Covered Species may be introduced over the course of the KSHCP. Participants may consult at any time with USFWS and DLNR to determine if implementation of new technologies is practicable and appropriate, and develop monitoring protocols to measure the effectiveness of new measures. This might include a different design of lighting, different bulbs or more effective searching strategies.

Participants will also identify the need for Adaptive Management of minimization measures in their Participant Annual Reports, and suggest options to alter currently implemented measures. These will be discussed during the KSHCP Annual Review Meeting or in individual meetings with the regulatory agencies, and will be implemented as soon as reasonably possible.

In addition, a running 5 year average of take will be evaluated annually to enable Adaptive Management of minimization efforts. The 5 year averages will serve as triggers to inform individual Participants, the Prime Contractor and the regulatory agencies that changes are needed to increase minimization and reduce annual take to avoid exceeding the 30 year take request. In the event that take monitoring results indicate potential take exceedance, additional avoidance or minimization measures would be required through Adaptive Management. Specific measures will be tailored to relevant Participant facilities and will follow minimization guidelines outlined in [Section 5.3](#) and *Appendix E: Guidelines for Adjusting Lighting at Facilities*.

Adaptive Management is intended to provide an opportunity to improve programs based on implementation efforts and results. As a result, successes and failures at individual Participant facilities will be evaluated and the results shared among all Participants so that best practices for lighting, predator control on facility, worker training, and guest outreach can be constantly refined, improved, and shared among all Participants.

#### **6.9.2 ADAPTIVE MANAGEMENT OF MITIGATION MEASURES**

Uncertainties exist regarding the long-term effectiveness of the mitigation site. Social attraction efforts have shown excellent results in other projects worldwide, but there exists some uncertainty that may influence the effectiveness of the KSHCP social attraction project, including, for example, changes in the projected decline of the Covered Seabirds' population which might affect the number of birds available to colonize the social attraction site.

A conservative estimate of fledgling reproduction (*Appendix C: Social Attraction Benefit Estimator*) was selected to provide a high level of confidence and certainty in the reproductive outcome that will result from implementation of the social attraction project and associated barn owl and feral cat control. However, in the event that KSHCP Objectives (see [Section 5.2](#)) are not reached as scheduled (e.g. prospecting birds have not been observed at the mitigation site by year 4 after fence construction, or birds have not begun breeding by year 5-7, etc.), the Participants and the Prime Contractor will meet with USFWS and DLNR to evaluate probable reasons and possible options using the Adaptive Management process described above.

Failure to meet KSHCP objectives by target dates is the trigger for Adaptive Management discussions, and implementation, as needed. Specific management options to address delays in meeting mitigation objectives are outlined in Section 16 of *Appendix A: Kahuama'a Seabird Preserve Management Plan*, but Adaptive Management is not limited to those options.

The Year 10 KSHCP objective (Cumulative upward trend in Covered Seabird breeding documented at mitigation site) is a significant milestone in terms of Adaptive Management. Absent a catastrophic event, it is anticipated that this is the first year of the KSHCP that abandonment of the social attraction site, and redirecting existing funds towards an alternative mitigation project would be considered. Given the life history of 'a'o, with long generation times (5-6 years), any earlier would likely not provide enough time and data to justify this decision. At Year 10, if this target is not met, and the USFWS and DLNR, with input from the Prime Contractor and Participant representatives, determine further Adaptive Management strategies will not be successful, funds may be shifted to a different mitigation alternative and funded as specified in [Section 6.11.11](#) to achieve mitigation benefits committed to by the KSHCP.

Mitigation options may include (but are not limited to) expanding predator control (barn owl, feral cats or rats) and / or funding conservation actions implemented by DOFAW, the Kaua'i Watershed Alliance (KWA), the Kaua'i Endangered Seabird Recovery Project (KESRP), or another entity approved by USFWS and DLNR that provide direct benefit to Covered Seabirds. These in-depth changes to the management protocols or the scope of the mitigation actions may be addressed as an amendment to the KSHCP as determined by USFWS and DLNR, which would require compliance with applicable requirements, including possibly supplemental NEPA analysis.

The Adaptive Management process for the KSHCP mitigation measures consists of the following steps:

1. The draft KSHCP Annual Report will include a thorough review and analysis of biological data. Through these analyses, the Prime Contractor will identify whether biological objectives are being met by the target dates, and if not, will suggest any necessary Adaptive Management responses to be implemented. Responses may correspond to the preliminary list of potential Adaptive Management for proposed actions, as described in Section 16 of *Appendix A: Kahuama'a Seabird Preserve Management Plan* or may result

from consultation with experts. The need for Adaptive Management may also be identified by DLNR and/or the USFWS. Adaptive management measures are not limited to those described in *Appendix A*.

2. During the KSHCP Annual Review meeting, the Prime Contractor will receive input from USFWS, DLNR, and Participant representatives on suggested Adaptive Management options, and the USFWS or DLNR as regulatory agencies can disapprove of proposed measures, if necessary. The Prime Contractor will make the final decisions on Adaptive Management after discussion and input by the USFWS, DLNR and Participant representatives, but Participants remain responsible for meeting the biological objectives of the KSHCP.
3. Adaptive management of minimization and/or mitigation measures will occur as soon as reasonably possible following a decision(s).
4. The final KSHCP Annual Report will include the Adaptive Management measures selected by the Prime Contractor after consultation with USFWS and DLNR.

#### **6.9.2.1 Applying Results of Covered Seabird Monitoring through Adaptive Management**

Results of biological monitoring for Covered Seabirds will be compared against predictions from the social attraction estimator model. Model results reflect possible outcomes for the number of seabird burrows likely to be present, fledglings produced, and population trends within the fenced enclosure. **Table 6-5** presents initial model results (see *Appendix C: Social Attraction Benefit Estimator* for details on model inputs) for the number of seabird burrows predicted at 5-year time intervals for the life of the mitigation project. These give context for the KSHCP Objectives and will help to direct Adaptive Management decisions.

Although the total number of seabird burrows predicted is presented here, seabird burrows are very cryptic and it can be difficult to determine their exact location. One study found a human searcher efficiency rate for burrow searching to be ~57% effective, (versus detection dogs) (Kaheawa I HCP 2015 Annual Report). While exact searcher efficiency is a function of experience, terrain, and other factors, Adaptive Management triggers described below are linked to modeled outputs on the number of seabird burrows after applying a 50% searcher efficiency rate. Note that the USFWS, DLNR, or Prime Contractor may re-run the model during KSHCP review periods to use real-time data to inform Adaptive Management discussions. Thus the active burrow numbers in **Table 6-5** below may be modified by the time Adaptive Management triggers are evaluated. The most up-to-date model results will always be applied before implementing Adaptive Management actions. However, updating the model results does not change the biological objectives, including the total cumulative number of fledglings that must be produced by year 30 of the KSHCP.

**Table 6-5. Model-estimated number of active ‘a’o burrows at the social attraction site at five-year project intervals.**

Project Year	Objective	Model Predicted # of active burrows	# of known active burrows assuming 50% searcher efficiency
Year 5	<b>2.D</b> Successful breeding documented	4	2
Year 10	<b>2.E</b> Cumulative upward trend in breeding	21	10
Year 15		37	18
Year 20	<b>2.F</b> Cumulative upward trend in breeding	52	26
Year 25		67	33
Year 30		80	40
<b>TOTAL cumulative number of fledglings produced</b>	<b>923*</b>		

\*This number represents the total number of fledglings produced at the mitigation site in 30 years and not the mitigation benefit (697 fledglings) which is the difference between the number of birds produced inside the fence and those that would have been produced in the absence of the conservation program.

## 6.10 NO SURPRISES RULE

The USFWS “No Surprises” rule (50 CFR 17.22, 17.32) provides that once an Incidental Take Permit has been issued and as long as the HCP, including its Adaptive Management program, is being properly implemented, the USFWS will not require the commitment of additional conservation or mitigation measures by the permittee (including additional land, water, or financial contribution, or additional restrictions on the use of land, water or other natural resources) beyond the level provided in the HCP, without the permittee’s consent. The State of Hawai‘i provides similar assurances in HRS § 195D-23. However, the “No Surprises” policy is not applicable to situations where authorized take levels are exceeded or the minimization or mitigation measures are not functioning to provide the conservation benefits anticipated by the HCP and consequently relied upon to meet permit issuance criteria.

No surprises assurances also do not apply to Changed Circumstances. An HCP must identify and analyze reasonable Changed Circumstances that could affect a species or geographic area during the permit term. Should such a Changed Circumstance occur, the permittee is required to implement the measures specified in the HCP to respond to the change.

Conditions that are not analyzed, and for which the “No Surprises” assurances are designed, are called Unforeseen Circumstances – those that 1) could not reasonably have been anticipated by the Applicant, USFWS, and DOFAW during the development of the HCP and 2) which result in a substantial and adverse change in the status of a Covered Species. The USFWS bears the burden

of demonstrating that Unforeseen Circumstances exist, using the best scientific and commercial data available.

## **6.11 CHANGED CIRCUMSTANCES**

Changed Circumstances are specific foreseeable events or circumstances adversely affecting a species or geographic area covered by a habitat conservation plan. Such circumstances and planned responses are treated as part of the plan's operating conservation program. The following section describes Changed Circumstances identified by the USFWS and DLNR that are addressed under the KSHCP.

When a Changed Circumstance is detected there will be communication between the Participants and the Wildlife Agencies within seven (7) calendar days. As soon as practicable thereafter, but no later than thirty (30) calendar days after a Changed Circumstance(s) is detected, the Participant, as appropriate, shall begin implementing the planned responses identified in [Section 6.11](#) for the specific Changed Circumstance to the extent necessary to minimize or mitigate the adverse effects of the Changed Circumstance on Covered Species.

If the Wildlife Agencies determine that a Changed Circumstance has occurred and the Participants have not responded in accordance with [Section 6.11](#) of the KSHCP, the Wildlife Agencies shall so notify the Participants, as appropriate, and direct the Participants to implement the appropriate plan response(s) to the changed circumstance within thirty (30) calendar days after receiving such notice, and report to the Wildlife Agencies on its actions.

Under the KSHCP and in accordance with Federal and State regulation, the Participants are responsible for ensuring the minimization and mitigation of take impacts to the Covered Species to achieve the biological goals of the HCP. Planned responses would be implemented using available funds described in funding [Section 7.1](#). Exceptions to this funding approach are noted below.

Beyond the Changed Circumstances and thresholds identified in this section, no other Changed Circumstances affecting a Covered Species or geographic area covered under the KSHCP were reasonably anticipated by the DLNR or USFWS at the time the KSHCP was prepared. Other changes in circumstances affecting a Covered Species or a covered geographic area under the KSHCP that result in a substantial and adverse change in the status of the Covered Species are considered as Unforeseen Circumstances as defined by Federal regulation (50 CFR §17.3) (see Section 6.12).

### **6.11.1 HURRICANES, SEVERE TROPICAL STORMS, WILDFIRES, AND OTHER NATURAL DISASTER**

Severe storms and hurricanes occur periodically in the Main Hawaiian Islands (MHI). The two most recent hurricanes that directly impacted Kaua'i were 'Iwa in 1982 and 'Iniki in 1992. Hurricane 'Iniki caused widespread and devastating damage to infrastructure, property, and natural resources. Wildfire is also a threat on Kaua'i, particularly in times of drought. The Hawai'i Wildfire Management Organization did a Wildfire Hazard Analysis in 2013 and the area

of the KSHCP operating conservation program (Kōkeʻe State Park) was identified as a moderate to high risk in all assessment categories (Hawaiʻi Wildfire Management Association 2013)). Because Hawaiʻi's native forest evolved with infrequent naturally occurring fires, most native plant species are not fire adapted and do not recover quickly, making the landscape vulnerable to erosion and non-native weed invasion.

Detailed storm records have been kept for the state of Hawaiʻi since 1950. In the time period from 1950-2017, hurricane and/or tropical storms have impacted Kauaʻi on average every 10 years (see Table 7-1, in Section 2.1.1). This is the basis for the planned response threshold described below. Climate change trends indicate increases in storm frequency (IPCC 2014) and changes in rainfall patterns. On that basis, hurricanes, severe storms, wildfire events, and other natural disasters can reasonably be anticipated during the 30-year term of the KSHCP and are regarded as a Changed Circumstance.

Natural disasters have potential to adversely affect the KSHCP in several ways. First, a hurricane or severe storm may pose a threat to the overall population of Covered Seabirds by killing adult birds, fledglings and chicks, destroying eggs and severely altering vegetation in breeding colonies, and damaging or destroying burrows. Second, a hurricane or severe storm may cause significant damage or destruction to Participant facilities and/or to the KSHCP operating conservation program, which may alter the effectiveness of minimization and mitigation measures and/or the amount of take requested by Participants. A hurricane or severe storm may alter the natural and human environment in areas surrounding Participant facilities and the operating conservation program in ways that increase the potential effects of those facilities or sites on the Covered Species.

Finally, fire could alter the natural environment in breeding colonies, making it unsuitable as nesting habitat, and it could cause damage to the KSHCP operating conservation program, which could alter the effectiveness of mitigation measures.

Planned Response. In the event of a hurricane, severe storm, or other natural disaster, the Participants, DLNR and USFWS will evaluate the extent of the damage as it pertains to the KSHCP operating conservation program and the Participants' facilities and the resulting impacts on the Covered Species, as determined based on the best available information at that time. If determined to be necessary by USFWS and DLNR, following consultation with the Participants, damage to the conservation program (i.e. fence enclosure or social attraction equipment) may be repaired or replaced or alterations to the conservation measures may be needed to achieve the mitigation objectives of the KSHCP. The estimated cost of full fence replacement, social attraction equipment replacement and vegetation restoration is presented in Chapter 7.

Up to 2 events requiring complete replacement of the fence and social attraction equipment are considered a Changed Circumstance. Subsequent event(s) would be treated as an Unforeseen Circumstance (see [Section 6.12](#) below).

### **6.11.2. VANDALISM AT THE MITIGATION SITE**

Over the course of the 30-year permit term, the predator proof fence, predator control equipment and/or social attraction equipment may experience vandalism. This may occur with malicious intent or at random. Fences on public lands are often perceived as a threat to full public access (e.g., for hunting and hiking) and this may draw negative attention that leads to destructive acts of vandalism.

Planned Response. In the event of vandalism the Participants, DLNR and USFWS will evaluate the extent of the damage as it pertains to the KSHCP operating conservation program and the resulting adverse effects on the Covered Species, as determined based on the best available information at that time. If determined to be necessary by USFWS and DLNR, following consultation with the Participants, damage to the mitigation site will be repaired or replaced. Additional Adaptive Management actions intended to reduce occurrences of vandalism at the mitigation site will be implemented as necessary if vandalism events occur (e.g., the installation of additional cameras and/or additional signage on the mitigation site). The estimated cost of fence repair in the event of vandalism, and the cost of additional vandalism prevention measures is less than the cost of a single full fence replacement. Up to 2 events requiring complete replacement of the fence and social attraction equipment are considered a Changed Circumstance. Subsequent event(s) would be treated as an Unforeseen Circumstance (see [Section 6.12](#) below).

### **6.11.3. LISTING OF NEW SPECIES OR DELISTING OF A COVERED SPECIES**

Species not listed as threatened or endangered under the Federal ESA or HRS Chapter 195D at the time this HCP is approved and that are not addressed as Covered Species in this HCP will not automatically be included in the Incidental Take Permits should they become listed during the term of this HCP. Over the 30-year term of the KSHCP program, it is possible that changes in the listing status of species present at Participant facilities or in the mitigation areas associated with the KSHCP could occur.

Planned Response. If a new species on Kaua'i becomes listed under the ESA or HRS Chapter 195D, the Participants, DLNR, and USFWS will evaluate the likelihood of incidental take of a newly listed species caused by KSHCP Covered Activities.

If adverse effects to the new species or incidental take are likely, the Participants, DLNR, and USFWS will meet to discuss whether conservation measures in place can avoid incidental take, what additional measures should be put in place to address newly listed species, and whether an amendment to the HCP is required to address these issues. Unless and until a Participant's permit is amended to authorize incidental take of new species, the Participant shall take all necessary steps to avoid incidental take of that species. The costs of minimization and mitigation measures for newly listed species are not covered by the current funding mechanisms for the KSCHP.

If the USFWS determines that Participant-covered activities or mitigation, individually or collectively, may affect the newly listed species, the USFWS will reinstate ESA section 7

consultation on the issuance of ITPs for Participant plans. If the consultation determines that any such activities are likely to jeopardize the newly listed species, the USFWS will provide reasonable and prudent alternatives (RPAs), if any, to the Participant(s) to avoid such an outcome. Failure to implement RPAs could result in revocation of the permit(s).

If any of the Covered Species become delisted over the term of the KSHCP, measures for that species will continue in accordance with the KSHCP, but the Participants may initiate discussions with the USFWS and DLNR to determine if such actions may be discontinued.

#### **6.11.4. CRITICAL HABITAT DESIGNATION**

The Covered Species do not currently have designated Critical Habitat. If the USFWS designates Critical Habitat, and such Critical Habitat may be adversely affected by the activities covered in the KSHCP, such an occurrence is regarded as a Changed Circumstance.

Planned Response. If the USFWS determines the covered activities or mitigation may adversely affect Critical Habitat, it will reinitiate consultation on the issuance of ITPs for Participant plans to determine if the covered, minimization and mitigation activities under the KSHCP, individually or cumulatively, would be likely to destroy or adversely modify critical habitat. If so, the USFWS shall develop reasonable and prudent alternatives to the KSHCP and/or Participant plans, in consultation with the Participants, to avoid this outcome that will be implemented by the Participants as necessary.

#### **6.11.5. GLOBAL CLIMATE CHANGE**

The vast body of scientific evidence supports the concept that warming of global temperatures is occurring and will continue into the future and that a contributing factor is the release of greenhouse gases from human-caused actions (IPCC 2014). Predicted impacts of climate change include changes in ocean temperatures and acidity levels, and the spread of invasive organisms (IPCC 2014). The impact and timing of climate change is uncertain, but is anticipated to impact the Covered Seabirds in at least two ways:

1. Ocean acidification and increased ocean temperatures could result in changes to seabird prey base (Kroeker et al. 2013) impacting prey abundance and foraging; and
2. Increasing temperatures could increase the spread of disease or invasive species that either impact Covered Seabirds directly or negatively impact seabird breeding habitat (Oro 2014).

*Appendix B: Covered Species Biological Details* provides more detailed information on the potential impacts of climate change on the Covered Seabirds.

Planned Response. If the USFWS and DLNR determine that climate change is negatively impacting anticipated benefits of the conservation measures of the KSHCP, the USFWS and DLNR shall evaluate the extent of the impact and the resulting effects on KSHCP mitigation measures, based on the best available information at that time. As determined necessary by DLNR and USFWS, following consultation with the Participants, adjustments to conservation measures will be implemented to achieve mitigation benefits committed to by the Participants

under the KSHCP program. Climate change impacts will be considered a Changed Circumstance only if impacts are directly affecting the KSHCP operating conservation program. For example, if climate change is impacting habitat conditions at the mitigation site, this could be addressed by altering vegetation management.

#### **6.11.6. INVASIVE SPECIES**

Invasive species of both plants and animals have had, and will continue to have, a detrimental effect on the Covered Species and their habitat.

Introduction of a New Predator Species. Predation by alien mammalian species has been shown to constitute a very substantial threat to the Covered Species on Kaua'i, and other, non-mammalian, predators also have had significant impacts to seabirds in the MHI. The possibility exists that the small Asian mongoose (*Herpestes javanicus*) will become established on Kaua'i during the term of the KSHCP, which would be highly likely to have a negative impact on the overall populations of Covered Species. Several individuals have been caught on Kaua'i in recent years and 'credible sightings' are reported to the Kaua'i Invasive Species Committee annually from multiple locations on the island. Other potential predators on the Covered Species such as the brown tree snake (*Boiga irregularis*), a new species of rodent or a harmful insect such as yellow crazy ants (*Anopolepis gracilipes*) may be introduced during the 30-year permit term as well.

Alien plants have displaced native vegetation from former breeding colony areas, reducing or eliminating the suitability of the area for Covered Species. In addition, invasive species of insects, fungus, nematodes, mites and other plant pests may be introduced, which may adversely affect native species, and seabird habitat suitability within the mitigation site over the term of the HCP.

In general, the threat of new invasive species is heightened by the challenge of maintaining biosecurity on imports into the MHI. The likelihood that invasive species will be introduced or increase during the term of the KSHCP is sufficient to warrant treating this species introduction or increase as a Changed Circumstance.

Planned Response. Proposed monitoring at the KSHCP mitigation site, including predator control, vegetation and burrow monitoring (see Section 6.8.2) should be sufficient to provide early detection of any new invasive plants or animals at the site. In the case of introduction of a new mammalian predator (such as a mongoose), the predator proof fence at the mitigation site would prevent access to the social attraction site. Outside of the predator proof fence, within the geographic area where feral cat trapping will occur, mongoose will be removed by using existing cat traps. In the event that other types of invasive species (e.g., insects, amphibians, reptiles, non-native plants, etc.) impact the KSHCP operating conservation program, necessary management actions would be evaluated and implemented after discussion with the Participants. These include but are not limited to trapping insects, disinfecting artificial burrows within the social attraction site, or trapping snakes where seabird burrows occur along cat trap lines outside of the enclosure. The estimated cost of these adaptive management solutions to

additional invasive species are expected to be minimal and within the current KSHCP operations budget.

In the event habitat enhancement and/or vegetation management measures at the KSHCP operating conservation program sites are compromised by new and/or increased populations of invasive plant or insect species, vegetation management activities (including increased monitoring) may be modified. The USFWS and DLNR will determine, after discussion with Participants, that such a response is necessary to achieve the mitigation objectives of the KSHCP.

#### **6.11.7. DISEASE OUTBREAKS IN A COVERED SPECIES**

Hawaiian endemic species evolved in the absence of many pathogens. As a result, their lack of resistance to some diseases may have played an important role in their decline. The estimated risk to the Covered Species of disease outbreaks varies by species or is unknown. Among the 'a'o populations, fledglings have been found with mild symptoms of avian pox (Ainley et al. 1997b) and avian malaria (Warner, 1986; A Raine, 2017, pers. comm.). The likelihood that the threat from disease will occur during the term of the KSHCP is sufficient to warrant treating this threat as a Changed Circumstance.

Planned Response. Conservation measures may be implemented if USFWS and DLNR determine, after discussion with Participants, that it is necessary to respond to the increased prevalence of disease and its threat to the KSHCP operating program. For example, mosquito trapping would be evaluated and implemented should avian malaria impact populations of Covered Seabirds breeding in the social attraction enclosure or along trap lines. The estimated cost of these adaptive management solutions to disease are expected to be minimal and within the current operations budget.

#### **6.11.8. CHANGES IN SURVIVAL OF BIRDS REHABILITATED AND RELEASED**

The SOS program is the anticipated means to achieve the KSHCP objective of recovering, rehabilitating and releasing all downed birds found at Participant facilities (see [Section 5.3.4](#)). Given the 30-year term of the KSHCP, it is reasonable to anticipate that the SOS Program may not be available to serve this function during the entire term of the KSHCP, which warrants treating this as a Changed Circumstance.

It is also foreseeable that, during the course of the KSHCP, new information will become available on the survival of birds released through the SOS Program or any replacement program. The KSHCP, using the best available science, assumes that all birds evaluated and released through the SOS program in a timely manner will survive at the same rate as wild fledglings not recovered and released through SOS (see Section 4.1.3 for details). It is foreseeable that new data will become available that alters this assumption on SOS survival. In addition, if the SOS program is no longer available as a means to achieve the KSHCP minimization objective of recovering, evaluating and releasing downed seabirds, survival of released birds may be different under the care of separate veterinarians.

If the survival of recovered and released downed seabirds changes, this will impact the ratio of lethal versus non-lethal take in the KSHCP. If released seabirds do not survive at the same rate as wild birds that do not experience fallout and subsequent release, then the changed ratio may require a response as explained below.

Planned Response if SOS Program is no Longer Available: The KSHCP intends to rehabilitate and release downed seabirds that are recovered by Participants via the SOS Program. The SOS Program provides expertise, cost effective rehabilitation, established aid stations and more. However, the KSHCP provides for the contingency that the SOS Program may not be available for the life of the program by collecting funds adequate to provide the required services (rehabilitation and release of downed seabirds) independent of the continued existence of the SOS Program. If necessary, the Participants would use a certified veterinarian to handle and rehabilitate downed seabirds from the Participants' premises. Each Participant would be responsible for arranging for the required services for its downed seabirds. The KSHCP funds would not be necessary to meet this contingency.

Planned Response Based on Changes in Survival: If information shows different survival of recovered and released birds than is assumed in the current KSHCP, this information could result in higher or lower take levels. If this results in higher take levels, individual Participants would need to determine whether this higher level is likely to exceed the amount of take authorized by their permit and, if so, may apply for a permit amendment. If the increased lethal take can be accommodated under the current KSHCP, the process for re-evaluating costs is described in Section 6.5. If it cannot be accommodated under the current KSHCP, Participants or an individual Participant may elect to initiate a Major Amendment pursuant to Section 6.13.2. Each participant is responsible to address its additional minimization and mitigation as necessary.

If the information results in a lower take level for a Participant, the Participant may request to amend its permit pursuant to Section 6.5.

## **6.12 UNFORESEEN CIRCUMSTANCES**

Unforeseen circumstances are defined by Federal regulation (50 CFR §17.3), this refers to circumstances affecting a species or geographic area covered by the HCP that cannot be reasonably anticipated by the Participant or the wildlife agencies. In the event that USFWS or DLNR makes a finding that unforeseen circumstances have arisen during the term of the KSHCP, the USFWS and DLNR will notify the Prime Contractor and Participants in writing. If it is demonstrated by USFWS and DLNR that unforeseen circumstances exist during the permit term, and additional conservation measures are recommended, the Prime Contractor and the Participants will have the opportunity to evaluate the feasibility of implementing any measures recommended by USFWS and DLNR and propose other conservation measures.

Provided the KSHCP is being properly implemented, additional conservation measures are limited in that the USFWS and DLNR:

- 1) shall neither require the commitment of additional land, water, or financial compensation by Participants without Participants' consent nor shall they impose additional restrictions on the use of land, water, or other natural resources otherwise available for use by Participants under the original terms of the KSHCP;
- 2) shall have the burden of demonstrating that such unforeseen circumstances exist, using the best scientific and commercial data available. Their findings must be clearly documented and based upon reliable technical information; and
- 3) shall not require additional mitigation than originally agreed (i.e. may not increase the number of birds required to mitigate for lethal take) for a species where the terms of the properly functioning KSHCP were designed to provide an overall net benefit for that species and contained measurable criteria for the biological success of the KSHCP, which have been or are being met.

Notwithstanding these provisions, an ITP may be revoked if continuation without additional mitigation would be inconsistent with the requirement that the incidental taking not appreciably reduce the likelihood of the survival and recovery of the species in the wild (50 C.F.R. §§ 17.22(b)(8), 17.32(b)(8)).

## **6.13 CHANGES AND AMENDMENTS TO THE KSHCP**

There are two types of changes which may be made to the KSHCP; Minor Amendments and Major Amendments. All revisions and amendments will be processed in accordance with all applicable legal requirements.

### **6.13.1 MINOR AMENDMENTS**

Minor Amendments are changes to the KSHCP provided for under the operating conservation program, including Adaptive Management changes and responses to Changed Circumstances. They include revisions that do not materially modify the scope or nature of effects on the Covered Species, do not diminish the level or means of mitigation, or do not increase the take threshold of the HCP. Minor Amendments may include, but are not limited to, the following:

- Correction of any maps or exhibits or documents to correct errors or spelling;
- Routine administrative revisions;
- Modifying reporting protocols or formats for Annual Reports;
- Minor changes to monitoring or reporting protocols;
- Minor changes to the size, design, and management of the mitigation site to enhance the potential for success;
- Minor changes to the schedule of mitigation milestones;
- Any other modifications to the KSHCP that are consistent with its biological goals and objectives that will not:
  - result in operations under the KSHCP being materially different from those analyzed in connection with the KSHCP as approved,
  - have adverse impacts on the environment that are new or materially different from those analyzed in connection with the KSHCP as approved,

- result in take of Covered Species not analyzed in connection with the KSHCP as approved.

Such Minor Amendments do not alter the terms of the incidental take permit or incidental take license. Upon the written request by the Participants, the USFWS and DLNR may approve Minor Amendments to the HCP.

### **6.13.2 MAJOR AMENDMENTS**

Amendments that substantively alter the total take of the KSHCP, the term of the KSHCP, or the mitigation provided to compensate for take, would be considered a Major Amendment.

Examples include but are not limited to the following:

- Mitigating for take of honu;
- Adding a new species to the list of Covered Species contained in the KSHCP;
- Abandoning the predator proof fence and/or associated barn owl and feral cat control, and redirecting mitigation funding to a new project
- Extending the term of the KSHCP and associated incidental take permits beyond the original term;
- Additional take requests that would exceed the maximum amount of take in the KSHCP;
- A reduction in initial authorized take amount of greater than 50%;
- Changes to the Covered Activities which were not addressed in the KSHCP as originally approved, and which otherwise do not meet the criteria for a Minor Amendment.
- Changes to the mitigation which were not addressed in the KSHCP as originally approved, and which otherwise do not meet the criteria for a Minor Amendment.
- Changes to take levels due to survival of downed seabirds rehabilitated and released through the SOS Program or certified veterinarian.

A Major Amendment requires submittal to USFWS and DLNR of a written application and implementation of all permit processing procedures applicable to an original incidental take permit. The specific documentation required to comply with the Federal ESA, HRS Chapter 195D, the National Environmental Policy Act, and HRS Chapter 343 may vary based on the nature of the amendment.

Costs for submitting and processing a Major Amendment would be paid by relevant Participant(s). For example, if only one Participant needed take coverage for honu, or a new species, they would be responsible for associated costs. In contrast, an amendment required for multiple Participants may result in adjustments to shared costs.

### **6.14 AMENDMENTS TO PERMITS**

Any increase or material change to minimization plans or take requests would require an amendment to the permit according to applicable regulations at that time. Permit changes may need to be made to reflect amendments to the KSHCP as determined by the USFWS and DLNR. The USFWS is not required to approve amendments made to the incidental take license by

DLNR, and DLNR is not required to approve amendments made to the incidental take permit issued by USFWS.

#### **6.15 SUSPENSION/REVOCATION**

USFWS and DLNR may suspend or revoke a Participant's permit if the KSHCP Participant is not in compliance with the terms of its permit/license (which incorporates the KSHCP and PIP) or as otherwise provided for by State or Federal law. Suspension or revocation of the permit/license shall be done in accordance with applicable Federal or State law and regulations.

#### **6.16 PERMIT TRANSFER**

In the event of sale or transfer of ownership of facilities covered under the KSHCP during the term of the permits, the permit/license may be transferrable to the new owners. Participants must notify USFWS and DLNR in advance of the sale or transfer of ownership for information on the requirements for transfer in effect at that time.

#### **6.17 KSHCP EXTENSION AND RENEWAL OF PERMITS**

At the end of the 30-year duration, the KSHCP may be extended and permits renewed under certain circumstances and to the extent permitted by law. Two years prior to the end of the KSHCP, interested Participants, DLNR and USFWS will meet to gauge the extent of interest in extending the KSHCP and discuss whether biological circumstances (e.g. threats and conservation needs) and the nature of effects to Covered Species make the KSHCP still the appropriate vehicle to mitigate incidental take. If so, the Prime Contractor will work with the Participants and the wildlife agencies to make any necessary changes to the KSHCP. Participants may apply for renewal of their permits in accordance with State and Federal regulations in effect at that time. (Federal regulations governing permit renewal are currently codified at 50 C.F.R. 13.22.)

## 7. FUNDING

The KSHCP consists of a unique payment scheme and funding assurance approach. The combined funding provided by multiple Participants (entities issued with incidental take authorization) enables the Plan to take advantage of economies of scale to conduct conservation actions and allows for cost-sharing of some project components.

Cost sharing is achieved by dividing the total costs among the KSHCP Participants in accordance with the amount of take requested per Participant. With a defined mitigation project and identified Plan costs, the cost per Participant becomes a function of how many Applicants join the KSHCP, how much total, combined take will be authorized by the regulatory wildlife agencies, and the amount of take for a given Participant. **Table 7-1** provides a summary list of cost categories of the KSHCP, and which are shared. Costs that are specific to individual Participants and Participant facilities are not shared costs.

**Table 7-1. Cost components of the KSHCP and cost sharing.**

Cost Item	Payment	Description	Shared
<b>Project Administration</b>	Paid to KSHCP Conservation Measures Implementing Fund	Administration and coordination of the KSHCP	Shared
<b>Mitigation through predator proof fence, seabird social attraction, associated barn owl and feral cat control &amp; effectiveness monitoring</b>	Paid to KSHCP Conservation Measures Implementing Fund	Build fence, implement social attraction, predator control and associated actions and measure results	Shared
<b>Changed Circumstances/Adaptive Management fund</b>	Paid to KSHCP Reserve Account	To fund Changed Circumstances, including Adaptive Management measures that exceed operating budget	Shared
<b>Financial Assurances</b>	Paid to KSHCP Reserve Account	To cover costs for remaining Participants if other withdraws or fails to make required payments	Shared
<b>State compliance &amp; annual review</b>	Paid to DLNR by Participants	Conduct annual review and HCP compliance	Shared
<b>Avoidance and minimization measures</b>	Costs incurred by each Participant but not paid to KSHCP accounts	Measures to reduce the effects of light attraction and reduce on-site predation	Not shared (cost is facility-specific)
<b>On-site take monitoring</b>	Costs incurred by each Participant but not paid to KSHCP accounts	Participant must provide trained monitors to search property for impacted wildlife and report the results	Not shared (cost is facility-specific)
<b>Beach honu nest monitoring and light avoidance</b>	Costs incurred by each Participant but not paid to KSHCP accounts	Measures to prevent honu disorientation at nests	Not shared (cost is facility specific)

## 7.1 SHARED COST COMPONENTS

Section 10(a)(2)(B)(iii) of the ESA requires that “the Applicant will ensure that adequate funding for the plan will be provided.” This issuance criterion requires that the Applicant detail the funding that will be available for all shared and facility specific funding components of the KSHCP.

HRS Chapter 195D states that the Applicant shall provide adequate funding for the plan. This may be accomplished by “depositing a sum of money in the endangered species trust fund created by Section 195D-31, or provid[ing] other means approved by the board....” HRS § 195D-4(g)(3). Similarly, each HCP shall also “identify ... an adequate funding source to ensure that the actions or measures, including monitoring, are undertaken in accordance with the schedule.” HRS § 195D-21(b)(2)(D).

In connection with the KSHCP, the National Fish and Wildlife Foundation (“NFWF”) will establish two accounts to receive, manage, and disburse certain funds to be deposited by Participants in the KSHCP for purposes of the Participants’ implementation of the 30-year KSHCP. The KSHCP Conservation Measures Implementation Funding Account will receive the Annual Payments, adjusted for inflation, paid by Participants under Section 7.1, below. The KSHCP Reserve Account will receive the Financial Assurances Payments and the Changed Circumstances/Adaptive Management Payments paid by the Participants under Section 7.1, below.

The proposed funding required in any given year of Plan implementation is derived from cost estimates in *Appendix G* for implementing conservation actions as specified in Chapter 5 and *Appendix A: Kahuama’a Seabird Preserve Management Plan*.

Upon issuance of the ITP and ITL, each Participant will, within 30 days make payments indicated below as due for year one. Initial payments must be made before the ITP and ITL can become effective. Thereafter, payments must be made on or before the anniversary of the effective date of either the ITP or ITL, whichever occurs earlier. NFWF will send an email confirmation of receipt of payments to the Payor, USFWS and DLNR and Participants.

Payment descriptions are as follows (also see **Table 7.2**):

### **Annual payments**

Annual Payments will be used for the implementation of the mitigation measures on an annual basis. These funds will be paid to the KSHCP Conservation Measures Implementing Funding Account. The first year’s collective payment will be greater than the following years’ payments to provide sufficient funds for construction of the fence, predator removal, and social attraction site equipment. The first year collective payment will be \$643,884.

A Participant shall have the right, but not the obligation, to pre-pay its annual payments for the remainder of the KSHCP term or a portion thereof, accounting for inflation.

### **Reserve Funds for Financial Assurance and Changed Circumstances/Adaptive Management**

In addition to the annual payments, Participants will make payments to the KSHCP Reserve Account to 1) provide Financial Assurances (three years of annual payments) and 2) provide a fund for Changed Circumstances and Adaptive Management (the cost of one complete fence and social attraction equipment replacement).

First, to provide financial assurances, Participants will collectively pay three times the anticipated annual payments after Year One. As shown in Table 7-2, the collective anticipated annual payment after Year One is approximately \$200,000. Therefore, the Financial Assurances payment will be \$600,000. This financial assurances reserve fund is available to be drawn upon by the other Participants if a Participant does not make its annual payment or elects to withdraw from the KSHCP. This will allow the remaining Participants to cover the mitigation costs that the delinquent or withdrawing participant would have paid. The collective financial assurances payment will be made to the KSHCP Reserve Fund with half (\$300,000) to be paid in Year 1 and the other half (\$300,000) to be paid in Year 2.

Second, the Participants will fund a reserve to provide for Changed Circumstances and Adaptive Management measures that exceed the annual payments. As provided in Section 6.11, up to 2 events requiring complete replacement of the fence and social attraction equipment is considered a Changed Circumstance. The Reserve Fund shall be funded initially in the amount of one complete fence and social attraction equipment replacement. This collective payment will be \$225,000. These funds may be used if there are Changed Circumstances or Adaptive Management measures that require the expenditure of funds beyond those available from the annual payments. This collective payment will be made in year 2 (as the first year cost includes a cushion for increased costs in year 1). The Reserve Fund shall be replenished following withdrawals so that there are sufficient funds to pay for one complete replacement of the fence and social attraction equipment, provided however that the Changed Circumstances reserve, as replenished, shall not exceed the cost of up to 2 events requiring complete replacement of the fence and social attraction equipment, as provided in Section 6.11. Notwithstanding any limits on replenishment of the Changed Circumstances/Adaptive Management Reserve Fund, the Participants remain responsible for meeting the biological goals of the KSHCP (see Adaptive Management Process in Chapter 6).

No later than Year 28 of the KSHCP, the Participants will determine whether they wish to seek an amendment to extend the term of the KSHCP. If the Participants conclude they will seek an amendment to extend, the annual payments shall be made and the Reserve Fund maintained pending consideration of the amendment. If the Participants conclude they will not seek an amendment to extend, they will advise the USFWS and DLNR. At the end of Year 28, one year of the three years of Financial Assurance funds in the KSHCP Reserve Account (\$200,000) shall be transferred to the KSHCP Conservation Measures Implementing Fund and shall offset the annual payment for Year 29 to the extent of the funds transferred. At the end of Year 29 of the KSHCP, one year of the three years of Financial Assurance funds in the KSHCP Reserve Account (\$200,000) shall be transferred to the KSHCP Conservation Measures Implementing Fund and shall offset the annual payment for year 30 to the extent of the funds transferred. At the end

of the original term of the HCP, or any sooner termination, any interest accrued and remaining monies in both the KSHCP Reserve Account and the KSHCP Conservation Measures Implementing Fund will be paid to the Participants remaining in the HCP based on their proportionate share of the authorized take.

**Inflation** – Participants will work with the Prime Contractor to manage costs of implementation of the KSHCP. The budget includes inflation at three percent (3%) per annum for the annual payments. Both the KSHCP Conservation Measures Implementation Funding Account and the KSHCP Reserve Account will be invested by NFWF in one or more investment portfolios or an interest-bearing account maintained by NFWF. The Changed Circumstances/Adaptive Management funds will be replenished following withdrawals so that there are sufficient funds in then-current dollars to pay for one complete replacement of the fence and social attraction equipment, provided however that the Changed Circumstances reserve, as replenished, shall not exceed the cost of up to 2 such events, as provided in Section 6.11.

For the Financial Assurances portion of the Reserve Account, the Participants will have funded an initial three years of payments into a NFWF investment account. In the event of an early withdrawal of a Participant, the remaining Participants will replenish their individual pre-withdrawal shares for inflation, taking into account investment income, so that their three years of Financial Assurance payments are in then-current dollars.

**Table 7-2: Schematic of types of payments needed for KSHCP funding, and which payments will required in specific years.**

	Year 1	Year 2	Year 3	Year 4	Year 5
Annual Payment	\$643,885	\$181,094	\$186,227	\$191,514	\$196,959
Changed Circumstances	0	\$225,000			
Financial Assurances	\$300,000	\$300,000			

The Prime Contractor shall have the right, but not the obligation, to accept payment in kind for materials or labor needed to implement the KSHCP from a Participant in satisfaction of its annual payment(s). The Participants shall have the right, but not the obligation, to provide a letter of credit in lieu of the Financial Assurances payment, provided that the Letter of Credit shall be made payable to NFWF or the KSHCP accounts, as directed by NFWF.

## 7.2 NON-SHARED COST COMPONENTS

The minimization measures described in individual PIPs will be performed by each individual Participant. The measures consist of lighting minimization; recovery of downed seabirds and their transportation to SOS or another appropriate facility; predator control at facilities; outreach and worker training; and honu actions (see [Chapter 9](#)). These measures will be

implemented by the Participants within one year of Implementing Agreements (IA) and the issuance of the ITP and ITL.

Each Non-Governmental Participant will:

- Provide the estimated cost of its non-shared minimization and other measures in its PIP, along with an explanation as to how the Participant plans to fund these costs. Unless the Participant is going to provide a funding guarantee such as an irrevocable letter of credit, the Participant should provide sufficient information to show that it has the financial ability to fund these costs, i.e., that it is financially solvent and capable of providing the necessary funding.
- Warrant that it has, and will expend, the operating funds necessary to continue its minimization obligations.
- Agree to promptly notify the Prime Contractor and regulatory wildlife agencies (USFWS and DLNR) of any material change in its financial ability to fulfill its ongoing minimization obligations.
- Certify in its Annual Report to the Prime Contractor that it has, and will continue to expend, the operating funds necessary to continue its minimization obligations throughout the term of the ITP and ITL.

Each Governmental Participant will:

- Provide the estimated cost of its non-shared minimization and other measures in its PIP, along with an explanation as to how the Governmental Participant plans to fund those costs. If the Governmental Participant relies on annual appropriations for its funding assurances, the effective date of its incidental take authorization and the incidental take authorization for each year thereafter will be contingent on the Governmental Participant certifying to the agencies that funds have been appropriated for that year and will be expended. For this reason, the agencies recommend that Governmental Participants request appropriations for any non-shared measures not included in the normal operating budget in their next respective biennium budgets and as a recurring annual expense thereafter.
- Agree to promptly notify the Prime Contractor and regulatory agencies (USFWS and DLNR) if the funds requested to carry out its obligation under the KSHCP are not authorized.
- Certify in its Annual Report to the Prime Contractor that it will request in its annual budget and if approved expend, the operating funds necessary to continue its minimization obligations throughout the term of the ITP and ITL.

## **7.3 READJUSTING COST PER TAKE**

### **7.3.1 LATE ENTRY TO THE KSHCP**

The KSHCP is designed to accommodate new Applicants, or Participant requests for additional incidental take amounts annually up to the maximum level authorized by the wildlife agencies

in the form of new or amended permits (see [Section 6.3](#)). This may result in a reduction to cost per take estimates. The cost readjustments described below will occur if the additional incidental take request does not exceed the maximum amount analyzed in the KSHCP and is authorized by the wildlife agencies. (Note: If the maximum amount of take authorized in the KSHCP is exceeded, this will trigger a Major Amendment so is not discussed further here, see [Section 6.13.2](#)).

The fundamental issue for any late entries to the KSHCP, in terms of funding, is distributing costs equitably while accounting for the higher “set up” costs paid by the initial Participants. Additional incidental take requests will generally fall into three categories:

1. Results of Take Monitoring demonstrate the need for existing Participants to request additional incidental take;
2. Additional new Applicants who have been incurring ongoing take since the KSHCP initiation and are approved to join the KSHCP; or
3. Additional Applicants who have not incurred take in the past (e.g. opening a new facility) are approved to join the KSHCP.

In the case of category 1, the Participant will have already contributed towards the initial set up costs. The overall cost per take will reduce for all Participants to reflect the increase in overall take authorization within the planned-for mitigation

In the case of Category 2, the new Applicant will be required to pay for a portion of the set up costs (relative to the additional incidental take request) plus a portion of the annual implementation costs since the first year of the KSHCP, based on its proportional amount of incidental take. This is because the new Participant has been incurring take during this time period and because it is not equitable for a new entrant to pay only for the maintenance of infrastructure built and paid for by others. The set up costs include but are not limited to the cost of fence construction, predator control and social attraction site equipment that the initial Participants funded in the first years of the KSHCP. The annual fee for the Participants will be reduced as a result of the allocation of a portion of the set up costs as well as a reduced annual payment given the increase in authorized take.

In the case of Category 3, the new Participant will be required to pay a portion of the set up costs, but will begin paying their share of annual implementation costs at the time of joining, and for the remainder of the permit term. It is not equitable for a new entrant to pay only for the maintenance of infrastructure built and paid for by others. The set up costs include but are not limited to the cost of fence construction, predator control and social attraction site equipment that the initial Participants funded in the first years of the KSHCP. The annual fee for the Participants will be reduced as a result of the allocation of a portion of the set up costs as well as reduced annual costs given the increase in authorized take.

Late Participants (categories 2 & 3) will be required to make an initial payment consisting of:

- (1) a proportional contribution towards Year 1 set up costs (\$600,000) and (if applicable) proportional contribution towards annual implementation costs for missed years, both adjusted for inflation;
- (2) a proportional contribution toward the \$600,000 Financial Assurances Payment, as adjusted for inflation to reflect three years of annual payments in then-current dollars; and
- (3) a proportional contribution towards the \$225,000 Changed Circumstance/Adaptive Management payment, as adjusted for inflation to reflect to the cost of one complete fence and social attraction equipment replacement. See [Section 7.1](#) for details on these payments and their function in the KSHCP funding scheme.

The term of the KSHCP shall not be extended by the addition of Participants.

In all cases, the overall costs per take should be reduced for the initial group of Participants, and their 30 year costs will be adjusted to reflect this. The resulting reduction in annual costs and set-up costs for the initial Participants will be re-calculated to reflect a new annual cost per take, and applied retroactively to credit initial Participants for payments at the higher rate. Participants will subsequently pay a lower annual rate.

### **7.3.2 EARLY WITHDRAWAL FROM THE KSHCP.**

A Participant may withdraw from the KSHCP before the conclusion of its permit term if it discontinues its Covered Activities or otherwise surrenders its permit in accordance with applicable law. Upon withdrawal from the KSHCP, the Participant shall forfeit the Financial Assurances Payment and the Changed Circumstances payment, except as provided below. Participants that withdraw early will have paid annual fees for an annual incidental take estimate averaged over the 30 year term, and will not be credited if their incidental take did not reach the annual take estimates.

For example, if a Participant withdraws at Year 10, and the initial take request was 2 birds/year, even if the Participant facility's monitoring has not documented incidental take of 20 birds, the fees paid in years 1-10 will be retained to pay for sufficient mitigation offset. However, if incidental take exceeded annualized take estimates, the withdrawing Participant will be required to pay additional fees as determined by DLNR and USFWS, with assistance from the Prime Contractor.

Where there is a new Participant with take to replace the take of the withdrawing Participant in whole or in part, the new Participant will pay into the KSHCP Reserve Account its share of the Financial Assurances and Changed Circumstances/Adaptive Management payments, and the withdrawing Participant will receive its pre-payments or a portion thereof.

In the case of withdrawal of a Participant or Participants or Participant reductions in take request, the wildlife agencies will work with the Participants to enroll additional Participants or provide mitigation for other programs or entities that require mitigation for seabird take. The Prime Contractor will work with the wildlife agencies to determine whether mitigation can be scaled to reflect the reduced take. If these strategies do not work, all shared costs must be

collected from remaining Participants, provided however that the Participants may elect to initiate a Major Amendment if there is a reduction of greater than 10% of the initial authorized take (see [Section 6.13.2](#)).

A change in ownership shall not constitute an Early Withdrawal if the permit is transferred to the new owner (see [Section 6.16](#)). The Federal permit may be transferred in accordance with regulations in existence at that time (currently codified at 50 C.F.R. 13.25). In the event of a change of ownership of the Facility, the Implementing Agreement, the ITP and the ITL shall be transferred to the new owner. There shall be no change to the annual payment in the event of a change of ownership. The amounts paid to the KSHCP accounts, including the Financial Assurances and Changed Circumstances/Adaptive Management payments, shall be transferred and credited to the new owner.

#### **7.4 PERMIT SUSPENSION OR REVOCATION**

In the case of Participant's permit suspension or revocation, the costs and obligations of the other Participants in the KSHCP will be adjusted in the same manner as Early Withdrawal.

#### **7.5 MITIGATION CREDIT**

The KSHCP is a comprehensive plan that includes measures to avoid, minimize and mitigate for incidental take of Covered Seabirds caused by light attraction. The plan is structured to achieve the [Goals and Objectives](#) outlined in **Table 5-1**. The following section describes how mitigation credit is allocated based on successful completion of these objectives. The chronological sequence of plan objectives with substantive mitigation targets provides a phased approach towards accruing mitigation credit. This approach will enable the wildlife agencies and the Prime Contractor to determine the degree to which the KSHCP goals and objectives are achieved by the Participants over time.

The relationship of KSHCP objectives achieved and mitigation credit allotted is set by completion of biological performance targets, which in turn is tied to providing required annual funds. Year one has higher costs as the project is set up (8% of total 30-year project cost). As the project then moves into long-term maintenance, biosecurity and monitoring, the annual cost stabilizes, and each year 3% of the total project budget is spent.

**Table 7-3. Proportion of total proposed KSHCP costs to be spent by project year.**

<b>Project Year</b>	<b>Percentage of Total Project Cost*</b>
1	7.7%
2	3.3%
3-30	3.3%

\*Total project cost includes funding of infrastructure, predator removal and biosecurity, biological and compliance monitoring and the KSHCP Prime Contractor and is presented in *Appendix G: KSHCP Budget Details*. Total project cost does not include funds collected for Changed Circumstances/Adaptive Management or Financial Assurances.

For each of the objectives associated with the mitigation project, the cumulative financial investment is reflected in the mitigation credit (**Table 7-3**). For example, if Objective 2.C is achieved by the end of Year 4, 17% of the total take of each Participant has now been successfully mitigated (8% in Year 1, 3% in each of Years 2, 3, & 4). If Objective 2.D is achieved by Year 7, 26% of the total take for each Participant has been mitigated. These numbers are derived from cumulative years of contributing 3% per year towards total project costs. Under this approach, a total mitigation credit equaling 100% can be achieved by the end of the 30-year permit term if all KSHCP goals and objectives are met in a timely manner.

Calculating the accrued mitigation credit at annual intervals is important for multiple reasons. Firstly, this helps determine the level of progress towards KSHCP goals and objectives. Secondly, if through the [Adaptive Management](#) process that decision on whether the mitigation project must be abandoned and funding shifted to an alternate mitigation project. This also provides a defined metric, based on which biological objectives were successfully met, for determining how much take has already been successfully mitigated (see **Table 7-4**). Criteria for project abandonment include inability to meet multiple project objectives on the scheduled timeline, even with the implementation of Adaptive Management measures.

Successful completion is a **requirement** for all KSHCP Participants (see [Section 5.2](#)) for all of the objectives associated with Biological Goal 1. Thus there is no specific mitigation credit associated with achieving these objectives, as it is necessary for permit compliance.

The level of mitigation credit allotted for achieving specific objectives is detailed in **Table 7-4** for the objectives associated with Goal 2.

**Table 7-4. Mitigation credit standards under the KSHCP by Biological Objective.**

<b>Biological Goals</b>	<b>Biological Objectives</b>	<b>Mitigation Credit Standard</b>
Goal 2: Mitigate authorized take impacts of Covered Seabirds by enhancing, protecting and managing suitable seabird breeding habitat on Kaua'i to facilitate successful production of fledglings at a level that over the 30-year term of the Plan offsets or exceeds the impacts of take caused by Covered Activities on the production of fledglings in the wild.	2.A. Construct a predator-proof fence and install social attraction equipment (nest boxes, speakers) within the fenced area at mitigation site in Year 1 of KSHCP implementation.	Achieving objectives 2.A, 2.B, 2.G & 2.H results in <b>7.7%</b> of mitigation credit.
	2.B. Remove predators from within the fenced enclosure with monitoring confirmation of their absence, and activation of social attraction equipment by Year 2; predator eradication within fenced enclosure maintained for the life of project.	
	2.C. Ground activity by Covered Seabirds documented at the mitigation site by Year 4 of KSHCP implementation.	Achieving this objective results in <b>17.5%</b> of mitigation credit.
	2.D. Breeding activity by Covered Seabirds documented at the mitigation site by Years 5-7 of KSHCP implementation.	Achieving this objective results in <b>20.8-27.4%</b> of mitigation credit.
	2.E. Cumulative upward trend in Covered Seabird breeding documented at the mitigation site by Year 10 of KSHCP implementation.	Achieving this objective results in <b>37.2%</b> of mitigation credit.
	2.F. Continued cumulative upward trend in Covered Seabird breeding documented at the mitigation site by Year 20 of KSHCP implementation.	Achieving this objective results in <b>70%</b> of mitigation credit.
	2.G. Maintain high quality seabird habitat at the mitigation site by removing habitat modifying invasive plants in Year 1 and annually throughout the 30-year duration of the KSHCP.	Achieving Objectives 2.A, 2.B, 2.G & 2.H results in <b>7.7%</b> of mitigation credit
	2.H. Protect nesting birds inside mitigation fence and in nearby source colonies by implementing predator control of 1) barn owls within the area surrounding the fenced enclosure and the Kalalau Valley, and 2) feral cats at ingress points to source colonies in the Kalalau Valley, beginning in year 1 and annually throughout the 30-year duration of the KSHCP.	Achieving Objectives 2.A, 2.B, 2.G, 2.H results in <b>7.7%</b> of mitigation credit
	2.I. Annual protection of any honu nests adjacent to facilities via shielding or other measures to avoid light attraction take.	Successful completion of this objective is a <b>requirement</b> for all KSHCP Participants where this applies.

The goal of using project tasks (Objectives 2.A-2.B) and biological targets (Objectives 2.C-2.G) in concert with the level of financial investment to inform the assessment of accrued mitigation credit is intended to provide a transparent and flexible process for evaluating the success of the KSHCP minimization and mitigation program.

## 7.6 BUDGET SUMMARY TABLE

**Table 7-5:** Summary of KSHCP costs throughout the 30-year term as estimated by Pacific Rim Conservation, based on annual costs in Appendix G, Table 1. **This table does not include Changed Circumstance/Adaptive Management or Financial Assurances Costs.** The Participants anticipate that the initial Prime Contractor will be Pacific Rim Conservation for the initial five years, with options to extend.

Yr	Total	Total plus 3% inflation annually	State HCP Compliance	NFWF cost	Grand Total
1	\$621,456	\$621,456	\$10,000	\$12,429	\$643,885
2	\$162,854	\$167,739	\$10,000	\$3,355	\$181,094
3	\$167,739	\$172,772	\$10,000	\$3,455	\$186,227
4	\$172,772	\$177,955	\$10,000	\$3,559	\$191,514
5	\$177,955	\$183,293	\$10,000	\$3,666	\$196,959
6	\$183,293	\$188,792	\$10,000	\$3,776	\$202,568
7	\$188,792	\$194,456	\$10,000	\$3,889	\$208,345
8	\$194,456	\$200,290	\$10,000	\$4,006	\$214,295
9	\$200,290	\$206,298	\$10,000	\$4,126	\$220,424
10	\$206,298	\$212,487	\$10,000	\$4,250	\$226,737
11	\$212,487	\$218,862	\$10,000	\$4,377	\$233,239
12	\$218,862	\$225,428	\$10,000	\$4,509	\$239,936
13	\$225,428	\$232,191	\$10,000	\$4,644	\$246,834
14	\$232,191	\$239,156	\$10,000	\$4,783	\$253,939
15	\$239,156	\$246,331	\$10,000	\$4,927	\$261,258
16	\$246,331	\$253,721	\$10,000	\$5,074	\$268,795
17	\$253,721	\$261,333	\$10,000	\$5,227	\$276,559
18	\$261,333	\$269,173	\$10,000	\$5,383	\$284,556
19	\$269,173	\$277,248	\$10,000	\$5,545	\$292,793
20	\$277,248	\$285,565	\$10,000	\$5,711	\$301,276
21	\$285,565	\$294,132	\$10,000	\$5,883	\$310,015
22	\$294,132	\$302,956	\$10,000	\$6,059	\$319,015
23	\$302,956	\$312,045	\$10,000	\$6,241	\$328,286
24	\$312,045	\$321,406	\$10,000	\$6,428	\$337,834
25	\$321,406	\$331,048	\$10,000	\$6,621	\$347,669
26	\$331,048	\$340,980	\$10,000	\$6,820	\$357,799
27	\$340,980	\$351,209	\$10,000	\$7,024	\$368,233
28	\$351,209	\$361,745	\$10,000	\$7,235	\$378,980
29	\$361,745	\$372,598	\$10,000	\$7,452	\$390,050
30	\$372,598	\$383,776	\$10,000	\$7,676	\$401,451
	\$7,985,517	\$8,206,439	\$300,000	\$164,129	\$8,670,568

## **8. ALTERNATIVES TO THE TAKING**

Section 10(a)(2)(A)(iii) of the Endangered Species Act of 1973, as amended, and 50 CFR 17.22(b)(1)(iii) and 17.32(b)(1)(iii)] requires that alternatives to the taking of species be considered and reasons why such alternatives are not implemented be discussed. This chapter addresses this requirement.

### **8.1 NO ACTION ALTERNATIVE**

The No Action Alternative means that an HCP would not be finalized and an ITP/ITL would not be potentially issued. This also means current conditions and activities that cause take of Federally listed species would continue absent take authorization in violation of Federal and State law.

Many HCPs commonly include a “no-action” alternative in a context where the action at issue is not already ongoing. Under those circumstances, the no-action alternative would obviate the need for an ITP/ITL because the action likely to cause take would not occur.

However, in the case of the KSHCP, the actions causing take have been ongoing (in some cases for decades) and is compounded by the effects of multiple existing facilities. Therefore under the “no action” alternative, entities on Kaua’i causing incidental take would continue operations with or without light minimization measures in place, without incidental take permit authorization from the DLNR or the USFWS under the KSHCP.

This alternative was not selected for several reasons, including the fact that in most cases the effects of light attraction can be reduced but not eliminated, leaving entities out of compliance with Federal and State law. In addition, failure to mitigate for the take that cannot be eliminated will continue to imperil these very vulnerable native species. However, it is likely that when considered island-wide, unavoidable take of the listed seabird species would inevitably continue and would be unmitigated and unauthorized. In addition, the entities with continuing take would remain exposed to enforcement actions either via one or both of the wildlife agencies as well as third parties under the Federal ESA.

### **8.2 THE “NO INCIDENTAL TAKE” ALTERNATIVE**

As noted above, the effects of light attraction causing take of listed seabirds can be minimized but not entirely eliminated. Thus, a “no incidental take” alternative necessitates that all businesses and agencies on Kaua’i would need to modify existing and future use of artificial light to completely avoid incidental take of the Covered Seabirds. This would mean eliminating most, if not all, sources of artificial lighting during the fallout season. This alternative is not feasible for several reasons. Artificial lights in publicly used facilities such as parking lots, recreational centers, hotels, harbors, and airports are necessary for public safety and security. There are too many existing facilities using lighting for it to be practical to eliminate all sources of lighting. It is not reasonable or feasible to extinguish all nighttime lights on Kaua’i during fallout season. This alternative therefore has little chance of succeeding and does not meet

socioeconomic and regulatory needs for lights and utilities to support the human population on Kaua'i and was not selected.

### **8.3 RESTRICTED USAGE OF LIGHTING ALTERNATIVE**

As noted above, the effects of light attraction can be minimized but not entirely eliminated. A "restricted usage of lighting" alternative would require that all businesses and agencies on Kaua'i modify existing and future use of artificial light to avoid incidental take of the Covered Seabirds by restricting light use during certain hours of the night during months when the Covered Seabirds are present on Kaua'i (April-December). If current data on seabird nighttime movement patterns were used to set the timing restrictions, this would result in 4-8 hours each night when night-time lighting would be restricted (Raine et al. 2017d).

This would mean restricting all sources of artificial lighting during the fallout season. This alternative is not feasible for several reasons. Artificial lights in publicly used facilities such as parking lots, recreational centers, hotels, harbors, and airports are necessary for public safety and security. These facilities require lighting during all night time hours, but especially 2-4 hours after sunset, which coincides with a high movement time and high risk of fallout for Covered Seabirds. It is not reasonable or feasible to restrict use of all nighttime lights on Kaua'i during fallout season. This alternative therefore has little chance of succeeding and does not meet socioeconomic and regulatory needs for lights and utilities to support the human population on Kaua'i and was not selected.

## 9. HONU (GREEN SEA TURTLE) IN THE KSHCP

According to Federal Endangered Species Act, incidental take permits may not be issued to cover take of a listed threatened or endangered species if the Covered Activity also impacts additional listed threatened or endangered species. Thus, since the Covered Activity of artificial lighting has the potential to impact honu hatchlings, they are included in the KSHCP. However, as described in the following sections, no incidental take request for honu is anticipated in the KSHCP. Therefore details related to honu have been summarized in this chapter, separate from other chapters that focus on Covered Seabirds.

### 9.1 EFFECTS OF ARTIFICIAL LIGHTS ON HONU

Hawai'i is home to several sea turtle species, including the honu, Hawksbill Turtle - honu'ea (*Eretmochelys imbricata*), Olive Ridley Turtle (*Lepidochelys olivacea*) and the Leatherback Turtle (*Dermochelys coriacea*). Of these species, only the honu is known to nest regularly on Kaua'i. Thus, it is the only turtle species with the potential to be affected by Covered Activities of the KSHCP.

Sea turtles nest most successfully on dark, quiet beaches. Lights can cause turtles to abandon nesting efforts, resulting in a false crawl, or a nesting attempt during which the female fails to deposit eggs (Witherington 1992). There is also the potential that gravid female turtles, deterred from nesting due to lights, may shed their eggs at sea (Witherington and Martin 2000). In addition, light pollution may cause some turtles to use sub-optimal nesting habitat due to a lack of better locations. In sub-optimal habitats, the number of hatchlings produced and hatchling survivorship may be compromised, and hatchling sex ratios may be altered.

Once hatchlings emerge from the nest cavity, they are highly sensitive to disorientation by lights, an outcome which causes mortality from dehydration, exhaustion, and/or predation particularly when they are attracted towards lights of developed areas and away from the sea, counter to their natural behavior (Witherington and Martin 2000, Salmon 2003).

Some studies have measured an indirect relationship between the amount of lighted beach development and sea turtle nest densities (Mattison et al. 1993). Adult females seem to use a "straight ahead" method to select a nest site. They do not appear to be affected as much by lights up and down the beach as they are by bright lights in front of them upon emerging (Witherington 1992, Salmon 2003). In addition, distant point sources and urban glow are more likely to affect hatchlings than adult females (Salmon et al. 1992).

Hatchling sea turtles exhibit a robust sea-finding behavior. Although the cues involved in sea finding are complex, hatchlings rely primarily on vision for proper orientation (Salmon et al. 1992, Lohmann et al. 1997, Witherington and Martin 2000). Hatchlings have a tendency to orient toward the brightest direction, but a combination of light and shapes is thought to be responsible for orientation of the clutch once they have left the nest. On natural undeveloped beaches, the brightest direction is almost always away from elevated shapes (e.g., dune, vegetation, etc.) and toward the broad open horizon of the sea (Salmon et al. 1992,

Witherington and Martin 2000). In contrast, on developed beaches, the brightest direction is often away from the ocean and toward lighted structures.

Artificial lighting cues cause either type of disorientation (Witherington 1990, 1997), however, the two behaviors described above are typically lumped under the term “disorientation.” Hatchlings that are disoriented may either travel along a consistent course away from the ocean and toward a light source, or they are unable to establish a particular course and wander aimlessly (**Figure 9-1**).



**Figure 9-1: Tracks of disoriented loggerhead (*Caretta caretta*) hatchlings, Melbourne Beach, Florida. Photograph by Blair E. Witherington.**

Hatchlings unable to find the ocean, or delayed in reaching it, are likely to incur high mortality from dehydration, exhaustion or predation (Witherington and Martin 2000). If the hatchlings are drawn landward from the beach, they may enter roadways and be run over or become irretrievably lost. Weakened hatchlings that eventually reach the water may still die as they are more vulnerable to marine predators, which are abundant in nearshore waters (Gyuris 1994, Stewart and Wyneken 2004).

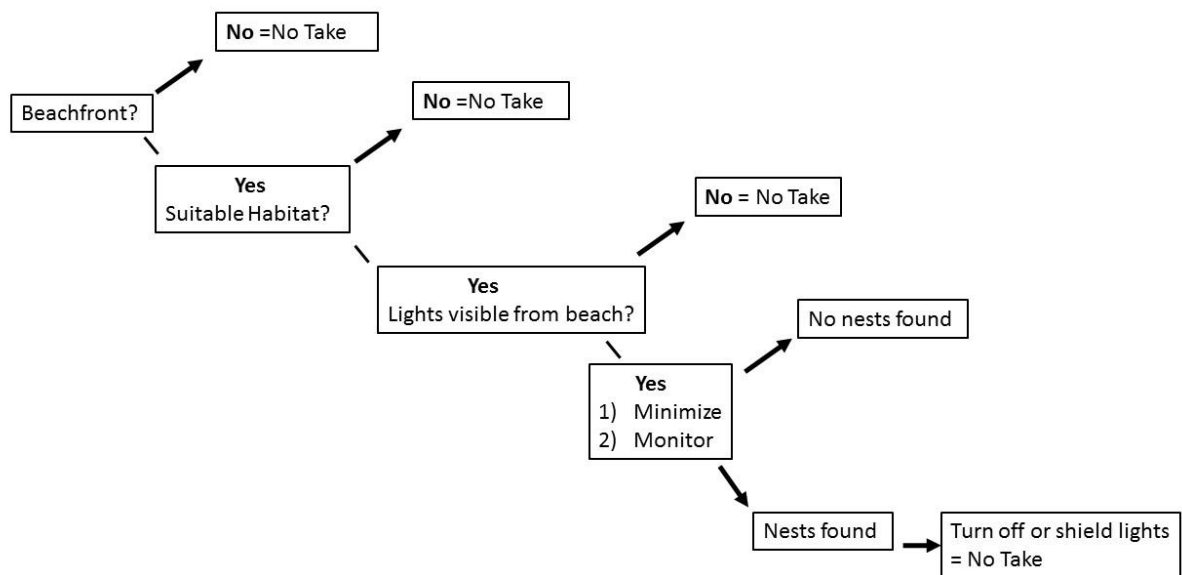
## **9.2 HONU TAKE RISK ASSESSMENT**

Unlike seabird light attraction data, for which we rely on the SOS program (as described above), honu light disorientation events are rarely witnessed or documented. Sea turtles prefer to nest on beaches with minimal light and human disturbance. Discerning hatchling disorientation relies primarily on following and counting hatchling tracks and is unlikely to be documented unless the nest is being purposefully monitored. There are no systematic surveys for sea turtle nests on Kauaʻi and thus the number and location of all nests is not known. Further, nests are not systematically monitored for the effects of light disorientation. Also, evidence of disorientation is easily and rapidly obliterated by natural and anthropogenic factors. Until more data are available on the distribution and success of honu nests, an island-wide quantification of honu take from light disorientation is not possible.

A study by Parker and Balazs (2015) reported 20 honu nesting sites that span the island, some with regular, annual nesting and others documented intermittently. Nesting density at these sites is low (1-2 nests annually). The majority of the known nesting locations are isolated beaches, away from lights and high human traffic, such as Allerton Beach at NTBG.

The process for determining whether an Applicant has a risk of honu take is based on 1) whether there is beachfront property at Applicant facilities with suitable habitat, and 2) whether there is light from the facility that will be visible from this beach habitat (**Figure 9-2**). Suitable habitat is very general for honu, and is defined as a beach with sufficient sand for digging (T. Jones, 2017, pers. comm.). Presence of native vegetation is also an indicator of suitable habitat.

If there is suitable beachfront habitat at the facility, the next step is to determine if there is light from the facility that is visible from this habitat. If there is no beachfront property, no suitable habitat and/or no light visible from this habitat, then there is no potential for take via the KSHCP Covered Activities.



**Figure 9-2: Flow chart of Applicant process for determining risk of honu take via light disorientation.**

If there is light visible from suitable habitat on a facility's property, the Applicant must determine the level of risk for take of honu hatchlings via light disorientation. The following questions may guide this risk assessment:

- Can the visible lights be turned off or minimized during turtle nesting season (May to November)?

- Can sufficient monitoring be done to ensure that any nests are found and properly shielded (as described in [Section 9.5](#))?
- Have there been documented honu nests on this beach before? Lack of documented nests is not an indication that there will not be future nests, but history of nesting could indicate a higher risk for light disorientation take.
- If there have been nests recorded on this beach, have there been documented light disorientation events?

Participants are responsible for minimizing light visible from beach habitat and monitoring for nests (see [Section 9.5](#) below). If nests are found, actions to shield and protect the hatchlings from the effects of light disorientation must be implemented, as described in [Section 9.5](#).

Each Applicant will do their own risk assessment. It is anticipated that Participants with beach front properties can completely avoid future incidental take of honu. Currently there is no provision for requested incidental take of honu in proposed Participant PIPs, and the minimization and mitigation measures outlined in [Section 9.4](#) will be implemented as described to ensure that there is zero take of the species. If incidental take of honu is requested by a Participant during the 30-year term of the KSHCP permit term, commensurate honu mitigation will be developed. The regulatory agencies would submit any such proposed mitigation for public review either as an amendment to the KSHCP or as part of processing a permit application.

### **9.3 NET EFFECT OF THE KSHCP ON THE HONU**

The honu population on Kaua'i is increasing, as is the State wide population. The effects of light disorientation do not seem to be causing significant negative effects on the overall honu population (Parker and Balazs 2015). To better support this conclusion, more long-term monitoring of honu nests and nest success on Kaua'i is warranted. Measures undertaken by Participants in the KSHCP to avoid hatchling sea turtle light disorientation and to respond to any disorientated hatchlings on their facility, will further increase the likelihood of the honu population on Kaua'i continuing to increase. The effects of light disorientation can be mitigated so that this effect does not negatively impact honu populations.

### **9.4 MEASURES TO AVOID AND MINIMIZE TAKE OF HONU**

Measures to avoid and minimize take to achieve Goal 1 of the KSHCP are described in [Section 5.3](#). All actions that are implemented to avoid and minimize take for Covered Seabirds will also benefit honu. Lighting guidelines fit the recommendations by Salmon (2003) to limit the impact of coastal light pollution on turtles.

Reducing predators at facilities will also benefit any honu that chose to nest on facility beaches. Adult turtles may be scared off by dogs, and hatchlings may be subject to predation by dogs or cats.

Outreach materials to inform staff and guests about the potential for nesting honu is also required. As many people as possible should be trained to recognize sea turtle tracks, and the signs of nesting. Materials should also discuss timing of nesting and hatching, other honu behaviors that might be observed (i.e. basking), and laws protecting sea turtles while they are on land. An example handout is provided in *Appendix F: Training and Outreach Materials*.

## **9.5 PROTECTION OF HONU NESTS FROM LIGHT ATTRACTION (OBJECTIVE 1.F)**

All KSHCP Participants must monitor for nests if they have beachfront property with suitable habitat and visible lights (see [Section 9.2](#) for process to evaluate take risk). Beach monitoring surveys will aid in determining sea turtle presence, active nests, potential threats (e.g., lights, excessive beach debris, deep tire tracks, etc.), and hatch date of nests. Standard monitoring techniques follow suggested protocols in Eckert et al. (1999) and Hillis-Star and Phillips (2012).

### **Methods & Protocols for Nest Finding and Monitoring:**

- Surveys will be conducted between May 15<sup>th</sup> and December 15<sup>th</sup> each year.
- Surveys should include sandy areas of all suitable beachfront property and consist of walking the area in the morning to look for evidence of nesting (turtle tracks, digging, presence of turtles etc.).
- Surveys should be completed by staff or volunteers that have completed annual training provided by USFWS or DLNR.
- Surveys should be completed at least once per week during peak nesting season (May-July) bi-weekly for the remainder of the nesting season (August-December).
- All sea turtle activity should be reported immediately to USFWS and DLNR and all potential nest sites shall be protected immediately using measures specified below:
  - Active nests (those at which eggs have been deposited or thought to have been deposited) must be monitored every 1-2 days.
  - Once the nest has been incubating for 45 days, monitors will begin checking the nest daily for signs of hatching to ensure that no obstacles inhibit hatchling movement from the nest to the ocean;
  - Evidence of hatching shall be reported to USFWS and DLNR within 24 hours. USFWS, DLNR, or their designee, will then be responsible for final nest excavation to determine species, proportion of eggs that hatched and to send remaining eggs to NOAA for DNA analysis.
- During nest surveys and nest monitoring the following minimum data shall be collected:
  - Maps of surveyed beaches which indicate:
    - The property and facilities of the Participant conducting the monitoring, and proximity to the beach that will be monitored;
    - Lights visible from the beach;
    - The general survey route along the beach;
    - Length of the beach monitored;
  - Date, personnel surveying, time spent on the survey;
  - Outcome of the survey – the number of nests found;
  - Nests should be mapped with a GPS unit;

- Assessment of potential threats at the nest;
- Status of protective measures installed (e.g. light fences) at all nests found;
- Hatching success and emergence success as determined by final nest excavation.
- Nest excavations shall only be completed by the DLNR or USFWS, or their designee.

(Methods and Protocols adapted from Eckert et al. (1999) and Hillis-Star and Phillips (2012))

The following actions to avoid take are based on the recommendations published in Witherington et al. (2014), Lake (2008), Salmon (2006) and Witherington and Martin (2003)

- If an active honu nest is found at a Participant facility, the most effective way to prevent hatchling disorientation is to turn off any lights that are visible from the nest site.
- If this is not possible,
  - lights must be shielded so that they do not shine on the nests;
  - a temporary light-proof silt fence must be erected that will not further endanger the nest and hatchlings. “Light-proof fencing” is a temporary fence built from wooden stakes and opaque black silt fence fabric.
- If the nest is located on a public beach, installation of a fence may draw attention to the nest and increase the risk of vandalism – in this case, the shielding and / or removal of lights is even more important.
- Participants should contact the NOAA Stranding Hotline and KSHCP Prime Contractor to assist with installing fence adjacent to nests.
- Materials and any installation costs will be the responsibility of the Participant.

The following fencing technique is recommended wherever light visibility from the nests, as visible from the sand surface, cannot be eliminated or shielded at the light source.

- a. The fence must be tall enough to shield the visibility of lights at Participant facilities and placement must be approved by a qualified biologist (e.g. DAR, NOAA, DOFAW, USFWS, biological consultant, or non-profit organization may be specified in the PIP);
- b. Photographs and GPS coordinates of the honu nest(s) shall be documented and the fence shall be placed 7 days prior to the expected hatch date, or when a sandy depression develops within the defined nest area, to indicate hatchlings are in the process of emerging. Photographs of lights at night from the nest before and after the fence installation shall be taken;
- c. The fence will be in place and maintained daily prior to hatchling emergence to be effective. Adjustments to the fence may be made with approval of a qualified biologist;
- d. After the honu hatchlings have emerged and entered the ocean, the fence shall be removed;

Areas seaward of the nest shall be maintained free of ocean debris and garbage on a daily basis. Feral and loose animals such as dogs, cats and rats shall be controlled per requirements of [Section 5.3.2](#).

Vehicles can crush hatchlings and deep tire ruts can trap hatchlings inside. Therefore, a ban on beach driving at Participant properties during the expected hatching period must be enforced and vehicle entry routes (even informal ones) must be effectively blocked off. “Enforcement” activities could include monitoring for beach driving and calling the police, DOCARE and / or the county if beach driving occurs. Daily raking or smoothing deep sand tracks adjacent to the nest is also required one week prior to and after the expected hatch date.

There is not anticipated to be any incidental take of honu requested in the KSHCP, as monitoring and nest protection measures described in [Section 9.5](#) will be implemented by all Participants with visible lights on beachfront property. However, if honu hatchling disorientation does occur, the following protocols should be followed:

- The Department of Aquatic Resources (DAR) should be contacted immediately so the hatchling turtles are only handled by staff or volunteers permitted to handle endangered species.
- Disoriented hatchlings should be protected from foot or vehicle traffic, predation, and handling.

All Participant staff should be trained on Standard Operating Procedures (SOPs) with regard to hatchling disorientation, to minimize take impacts.

## **9.6 ADAPTIVE MANAGEMENT FOR HONU**

The KSHCP was drafted assuming that all take of honu can be avoided through actions to identify honu nests prior to hatching and to implement temporary conservation measures to prevent hatchling disorientation from artificial light as outlined above. If honu nests cannot be effectively identified in advance or if temporary measures are insufficient to prevent hatchling disorientation, and incidental take occurs, the Prime Contractor affected Participant will meet with USFWS and DLNR to discuss the probable reasons for the situation and possible changes or alternatives. This might include an evaluation of monitoring protocols and the process for installing light shielding around the nests. Minor changes to protocols compatible with existing funding can be made as soon as practicably possible. If take cannot be avoided, the affected Participant will work with the wildlife agencies to amend the Plan to provide honu mitigation. If not considered feasible to provide mitigation through the KSHCP, the Participant will need to develop its own HCP for honu take. Under either scenario, the Participant should apply for an incidental take permit/license.

## 10. GLOSSARY FOR KSHCP AND ALL ASSOCIATED APPENDICES

**Active Burrow:** Determined when an adult bird is either observed or when signs of bird presence are documented during the breeding season (e.g., feathers, guano, digging, etc.).

**Adaptive Management:** A systematic science based approach for managing complex ecosystems that face a high degree of uncertainty. This approach aims to reduce uncertainty by incorporating what is learned from management, monitoring, and intensive research into future management actions.

**Adult:** Life stage in which a species has reached sexual maturity.

**Applicant:** A non-Federal entity seeking an Incidental Take License and an Incidental Take Permit under the Kaua'i Seabird Habitat Conservation Plan, once accepted, the "Applicant" becomes a "Participant".

**Avoidance Measures:** Actions that aim to eliminate all potential take of a Covered Species.

**Biological Goals (specific to the KSHCP):** To implement a statewide conservation strategy, for the duration of the Incidental Take Licenses and Permits, that supports the conservation goals of the State and Federal management and recovery plans.

(Goal 1) is "Under the KSHCP, avoid and minimize take impacts to the Covered Seabirds caused by nighttime lighting on Kaua'i to the maximum extent practicable for the 30-year term of the KSHCP. The effects of nighttime lighting on the Covered Seabirds represent a major threat to their survival and recovery."

(Goal 2) is "Under the KSHCP, mitigate authorized take impacts of the Covered Seabirds by enhancing, protecting and managing suitable seabird breeding habitat on Kaua'i to facilitate successful production of fledglings at a level that over the 30-year term of the Plan offsets or exceeds the impacts of take caused by Covered Activities on the production of fledglings in the wild."

**Biological Objectives (specific to the KSHCP):** As an extension of the Conservation goals, the objectives were developed from the USFWS and DLNR recovery and management planning documents and are intended to satisfy the Federal and State regulatory requirements for issuance of Incidental Take Licenses and Permits. An example would be to avoid take of Covered Seabirds due to light attraction by removing or turning off lighting as specified in the Participant Inclusion Plan.

**Biological Opinion:** A document prepared by the Fish and Wildlife Service (USFWS) for all Participant Inclusion Plans (PIP) submitted by Applicants. As required by the Endangered Species Act (ESA), the document addresses whether the proposed activities will jeopardize the continued existence of the listed species or result in the destruction or negative alterations of the listed species' critical habitat.

**Biosecurity:** Systematic measures intended to protect against the introduction or spread of harmful organisms to other plant and animal life (e.g. monitoring a predator exclusion fence line for any openings that might allow predators into a seabird nesting colony).

**Breeding Pairs:** Two animals that copulate and work cooperatively to produce offspring.

**Breeding Probability:** The likelihood that any one animal will breed in a given year.

**Breeding Success:** Number of chicks fledged from number of burrows active

**Carapace:** Bony or chitinous case or shield covering the back or part of the back of an animal (as a turtle or crab).

**Changed Circumstances:** As defined by Federal regulation (50 CFR §17.3), this refers to circumstances affecting a species or geographic area covered by the HCP that can be reasonably anticipated by the Applicant or wildlife agency and to which the parties can plan a response. Adaptive Management is one type of Changed Circumstances.

**Colony:** Area where birds nest and breed in close proximity as a group, often sharing communal behaviors for the benefit of the entire group. The size of the colony can vary from just a few breeding pairs to hundreds or thousands of birds depending on the species and availability of resources, including suitable nest sites and takeoff/landing zones.

**Colony-based Mitigation:** Efforts made to reduce primary threats (e.g., predation, burrow destruction by ungulates) at Covered Seabird breeding colonies.

**Colony Creation:** Small, existing colonies can be augmented and new colonies can be created, in a predator-free fenced enclosure, by increasing the colonization rate of an area using techniques such as social attraction and/or translocation.

**Covered Activities:** Activities that cause the incidental take of a Covered Species. Under the KSHCP this includes the placement, operation, and maintenance of light structures that can cause disorientation of fledgling seabirds and hatchlings of the honu.

**Covered Seabirds:** The 'a'o or Newell's shearwater (*Puffinus auricularis newelli*, threatened); the Hawaiian petrel or 'ua'u (*Pterodroma sandwichensis*, endangered); the band-rumped storm-petrel or 'akē'akē (*Oceanodroma castro*, endangered).

**Critical Habitat:** As a species is proposed for listing, USFWS is required to consider if the species survival is dependent upon vital geographical areas. The Endangered Species Act regulations specify the criteria for designating Critical Habitat as "those physical and biological features that are essential to the conservation of a given species and that may require special management considerations or protection" (50 CFR 424.12).

**Cut-off Lighting:** Lighting with flat glass lenses that eliminate or minimize glare and produce no upward visible light.

**Downed Seabirds:** Seabirds on the ground in locations where they normally should not be found, usually as a result of attraction and disorientation by artificial lights or structure collisions. These birds are unable to get off the ground again naturally.

**Enclosure:** An area that has been encompassed by a fence (i.e., ungulate, feral cat, or predator proof fencing) or by a combination of fencing along with a natural barrier such as a cliff.

**Endangered Species Act (ESA):** A key legislation for both domestic and international conservation. The act aims to provide a framework to conserve and protect endangered and threatened species and their habitats. It is administered by the U.S. Fish and Wildlife Service and the Commerce Department's National Marine Fisheries Service (NMFS).

**Endemic (endemism):** A species that is exclusively found in a specific area or region and is not found to naturally occur anywhere else. For example, The 'a'o and the 'ua'u can only be found in the central Pacific ocean and Hawaiian Islands.

**Enrollment Package:** This includes a written request (e.g. cover letter) from the landowner, facility operator, or other responsible party; State and Federal application forms (with Federal application fee); a completed Participant Inclusion Plan; an Implementing Agreement; and the final approved Habitat Conservation Plan Document.

**Essential Lighting:** A category of Participant facility lighting that cannot be turned off due to the necessity of the illumination for operation and/or safety at the facility.

**Facility:** Structure built, installed, or established to serve a particular purpose.

**Fallout:** When a seabird lands at a location that it normally would not have landed as a result from attraction and disorientation to artificial lights. These birds cannot get airborne again naturally.

**Fallout Season:** September 15<sup>th</sup> to December 15<sup>th</sup>, when the majority of 'a'o and 'ua'u are fledging from their burrows.

**Fledging:** The act of leaving the nest/burrow for the first time and migrating to the ocean to begin foraging. After fledging, seabirds will not return to their natal burrow until they are 2-5 years old (sub-adults).

**Fledgling:** A young bird, typically with fully developed wing muscles and feathers, that leaves the nest for good and is able to survive away from the nest.

**Fledging Success:** Number of chicks fledged from all successfully hatched chicks.

**Flight Corridor:** Heavily used flight path; defined airspace through which individuals of a particular species will travel regularly in transit between foraging areas and nest site. Areas in which regular bird traffic is reasonably predictable.

**Flyways:** Common flight paths that utilize natural topographic features leading inward or out from the mountainous interior where nest sites are located, typically flying seabirds are more concentrated here than elsewhere.

**Ground Calling:** Seabirds heard calling from the ground that suggests possible breeding activity in the vicinity of the calls, whereas, seabirds heard calling in flight may be the result of birds transiting over the island while traveling to or from the breeding colony.

**HAPE:** ‘ua‘u or Hawaiian Petrel (*Pterodroma sandwichensis*). This is based on an ornithological naming convention that creates standardized 4 –letter code from the first two letters of the common names.

**Hatchling:** A young animal that has recently come out of its egg. All of the Covered Species emerge from eggs and may be referred to as a “hatchling”, but in the KSHCP this is used in particular with reference to sea turtles.

**Habitat Conservation Plan (HCP):** An incidental take permit is required when non-Federal activities will result in “take” of threatened or endangered wildlife. A habitat conservation plan (HCP) must accompany an application for an incidental take permit. The purpose of the habitat conservation planning process associated with the permit is to ensure there is adequate minimizing and mitigating of the effects of the authorized incidental take.

**Impacts to Covered Species:** The effects that Covered Activities have on the Covered Species (e.g., death of Covered Seabirds due to light attraction, death of honu hatchlings due to light disorientation, etc.).

**Implementing Agreement:** A planning document that is part of the required Applicant enrollment package needed in order to receive an Incidental Take Permit.

**Incidental Take:** The taking of a species that is listed as endangered or threatened under the Endangered Species Act that is "incidental to, and not the purpose of, carrying out of an otherwise lawful activity" (50 CFR 17.3).

**Incidental Take License ITL:** All qualifying private, non-Federal entities, can request an incidental take license (ITL) under §195D-4(g) of the Hawai‘i Revised Statutes (HRS). The Incidental Take License provides a way for the State to authorize take that occurs as a result of otherwise legal activities. This licensing document must be accompanied with an approved Habitat Conservation Plan.

**Incidental Take Permit ITP:** Pursuant to Section 10(a)(1)(B) of the Endangered Species Act (ESA) of 1973, a permit can be issued by USFWS to non-Federal entities, allowing incidental take of an endangered or threatened species when the take results from otherwise lawful activities. This permitting document must be accompanied with an approved Habitat Conservation Plan.

**Invasive Species:** A non-native or non-indigenous organism that negatively affect the habitat that it has invaded. Environmental, ecological, and/or economic impacts may result from the invasion.

**IUCN Red List:** International Union for Conservation of Nature maintains a list of the conservation status of all plant and animal species, updated with scientific information and based on a globally recognized system for identifying risk of extinction. For more information see: [www.iucnredlist.org](http://www.iucnredlist.org).

**Kaua'i Seabird Habitat Conservation Plan (KSHCP):** This project is undertaken by the State Department of Land and Natural Resources Division of Forestry and Wildlife (DLNR-DOFAW)). The goal is to provide a streamlined, cost-effective way to attain legal authorization and coverage for unavoidable incidental take of Kaua'i's endangered and threatened seabirds and sea turtles due to light attraction and to achieve net conservation benefits for the Covered Species.

**KSHCP Stakeholders:** Team comprised of representatives from the KSHCP Implementing Entity (IE), Participants, USFWS, DOFAW and KESRP and other entities that will meet annually (at a minimum) to review KSHCP Annual Report, make management recommendations and support implementation of the KSHCP.

**Life History Parameters:** Factors that affect the likelihood of an individual from surviving one year to the next. The matrix modeling was based on the parameters of survival and fecundity (age of first breeding, breeding probability, reproductive success and sub-adult and adult survivorship).

**Light Attraction:** Disorientation in nocturnal seabirds or sea turtle hatchlings caused by artificial lighting.

**Light Disorientation:** Altered behavior in hatchling sea turtles that are attracted to an artificial light source and do not migrate directly to the ocean after emerging from their nest.

**Light(ing) Intensity:** Measure of the wavelength-weighted power emitted by a light source in a particular direction per unit solid angle, based on the luminosity function, a standardized model of the sensitivity of the human eye. The Standard International unit of luminous intensity is the candela (cd).

**Listed Species:** Any species designated as threatened or endangered under the Endangered Species Act.

**Lumens:** SI unit of luminous flux, equal to the amount of light emitted per second in a unit solid angle of one steradian from a uniform source of one candela.

**Maximum Extent Practicable:** Fully consistent with the enforceable policies of the management program unless full consistency is prohibited by existing laws or regulations. Involves applying best management practices (BMPs) that are effective in reducing take.

**Minimization Effort:** Action taken by Participant or permittee to reduce activities causing take.

**Mitigation:** [Environmental, compensatory] describes projects or programs intended to offset known impacts to an existing historic or natural resource such as a stream, wetland, endangered species, archaeological site, or historic structure.

**Mitigation Action:** Measure that reduces or addresses potential adverse effects of a proposed activity on species covered by a HCP. Should address specific needs of the species involved and be manageable and enforceable. Actions may take many forms, such as preservation (via acquisition or conservation easement) of existing habitat, enhancement or restoration of degraded or a former habitat, creation of new habitats, establishment of buffer areas around existing habitats, modifications of land use practices, and restrictions on access.

**Mitigation Production:** The number of birds that were produced, or able to successfully fledge at a mitigation site. Most often used in reference to biological production at a mitigation site in comparison to an unmanaged breeding site.

**Mitigation Sites:** Project area receiving mitigation action.

**Monitoring:** The systematic surveillance or sampling of air, water, soil, and biota in order to observe and study the environment, and to derive knowledge from this process. The processes and activities that need to take place to characterize and monitor the quality of the environment or effectiveness of a project.

**Moon Phase:** Shape of the illuminated (sunlit) portion of the moon as seen by an observer on Earth. Changes cyclically as the moon orbits the earth, and can be useful in predicting fallout of covered seabird fledglings during the fledging season.

**NESH:** ‘a’o or Newell’s Shearwater (*Puffinus auricularis newelli*). This is based on an ornithological naming convention that creates standardized 4 –letter code from the first two letters of the common names.

**Net Benefit:** Abbreviated reference to “net conservation benefit”, a requirement under Hawai‘i State law for HCPs to mitigate commensurate for the requested take plus additional mitigation to ensure the likelihood of the survival and recovery of the species in the wild.

**Non-Federal Entities:** Any entity without Federal status, as this is a requirement for eligibility.

**Participant Inclusion Plan (PIP):** A plan delineated by the Applicant describing Covered Activities at facilities, efforts to avoid and minimize take, and requested take for each Covered Species.

**Participant:** A non-Federal entity holding an Incidental Take License and an Incidental Take Permit under the Kaua'i Seabird Habitat Conservation Plan. Prior to being accepted, the "Participant" is referred to as an "Applicant".

**Pelagic:** Related to, or living in, the sea, far from shore.

**Permittees/Permit Holders:** Each Participant in the KSHCP will be a permittee with their own individual ITL and ITP.

**Polygon:** Area of calling activity recorded during an auditory survey, classified as either 'heavy' or 'light', the boundaries of which are defined subsequently on a map by the surveyor. May also include visual flight observations and/or breeding evidence on the ground such as burrows, scrapings, and guano.

**Predator Control:** The act of controlling animals defined as predators via a variety of techniques. In the KSHCP the primary predator for which predator control techniques are applied consist of non-native rats, feral pigs, feral cats, and barn owls.

**Predator Eradication:** Complete removal of predators from within a predator-proof enclosure or reserve featuring natural barriers.

**Predator-proof Fence:** A fence specially designed to exclude predators from entry to an enclosure. Can be created to exclude a variety of predators, from a 2 day old baby mouse (small mesh) to just ungulates.

**Prime Contractor:** The entity responsible for administering and coordinating all facets of the Seabird Mitigation under the KSHCP. This includes compiling, preparing, and submitting necessary information to the regulatory wildlife agencies, DLNR and USFWS, to enable the agencies to determine compliance with the terms and conditions of each ITP/ITL issued.

**Productivity:** Number of fledged young per nesting pair of seabirds.

**Recovery Plan:** A document which specifies what research and management actions are necessary to support recovery of a listed species, but does not itself commit manpower or funds. Recovery plans are used in setting funding priorities and providing direction to local, regional, State, and Federal planning efforts.

**Seabird:** A bird that frequents coastal waters and the open ocean.

**Seabird Fallout Period:** The time period each year (September 15-December 15) when listed seabirds on Kaua'i are fledging from their nests and may become subject to light attraction.

**Site:** Location that has been identified by HCP planning as a project area slated to receive monitoring in any capacity, ranging from the passive, such as the seasonal installation of an acoustic monitoring unit (song meter), to the highly active, such as the installation of a predator-free refugium for translocation and social attraction.

**Social Attraction:** A colony creation technique whereby seabirds are attracted to an area to initiate breeding by playing recordings of other seabirds of the same species. This is an effective technique due to the colonial nature of seabirds.

**Stakeholders:** Individuals or entities with an investment in the outcome of a planning process.

**Sub-adult:** For Covered seabirds in the KSHCP, this term refers to birds 2-5 years old who have not reached sexual maturity.

**Take:** To harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect endangered or threatened species of aquatic life or wildlife, or to cut, collect, uproot, destroy, injure, or possess endangered or threatened species of aquatic life or land plants, or to attempt to engage in any such conduct.

**Triggers:** Established milestones or circumstances that if not met will initiate the need for Adaptive Management.

**Upper Limahuli Preserve (ULP):** An upland area on the northern coast of Kaua'i that is owned and managed by the National Tropical Botanical Garden. An ungulate fence was installed to protect rare plants and seabird nesting habitat, and active predator control in the preserve is ongoing.

**Unforeseen circumstances:** As defined by Federal regulation (50 CFR §17.3), this refers to circumstances affecting a species or geographic area covered by the HCP that cannot be reasonably anticipated by the Applicant or wildlife agency.

**Ungulates:** A hoofed mammal. On Kaua'i, existing ungulates that may trample burrows and seabird habitat, or predate on nesting seabirds include feral pigs and goats and deer.

**Wildlife Agencies:** Public agencies involved in permitting and regulation of wildlife. These include the Department of Land and Natural Resources (DLNR) Division of Forestry and Wildlife (DOFAW) at the State level, and the US Fish and Wildlife Service (USFWS) at the Federal level.

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### **Personal Communications**

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- Dr. Todd Jones, 2017, Lead Scientist, Supervisory Research Biologist, Marine Turtle Biology and Assessment Program, NOAA
- Dr. Andre Raine, 2017, Manager, Kaua'i Endangered Seabird Recovery Project.
- Galen Reid, 2016, Predator Control Specialist, DOFAW.
- Dr. Lindsay Young, 2017, Vice President and Executive Director, Pacific Rim Conservation

# **KAHUAMA'A SEABIRD PRESERVE MANAGEMENT PLAN**



PART OF THE KAUA'I SEABIRD HABITAT CONSERVATION PLAN  
Helen Raine, K. Yuki Reiss, Jessica Hallman Behnke

# Kahuama`a Seabird Preserve Management Plan

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## 1. SUMMARY MANAGEMENT PLAN

The objective of the Kahuama`a Seabird Preserve Management Plan is to create and maintain a terrestrial predator proof sanctuary for `a`o. Birds will be attracted to the site through a Social Attraction component.

Implementation of the plan will, in part, fulfill one of the biological goals of the Kaua`i Seabird Habitat Conservation Plan (KSHCP): to mitigate authorized take impacts on the Covered Seabirds in the HCP (`a`o or Newell's Shearwater –*Puffinus auricularis newelli*, `ua`u or Hawaiian Petrel - *Pterodroma sandwichensis* and Hawai`i distinct population segment (DPS) of the `akē`akē or band-rumped storm-petrel - *Oceanodroma castro*, hereafter `akē`akē) due to light attraction by the participants of the plan, and provide a net benefit to the populations of the Covered Seabirds.

Management of the Kahuama`a Seabird Preserve (also referred to as 'the site') will be carried out by the Prime Contractor, on behalf of the participants in the KSHCP. The site is located in Kōke`e State Park and Nā Pali Coast State Park.

The creation of the site will commence with the construction of a predator proof fence around 2ha of suitable seabird habitat. Only terrestrial predators can be completely excluded, but barn owls will also be controlled to protect the birds within the site and in neighboring source colonies throughout the Kalalau Valley. Feral cats will also be removed at ingress points to the fenceline area and into neighboring source colonies in the Kalalau Valley.

The project will proceed with the removal of Black Rat (*Rattus rattus*), Norway Rat (*Rattus norvegicus*), Polynesian Rat (*Rattus exulans*), feral pigs (*Sus scrofa*), Black-tailed Deer (*Odocoileus hemionus columbianus*), feral goats (*Capra hircus*) and feral cats (*Felis catus*) inside the fence. House Mouse (*Mus musculus*) is expected to be eradicated by rat control but is not a target species. Eradication will be complete within the first year. The fence will be monitored constantly to ensure that predators cannot breach it and there will be monitoring within the fenced area in case of reinvasion.

After predator eradication within the fence is complete, the social attraction component of the project will be initiated to bring `a`o to the project site to breed. This will consist of installing artificial burrows and a speaker system to broadcast calls, simulating a large colony. A variety of monitoring methods will be undertaken to assess the effectiveness of management actions. For seabirds, these will include auditory and visual surveys, camera monitoring, acoustic bird monitoring and bird banding.

Invasive species (seabird habitat modifiers) will be removed from the site to optimize seabird nesting habitat. Monitoring will include a plant survey every five years.

Reporting obligations for the IE will include an annual report.

## 2. INTRODUCTION

Kahuama'a Seabird Preserve is a 2 hectare (ha) Social Attraction Site (SAS) for 'a'o or Newell's Shearwater (*Puffinus auricularis newelli*) that will be surrounded by a terrestrial predator proof fence. It is located along the Western rim of the Kalalau Valley, part of the Nā Pali coast on the Island of Kaua'i, Hawai'i at approximately 22°08'57.1"N 159°38'12.2"W.

The site is being developed as mitigation for "unavoidable incidental take impacts"<sup>1</sup> of 'a'o, a listed seabird, as part of the Kaua'i Seabird Habitat Conservation Program (KSHCP). In addition, barn owl (*Tyto alba*) control around the site and the Kalalau Valley will provide mitigation for the take of 'ua'u or Hawaiian petrel (*Pterodroma sandwichensis*) and 'akē'akē or band-rumped storm-petrel (*Oceanodroma castro*). Collectively, all three species are referred as the "Covered Seabirds".

The KSHCP is an island-wide program to permit and mitigate for impacts to Kaua'i's endangered seabirds caused by light attraction. The KSHCP aims to offset take and provide conservation benefit to these species by increasing productivity at breeding colonies. The KSHCP has set 'Biological Goals' and 'Biological Objectives'. The purpose of this Kahuama'a Seabird Preserve Management Plan is to explain how the objectives toward achieving the goal of "*mitigating authorized take impacts of the Covered Seabirds by enhancing, protecting and managing suitable seabird breeding habitat on Kauai to facilitate successful production of fledglings at a level that over the 30-year term of the Plan offsets or exceeds the impacts of take caused by Covered Activities on the production of fledglings in the wild*" will be delivered and monitored. As such, this Management Plan fulfils certain legal parameters of the KSHCP process as well as describing the management on site. The full suite of KSHCP requirements is described in the KSHCP document to which this Management Plan is an appendix.

'Social Attraction' is a well-established conservation strategy to encourage seabirds to breed in a predator-free location by the simulation of colony activity, principally through the playback of breeding calls, combined with the provision of artificial burrows area (Kildaw 2005, Sawyer and Fogle 2010, Major 2011, Jones and Kress 2012, Raine 2015b). The technique results in high productivity within a small and easily managed.

There are several benefits to establishing a breeding colony within a protected site free of terrestrial predators. The site offers protection from predation which is known to severely impact the breeding of both species on Kaua'i (Raine et al. 2017f, d, g, e, Raine et al. 2017h). Breeding in a predator-free area can result in a positive growth rate, vitally important for these endangered seabirds (Veitch 2011, Young et al. 2012, Kappes 2014, Buxton 2015). In addition, because of the potential for a high breeding density, a relatively large amount of birds can be

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<sup>1</sup> Section 9 of the Endangered Species Act prohibits taking, possession, sale, and transport of listed species. Taking is defined as to "harass, harm, pursue, hunt, shoot, wound, kill, capture, or collect." If an activity is conducted that would "take" a listed species, an 'incidental take permit' is required to avoid being in violation of Section 9 of the Endangered Species Act, a federal offense.

produced in a small area requiring less long term management and funding (Burger 1988, Buxton 2014) – fieldwork for management and monitoring is very labor intensive in this terrain, so having burrows close together for easy monitoring dramatically reduces staff time and thus costs. Finally, creating a “new” colony serves to expand the distribution of the species, recognized as important to the species persistence and survival in the wild (Jones and Kress 2012, Buxton 2015, USFWS 2017b, a). The site also has the potential to provide a sanctuary for other rare and endangered flora and fauna, several species of which are already present at the site. These include candidate or listed forest bird species (nests will be protected from rat predation), ‘ōpe‘ape‘a or Hawaiian Hoary Bat (*Lasiurus cinereus semotus*) and the suite of plant species shown in [Table 7.1](#).

Social Attraction relies on broadcasting breeding calls to attract seabirds to breed; distance to the source population has been identified as one of the most important drivers of seabird recolonization (Buxton et al. 2014). Research by the Kaua‘i Endangered Seabird Recovery Project (KESRP) indicates that Kahuama‘a is located close to several ‘hot spots’ (concentrated locations of seabird activity) on the Nā Pali coast, with the nearest “hot spot” polygon just 210m away, two more within 60m, and 26 within 3km. In fact, the majority of known breeding colonies of ‘a‘o and ‘ua‘u on Kaua‘i are located within 25km of the mitigation site. In addition, ‘a‘o and ‘ua‘u calls were recorded at the site in 2016 using an acoustic song meter (Raine et al. 2016). Kahuama‘a Seabird Preserve has therefore been identified as an excellent location for a SAS, within known seabird flyways along the Nā Pali Coast and nearby existing breeding colonies such as Hono O Nā Pali Natural Area Reserve and in Kalalau State Park.

In addition to the predator proof fenced area, Kahuama‘a Seabird Preserve will include feral cat removal at ingress points to nearby source colonies in the Kalalau Valley, as well as to the fenceline. The project is expected to benefit this native vegetation as well as other native wildlife such as the ‘ōpe‘ape‘a, pueo or Hawaiian Short-eared Owl (*Asio flammeus sandwichensis*) and various candidate or listed forest birds.

The site is on land owned and managed by the State of Hawai‘i - Department of Land and Natural Resources (DLNR) Division of State Parks and straddles two parks: Kōke‘e State Park and Nā Pali Coast State Park. The area is a designated hunting unit, restricted to archery use only (no firearms). Discussions with State Parks have indicated strong support for the project, which is in line with State Park goals of protecting and restoring native ecosystems.

When the Kahuama‘a Seabird Preserve is operational, management of it will pass to the KSHCP Implementing Entity (IE), DLNR Division of Forestry and Wildlife (DOFAW), on behalf of the Participants. Prior to the commencement of management by the IE of the KSHCP, a Memorandum of Agreement with State Parks will be in place.

### 3. VISION STATEMENT

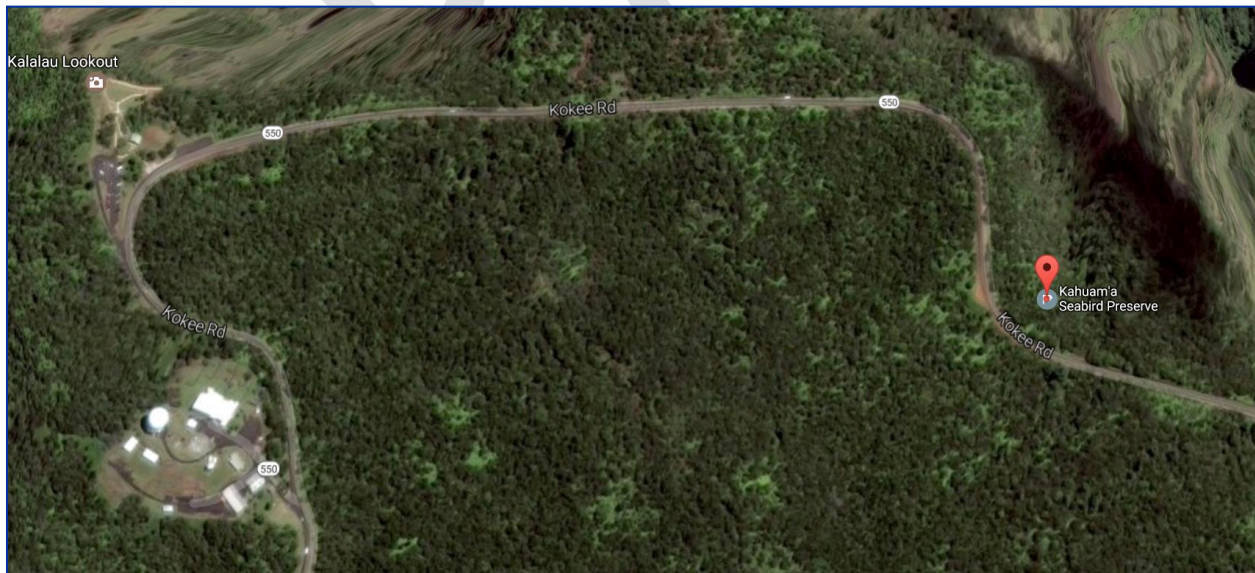
The Kahuama'a Seabird Preserve will become a terrestrial predator free sanctuary for a thriving colony of breeding 'a'o. 'Ua'u may also be present. The site will continue to attract new birds as well as seeing the return of previous breeders (both chicks and adults). Ongoing management will ensure that the interior of the fenced area remains completely terrestrial predator free and that feral cats are controlled at ingress points to the site and to neighboring source colonies. Mitigation for the take of 'ua'u and 'akē'akē will be provided through barn owl control. Neighboring colonies will also benefit from this work. The site will provide optimal breeding habitat through artificial burrows and the ongoing removal of invasive species. The site will also serve as a sanctuary for rare and listed plants.

Kahuama'a will act as a positive example of a Social Attraction Site benefitting a rapidly declining population of seabird. Key to the vision is that the site will meet its targets for successfully providing mitigation to offset take of a listed species as outlined in the KSHCP document.

### 4. INFORMATION

#### 4.1. Location and Statutory Information

The Kahuama'a Seabird Preserve is located near the terminal end of Highway 550, within Kōke'e State Park and Nā Pali Coast State Park, between the Kalalau and Pu'u O Kila visitor lookouts, identified on the map as part of Kahuama'a Flat (Figure 4.1)



**Figure 4.1: Satellite image of Kahuama'a Flats with Kalalau Lookout. Red pin indicates SAS. Google Maps.**

## Kahuama'a Seabird Preserve Management Plan

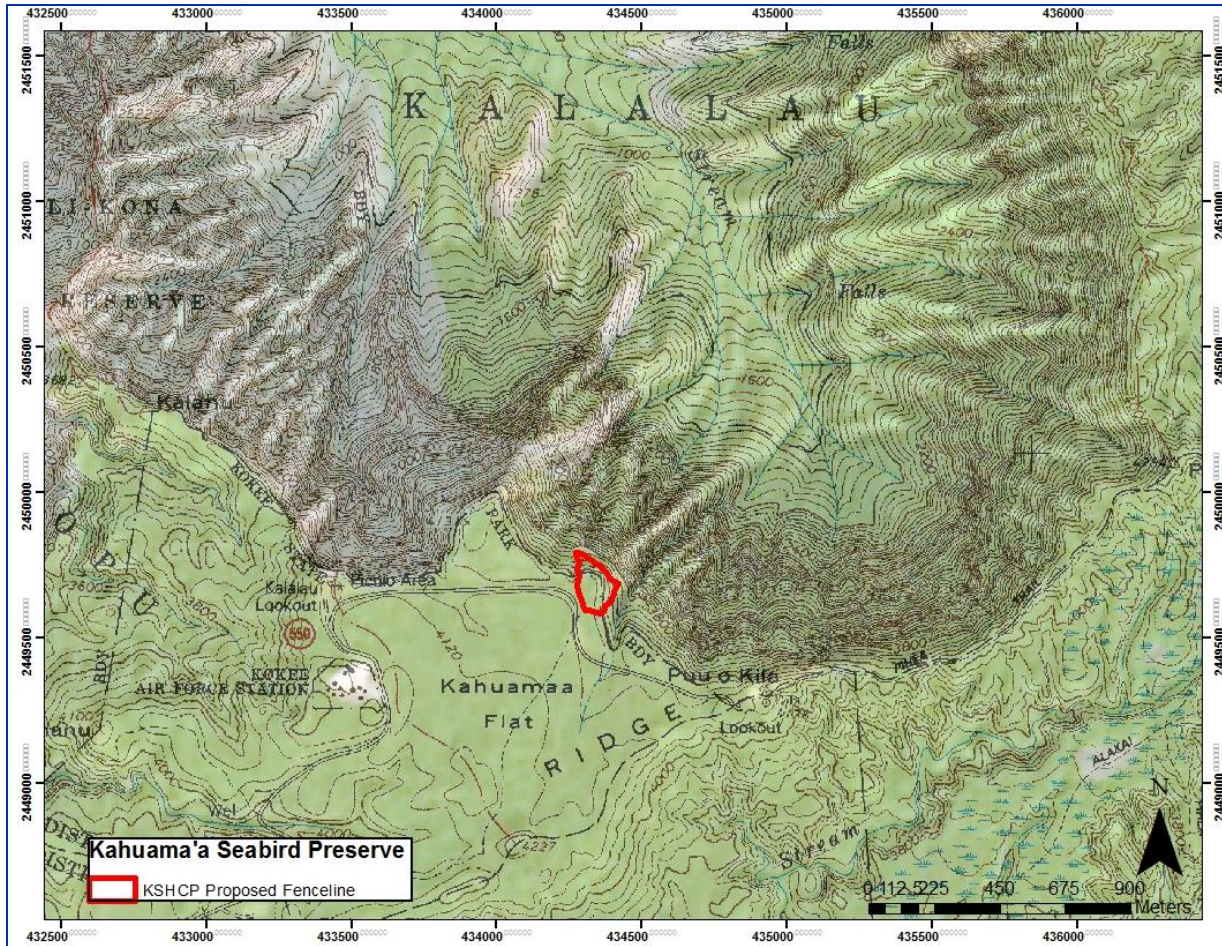


Figure 4.2. Map of SAS location in relation to Kalalau Valley.

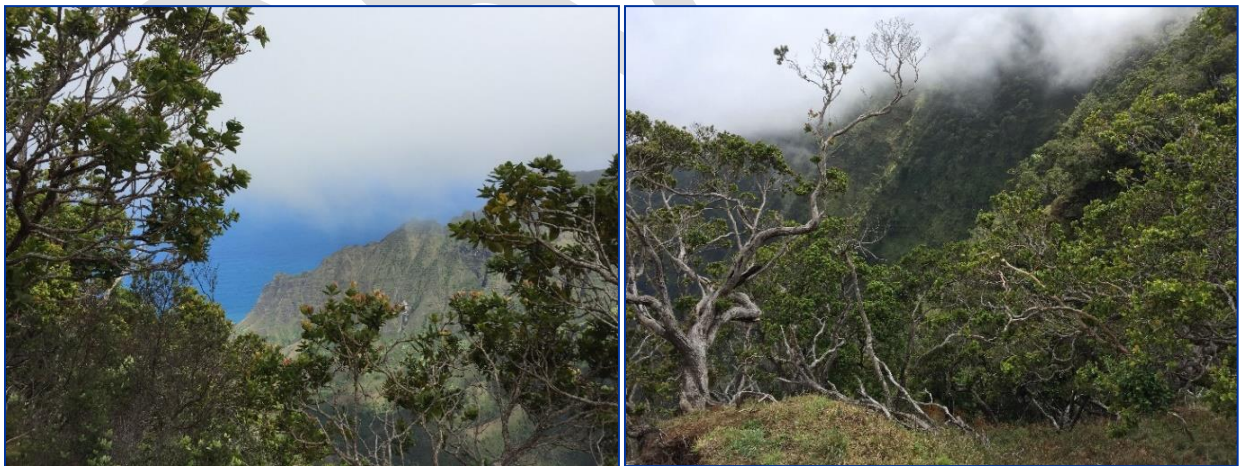


Figure 4.3. Photographs of the SAS along the rim of the Kalalau Valley. Y Reiss.

#### **4.2 Legal Status (legislation for site creation, ownership, official managers), MOA**

The site is situated on lands managed by DLNR Division of State Parks as Kōke'e State Park and Nā Pali Coast State Park. Prior to the commencement of management by the IE of the KSHCP, a Memorandum of Agreement between DLNR and State Parks will be in place as an Appendix to the KSHCP which will include all relevant permits for the activities specified in the Management Plan (for example use of rodenticide, erection of fence etc..). Discussions with State Parks have indicated strong support for this project, which is in line with State Park goals of protecting and restoring native ecosystems.

#### **4.3 Access**

The site lies immediately north of and adjacent to Highway 550. A small amount of parking (sufficient for construction and field staff) is available on the west side of the road adjacent to the site. Prior to fence construction, ideally this will be graveled as it is currently muddy (discussions will be held with State Parks or Highways upon commencement of the Management Plan). No public parking or vehicular access is currently planned as the focus of the project is the creation and maintenance of the seabird site for mitigation purposes.

There are no well-defined trails to the site. As management commences at the site, a foot trail to the site will be created to avoid rare plants (see section [17.7.4](#)). Access for fence building and maintenance will use this new foot trail, with heavier equipment and supplies being dropped via helicopter at specified construction staging location immediately adjacent to the site, which will be large enough to provide storage space (see section [10.3](#)). No permanent or vehicular access is planned.

The site is a designated hunting unit, restricted to archery use only. The site comprises only a tiny fraction of the archery hunting zone, therefore the exclusion of hunters from inside this small enclosure is not anticipated to negatively affect overall access to archery hunting.

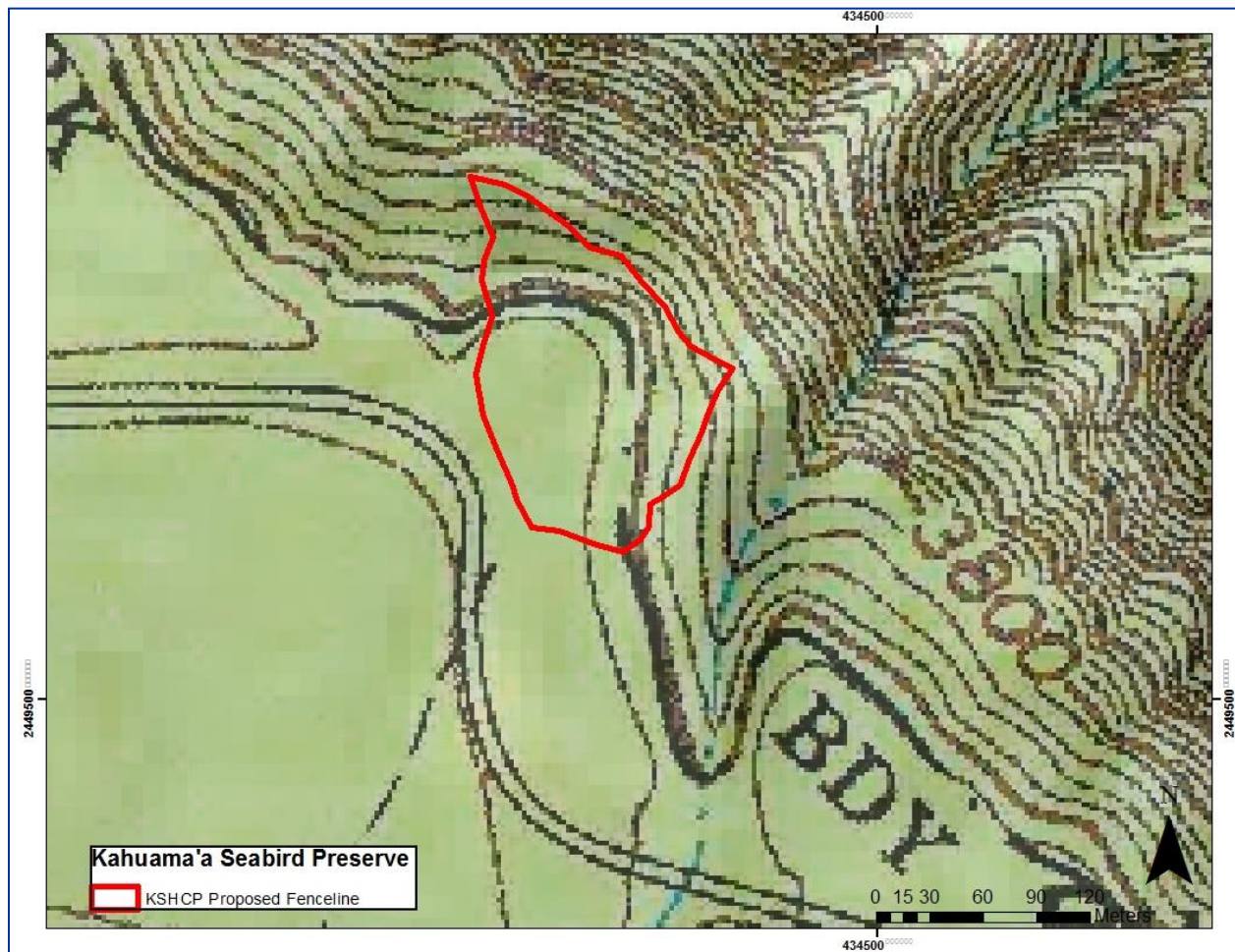
#### **4.4 Existing Infrastructure**

There are currently no utilities or infrastructure at the site as it is a 'wildland portion of Kōke'e State Park' (DLNR, 1997) and Nā Pali Coast State Park.

## 5. ENVIRONMENTAL INFORMATION

### 5.1 Environmental Setting

Kahuama'a Seabird Preserve is located on the northwestern side of Kaua'i, along the western rim of the Kalalau Valley and is part of the Nā Pali coast, which is characterized by steep cliffs and deeply eroded canyons and valleys. **Figure 5.1**



**Figure 5.1. Image of site showing topography.**

### 5.2 Climate

The Kahuama'a Seabird Preserve is located at an altitude of approx. 1250m. The site receives an estimated annual rainfall of around 150-200cm annually with fog (DLNR 1997). The average air temperature in Kōke'e ranges from 10°C in winter to 20°C in summer.

In the past 50 years, strong winds, heavy rains and storm surges caused by periodic hurricanes have resulted in devastating effects. Hurricanes Iwa (1982) and ‘Iniki (1992) caused extensive damage to native plant communities.

### **5.3 Topography/Geology**

The site consists of approximate 2ha of mostly sloping ground, interspersed with small hillocks. Carpenter (1994) describes the soils and topography as; “Kōke‘e silty clay loam on the upper flat (well-drained soils weathered from igneous rock, probably mixed with volcanic ash). There is rough, mountainous land on the valley wall (very steep land broken by numerous drainages, very thin soil mantle if any, much of surface is rock, rock outcrop, and eroded spots)”.

### **5.4 Hydrology/Streams, Rivers, Drainages**

The site lies within Hanalei aquifer sector / Nāpali System (DLNR 2014) characterized as

- High-level - fresh water not in contact with sea water.
- Unconfined - the water surface is in the upper surface of a saturated aquifer.
- Dike-contained - aquifers are confined in basaltic dike compartments.

There are no streams within the site itself, although in times of heavy rain there is at least one gulch which is likely to channel water.

### **5.5 Existing Land Use**

The primary use of the site and surrounding area is as a State Park which is intended to provide opportunities for outdoor recreation as well as protecting Hawai‘i’s natural and cultural history and aesthetic values.

The Kahuama‘a Seabird Preserve falls within a designated hunting unit, restricted to archery use only. Firearm hunting is prohibited because of safety concerns for other users in the park and its proximity to the public highway and visitor viewpoints.

## **6. SOCIAL INFORMATION**

### **6.1 Stakeholders**

Success of the Kahuama‘a Seabird Preserve depends in part upon cooperation amongst the stakeholders in the project. These include the KSHCP Participants, the IE, the regulatory agencies, conservation groups and landowners. Table 6.1 outlines these groups in more detail and provides a framework for the IE to identify the future point of contact.

**Table 6.1. Stakeholders in Kahuama'a Seabird Preserve**

<b>Stakeholder</b>	<b>Role</b>
<b>KSHCP Participants</b>	
Hawaii Department of Transportation	KSHCP Participant
Alexander and Baldwin (A&B)	KSHCP Participant
County of Kaua'i	KSHCP Participant
Marriott at Kalapaki	KSHCP Participant
Norwegian Cruise Line	KSHCP Participant
St. Regis	KSHCP Participant
Sheraton	KSHCP Participant
Kauai Coffee	KSHCP Participant
<b>Agencies</b>	
USFWS	Regulatory / Advisory
State Parks	Land Owner, mitigation site
DOFAW Plant Extinction Prevention Program (PEPP)	Regulatory / Advisory
DOFAW Admin (Oahu)	Regulatory / Advisory
DOFAW Kaua'i Branch	Advisory
<b>Prime Contractor</b>	
Pacific Rime Conservation	Mitigation Project Implementation
<b>Conservation Groups</b>	
KESRP	Advisory
Kōke'e Resource Conservation Program (KRCP)	Advisory
SOS (Kaua'i Humane Society) or other qualified vet / rehab center shearwaters	Resource
NTBG	Advisory
<b>Land Users</b>	
Hunters (archers only)	Land User
Kōke'e Discovery Center	Land User

## 6.2 Archaeological, Cultural and Historical interest

In 1994, prior to the construction of the Kalalau Rim Endangered Plant Exlosure (which is within 1km of the Kahuama'a Seabird Preserve), State Park archaeologists conducted a reconnaissance survey in the area of the Kahuama'a Flat. No archaeological sites or features were encountered during this survey (Carpenter and Yent 1994). However, due to dense vegetation and steep slopes, a complete evaluation was not possible. Therefore, while the archaeologists deemed it unlikely that any important archaeological sites exist in this area (there are few such sites in the uplands of Kōke'e and the area is thought to have been a resource-gathering zone rather than a permanent habitation), they made several

recommendations to ensure that any possible sites were not adversely affected. These are included in the Best Management Practices - Section [17.1.6](#) and [17.2.9](#)).

### 6.3 Visitors

The principal focus of the Kahuama‘a Seabird Preserve is to provide mitigation for unavoidable incidental take impacts to ‘a‘o. As a result, no funding is currently budgeted for outreach. However, the fence will be visible from the road and is between two popular lookouts, the Kalalau Lookout and the Pu‘u O Kila Lookout. Therefore, as part of the Management Plan, the IE will investigate ways to work with partner organizations that might allow for the erection of an interpretation panel at each lookout to explain the purpose of the Kahuama‘a Seabird Preserve as well as providing some information on the special importance of ‘a‘o to Kaua‘i. If further funding can be found, the site has potential for education, awareness raising, demonstration and advocacy.

## 7. BIOLOGICAL INFORMATION

### 7.1 Habitats and vegetation communities

The Kahuama‘a Seabird Preserve is within in a wider area known as the Kalalau rim, an extremely high cliff area which falls over a thousand meters into the Kalalau Valley. Due to the steepness and inaccessibility of the cliff, there are many rare, endemic plants which have survived undisturbed by humans, giving the Kalalau rim unique characteristics. The vegetation at the site is a subtype of ‘Ōhi‘a Lowland Mesic Forest, with ‘uluhe fern (*Dicranopteris linearis*) comprising much of the ground cover (Williams, 2016 unpublished report). DLNR (1997) notes that this habitat is significant for endangered, threatened, candidate and other plants of concern; a number of rare and endangered plant species have in fact been recorded within and around the site.

There is degradation from the encroachment of invasive and non-native plants, particularly in the understory. They include Australian Tree Fern (*Sphaeropteris cooperi*), Banana Poka (*Passiflora tarminiana*), blackberry (*Rubus argutus*) Bush Beard Grass (*Schizachyrium condensatum*, *Andropogon spp.*<sup>2</sup>), Karaka Nut (*Corynocarpus laevigatus*), Parasitic Maidenfern (*Cyclosorus parasiticus*), Air Plant (*Kalanchoe pinnata*), Fire Tree (*Morella faya*) and Daisy Fleabane (*Erigeron karvinskianus*). Koster’s curse (*Clidemia hirta*), Himalayan (Kahili) Ginger (*Hedychium gardnerianum*) and Strawberry Guava (*Psidium cattleianum*) are also present towards the road. Many of these plant species are significant threats for seabirds (particularly Australian Tree Fern, Himalayan (Kahili) Ginger and Strawberry Guava), as they modify the habitat in which they breed.

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<sup>2</sup> There is some taxonomic confusion about these species in Hawai‘i and they are frequently mis-identified and can co-occur. Ecologically they are, however, similar with regard to their invasion biology. (A Williams, 2017, pers.comm.)

In addition, feral pigs, Black-tailed deer and feral goats inhabit the area and are having a negative impact upon the vegetation community. Surveys carried out before fence construction (included as part of the Management Plan) will improve understanding of the vegetation communities and their condition.

The fenceline was decided upon based on characteristics suitable for seabirds, including vegetation, slope and aspect. However, PEPP experts and botanists from DOFAW and USFWS also identified the area as providing dual benefit for birds and listed plants, with the protection of rare and PEPP plants being a major consideration.

## 7.2 Flora

During a preliminary site visit by DOFAW Botanist Adam Williams and PEPP Botanist Steve Perlman, several listed plants were observed within the boundaries of the site. These include two federally Endangered Species, two species that are part of the Plant Extinction Prevention Program (PEPP), which indicates that there are less than 50 individuals left in the wild, and four State Species of Concern. These are highlighted in [Table 7.1](#). This represents a very high concentration of rare and endangered plants. It is anticipated that the fence will be of direct conservation benefit to these plants (Williams, 2016, unpublished report).

Surveys carried out before fence construction (included as part of the Management Plan) will detail the exact location and abundance of listed plants, as well as confirming the below species list in Table .

**Table 7.1. Preliminary plant list from KSHCP Social Attraction Site visit on May 12, 2016 with DOFAW and PEP botanists. Highlighted plants are federally or state endangered, threatened or PEPP.**

Family	Taxon Name	Common Name	Status	FedStat
Asteliaceae	<i>Astelia argyrocoma</i> A.Heller ex Skottsbo.	Pa'iniu	Endemic	
Cyperaceae	<i>Carex wahuensis</i> sp.	'Uki	Endemic	
Amaranthaceae	<i>Charpentiera elliptica</i> (Hillebr.) A.Heller	Pāpala	Endemic	
Asparagaceae	<i>Chrysodracon aurea</i> (H. Mann) P.-L. Lu & Morden	Halapepe	Endemic	
Araliaceae	<i>Cheirodendron fauriei</i> Hochr.	Olapa	Endemic	
Araliaceae	<i>Cheirodendron trigynum</i> subsp. <i>helleri</i> (Sherff) Lowry	Olapa	Endemic	
Dicksoniaceae	<i>Cibotium glaucum</i> (Sm.) Hook. & Arn.	Hāpu'u	Endemic	
Dicksoniaceae	<i>Cibotium nealiae</i> O.Deg.	Hāpu'u	Endemic	
Pteridaceae	<i>Coniogramme pilosa</i> (Brack.) Hieron.	Lo'ulu	Endemic	

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Rubiaceae	<i>Coprosma kauensis</i> (A.Gray) A.Heller	Kōi	Endemic	
Rubiaceae	<i>Coprosma waimeae</i> Wawra	'Ōlena	Endemic	
Corynocarpaceae	<i>Corynocarpus laevigatus</i> J.R.Forst. & G.Forst.	Karaka Nut	Naturalized	
Lauraceae	<i>Cryptocarya mannii</i> Hillebr.	Hōlio	Endemic	SOC
Thelypteridaceae	<i>Cyclosorus parasiticus</i> (L.) Farw.	Parasitic Maidenfern	Naturalized	
Liliaceae	<i>Dianella sandwicensis</i> Hook. & Arn.	'Uki'uki	Indigenous	
Gleicheniaceae	<i>Dicranopteris linearis</i>	'Uluhe	Indigenous	
Athyriaceae	<i>Diplazium sandwichianum</i> (C.Presl) Diels	Hō'i'o	Endemic	
Gleicheniaceae	<i>Diplopterygium pinnatum</i> (Kunze) Nakai	'Uluhe lau nui	Endemic	
Sapindaceae	<i>Dodonaea viscosa</i> Jacq.	'A'ali'i	Indigenous	
Blechnaceae	<i>Doodia kunthiana</i> Gaudich.	'Ōkupukupu, Pāmoho	Endemic	
Asteraceae	<i>Dubautia kalalauensis</i>	Naenae	Endemic	E, PEP
Dryopteridaceae	<i>Dryopteris fusco-atra</i> var. <i>fusco-atra</i>	'I'i	Endemic	
Elaeocarpaceae	<i>Elaeocarpus bifidus</i> Hook. & Arn.	Kalia	Endemic	
Elaphoglossaceae	<i>Elaphoglossum paleaceum</i> (Hook. & Grev.) Sledge	Māku'e	Indigenous	
Asteraceae	<i>Erigeron karvinskianus</i> DC.	Daisy Fleabane	Naturalized	
Euphorbiaceae	<i>Euphorbia remyi</i> var. <i>remyi</i>	'Akoko	Endemic	E
Santalaceae	<i>Exocarpos luteolus</i> C.N.Forbes	Heau	Endemic	E
Pandanaceae	<i>Freycinetia arborea</i> Gaudich.	'Ie'ie	Indigenous	
Zingiberaceae	<i>Hedychium gardnerianum</i> Sheppard ex Ker Gawl.	Himalayan (Kahili) Ginger	Naturalized	
Aquifoliaceae	<i>Ilex anomala</i> Hook. & Arn.	'Aiea	Indigenous	
Rubiaceae	<i>Kadua affinis</i> DC.	Manono	Endemic	
Rubiaceae	<i>Kadua foggiana</i> (Fosberg) W.L.Wagner & Lorence	Manono	Endemic	
Crassulaceae	<i>Kalanchoe pinnata</i> (Lam.) Pers.	Air Plant	Naturalized	
Epacridaceae	<i>Leptecophylla tameiameia</i> (Cham. & Schltdl.) C.M.Weiller	Pukiawe	Indigenous	
Campanulaceae	<i>Lobelia yuccoides</i> Hillebr.	Pānaunau	Endemic	SOC

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Primulaceae	<i>Lysimachia kalalauensis</i> Skottsbo.	no common name	Endemic	
Rutaceae	<i>Melicope clusiifolia</i> (A.Gray) T.G.Hartley & B.C.Stone	Kūkaemoa	Endemic	
Rutaceae	<i>Melicope feddei</i> (H.Lév.) T.G.Hartley & B.C.Stone	Alani	Endemic	
Myrtaceae	<i>Metrosideros polymorpha</i> var. <i>dieteri</i> J.W.Dawson & Stemmerm.	'Ōhi'a lehua	Endemic	
Myrtaceae	<i>Metrosideros polymorpha</i> var. <i>glaberrima</i> (H.Lév.) H.St.John	'Ōhi'a lehua	Endemic	
Dennstaedtiaceae	<i>Microlepia strigosa</i> var. <i>strigosa</i>	Palapalai	Indigenous	
Myricaceae	<i>Morella faya</i> (Aiton) Wilbur	Fire Tree	Naturalized	
Myrsinaceae	<i>Myrsine alyxifolia</i> Hosaka	Kōlea	Endemic	
Myrsinaceae	<i>Myrsine knudsenii</i> (Rock) Hosaka	Kōlea	Endemic	E, PEP
Lomariopsidaceae	<i>Nephrolepis exaltata</i> (L.) Schott	Kupukupu, Sword Fern	Indigenous	
Oleaceae	<i>Nestegis sandwicensis</i> (A.Gray) O.Deg., I.Deg. & L.A.S.Johnson	Olopuā	Endemic	
Solanaceae	<i>Nothocestrum longifolium</i> A.Gray	'Aiea	Endemic	
Passifloraceae	<i>Passiflora tarminiana</i> Coppens & Barney	Banana Poka	Naturalized	
Celastraceae	<i>Perrottetia sandwicensis</i> A.Gray	Olomea	Endemic	
Sapotaceae	<i>Planchonella sandwicensis</i> (A.Gray) Pierre	'Āla'a	Endemic	
Araliaceae	<i>Polyscias flynnii</i> (Lowry & K.R.Wood) Lowry & G.M.Plunkett	'Ohe 'ohe	Endemic	E, PEP
Araliaceae	<i>Polyscias waialealae</i> (Rock) Lowry & G.M.Plunkett	'Ohe 'ohe	Endemic	
Arecaceae	<i>Pritchardia minor</i> Becc.	Loulu	Endemic	SOC
Myrtaceae	<i>Psidium cattleianum</i> Sabine	Strawberry Guava	Naturalized	
Dennstaedtiaceae	<i>Pteridium aquilinum</i> subsp. <i>decompositum</i> (Gaudich.) Lamoureux ex J.A.Thomson	Kīlau pueo	Endemic	

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Rubiaceae	<i>Psychotria greenwelliae</i> Fosberg	Kōpiko	Endemic	
Rubiaceae	<i>Psychotria hexandra</i>	Kōpiko	Endemic	
Rosaceae	<i>Rubus argutus</i> Link	Sawtooth Blackberry	Naturalized	
Blechnaceae	<i>Sadleria cyatheoides</i> Kaulf.	'Ama 'u	Endemic	
Blechnaceae	<i>Sadleria souleyetiana</i> (Gaudich.) T.Moore	'Ama 'u	Endemic	
Goodeniaceae	<i>Scaevola procera</i> Hillebr.	Naupaka kuahiwi	Endemic	
Poaceae	<i>Schizachyrium condensatum</i> , <i>Andropogon</i> spp. (Kunth) Nees	Bush Beard Grass	Naturalized	
Selaginellaceae	<i>Selaginella arbuscula</i> (Kaulf.) Spring	Lepelepe a moa	Endemic	
Cyatheaceae	<i>Sphaeropteris cooperi</i> (Hook. ex F.Muell.) R.M.Tryon	Australian Tree Fern	Naturalized	
Gleicheniaceae	<i>Sticherus owhyhensis</i> (Hook.) Ching	'Uluhe	Endemic	
Myrtaceae	<i>Syzygium sandwicense</i> (A.Gray) Müll.Berol.	'Ōhi'a hā	Endemic	
Ericaceae	<i>Vaccinium calycinum</i> Sm.	'Ōhelo	Endemic	
Ericaceae	<i>Vaccinium dentatum</i> Sm.	'Ōhelo	Endemic	
Flacourtiaceae	<i>Xylosma Hawaiiense</i> Seem.	Maua	Endemic	
Rutaceae	<i>Zanthoxylum dipetalum</i> var. <i>dipetalum</i>	Kāwa'u	Endemic	SOC

### Key

SOC – Species of Concern (Fed)

E – Endangered (Fed)

PEP – Plant Extinction Prevention Program (State)

### 7.3 Fauna (mammals, amphibians, reptiles, invertebrates)

There have been no recent surveys of the site for mammals, amphibians, reptiles and invertebrates. However, a DLNR survey (DLNR 1997) carried out prior to construction of the nearby Kalalau Rim Endangered Plan Exclosure, encountered feral pigs, Black-tailed Deer, feral goats, feral cats, black rat, Norway rat, Polynesian rat and the house mouse.

The surveyors also noted that the 'ōpe'ape'a is known to occur 1km to the southwest of the site at the Hawai'i Air National Guard Radar Station and likely also resides in the forest surroundings. They further hypothesized at the time that the introduced Metallic skink (*Leiolopisma metallicum*) inhabits the area and the introduced wrinkled frog (*Rana rugose*) may inhabit the small drainages.

#### 7.4 ‘A‘o – Newell’s Shearwater

The ‘a‘o, or Newell’s Shearwater, is endemic to Hawai‘i, with Kaua‘i supporting the largest breeding population, estimated at 75 to 90% of the total world population (Ainley et al. 1995, USFWS 2011).

The species is listed as:

- ‘Threatened’ under Federal and State of Hawai‘i Endangered Species laws
- ‘Endangered’ on the International Union for Conservation of Nature (IUCN) Red List of Threatened Species (Birdlife International 2010).



**Figure 7.1. The ‘a‘o. N Banfield.**

The birds are nocturnal and ground nesting, breeding in burrows in steep, high elevation terrain. Their preferred habitat is open native forest dominated by ‘ōhi‘a lehua (*Metrosideros polymorpha*) with a dense understory of ‘uluhe fern (*Dicranopteris linearis*).

Breeding begins in early April, when birds return to search for nest sites (Ainley et al. 1997, Zaun 2007, Deringer and Holmes 2009, Raine et al. 2017f, d, g, e). In June, the female lays one egg, which hatches in approximately 60 days. After hatching, both parents take turns to make foraging trips to the ocean to provision chicks. Fledging occurs late September to mid-November, peaking in October (Raine et al. 2017f). Fledglings will remain at sea for the next several years, returning to their natal areas to prospect for nesting sites in years two to five, and breeding by years five or six (Ainley et al. 1997). The ‘a‘o exhibits high site and mate fidelity.

The population of ‘a‘o is estimated to have declined by 94% (at an average rate of ~13% per year) from 1993-2013 (Raine et al. 2017b) and is predicted to continue to decline (Griesemer and Holmes 2011). The restriction of the species’ breeding range on the island is predicted to continue (Day et al. 2003, Holmes et al. 2009, Raine et al. 2017b).

Factors contributing to this decline are principally the effects of collisions with utility structures, fallout from the effect of light attraction and predation at breeding colonies by non-native predators (Raine et al. 2017a, Raine et al. 2017b, Raine et al. 2017f, d, g, e, Raine et al. 2017h). Other threats include climate change which can affect ocean conditions and food availability (Oro 2014).

## 7.5 Other Avifauna

DLNR surveyors in 1997 noted the Koloa or Pacific Golden Plover (*Pluvialis dominica*), pueo and the nēnē or Hawaiian Goose (*Branta sandvicensis*) in the vicinity of the site.

During a site visit and forest bird point counts in 2016 and 2017, KSHCP and KESRP staff observed i‘iwi (*Drepanis coccinea*) (a candidate for federal listing under the ESA), ‘apanane (*Himatione sanguinea*), Kaua‘i ‘elepaio (*Chasiempis sandwichensis*), Kaua‘i amakihi (*Hemignathus Kaua‘iensis*) and ‘anianiau (*Magumma parva*). ‘Anianiau and Kaua‘i ‘amakihi were observed singing which may be an indication of breeding in the area.

The forest bird breeding season is from Jan – Jun, with most nests being high in the tops of trees. The pueo breeding season and population status is not fully understood but nests have been found throughout the year. Nests consist of simple scrapes in the ground (often under dense vegetative cover) lined with grasses and feather down (DLNR 2015).

Further surveys will be carried out in spring 2018 to complete a baseline of presence and nesting.

## 7.6 Listed Species

The following listed species are known to be present at the KSHCP mitigation site (Table 7.2).

**Table 7.2. Listed species and Federal Species of Concern known to be present at the site.**

Species Common Name	Scientific Name	Confirmed Present	State Status	Federal Status	IUCN Status
<b>Plants</b>					
‘Ohe‘ohe	<i>Polyscias flynnii</i>	✓	Endangered, PEP	Endangered	Critically Endangered
Kōlea, (Rock) Hosaka	<i>Myrsine knudsenii</i>	✓	Endangered, PEP	Endangered	Endangered
Heau	<i>Exocarpos luteolus</i>	✓	Endangered	Endangered	Critically Endangered
‘Akoko	<i>Euphorbia remyi</i> var.	✓	Endangered	Endangered	Critically Endangered
N - CONFIDENTIAL	D – CONFIDENTIAL	(outside fence)	Endangered, PEP	Endangered	Critically Endangered

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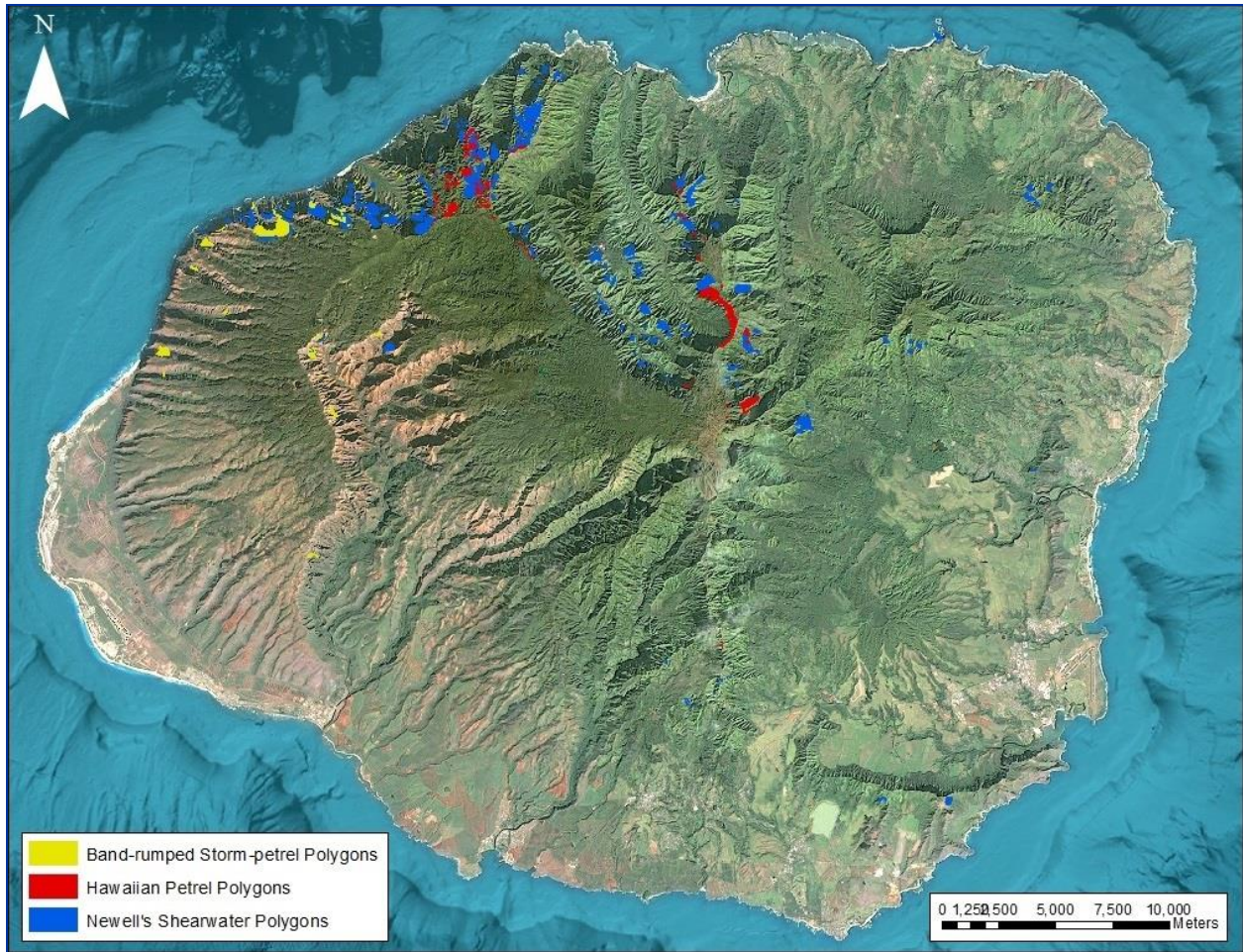
Pānaunau	<i>Lobelia yuccoides</i>	✓	Species of Concern	Not Listed	Not Assessed
Loulu	<i>Pritchardia minor</i>	✓	Species of Concern	Not Listed	Endangered
Kāwa‘u	<i>Zanthoxylum dipetalum</i> var. <i>dipetalum</i>	✓	Species of Concern	Not Listed	Near Threatened
Hōlio	<i>Cryptocarya mannii</i> Hillebr.	✓	Species of Concern	Not Listed	Near Threatened
<b>Birds</b>					
I‘iwi	<i>Drepanis coccinea</i>	✓	Species of Concern	Candidate for Listing	Vulnerable
<b>Bats</b>					
Hawaiian Hoary Bat - ‘ōpe‘ape‘at	<i>Lasiurus cinereus semotus</i>	possible	Endangered	Endangered	Least Concern

### 8. SEABIRD STUDIES ON SITE – KAHUAMA‘A SEABIRD PRESERVE

#### 8.1 Kaua‘i and the Kahuama‘a Seabird Preserve – Background to Site Selection and Role in ‘A‘o Conservation

The island of Kaua‘i is critically important for meeting recovery and conservation goals for the ‘a‘o as it supports up to 90% of the world population (Spear et al. 1995, Ainley et al. 1997).

The Kaua‘i Endangered Seabird Recovery Project (KESRP) conducted auditory surveys and identified the ridges and slopes along the northwest coast of Kaua‘i as displaying the highest levels of ‘a‘o and ‘ua‘u breeding activity. These areas are known as ‘polygons’ or ‘calling hotspots’ (Figure 7.2) (Banfield et al. 2013, Raine et al. 2017f, d, g, e). This work helped to focus a search for a suitable SAS on the Kalalau Valley area which has high levels of activity, is relatively easy to access and is on land belonging to the state.



**Figure 7.2. Map of ‘Calling Hotspots’ on Kaua‘i (KESRP).**

KESRP conducted a series of surveys within and along the rim of the Kalalau Valley from 2006 to 2016 (Raine and Holmes, unpub. data), the results of which contributed heavily to the final selection of the site for the Seabird Preserve. Survey results identified 26 seabird polygons within 3km of the social attraction site, with the nearest polygon only 210 m away (Figure 7.3).

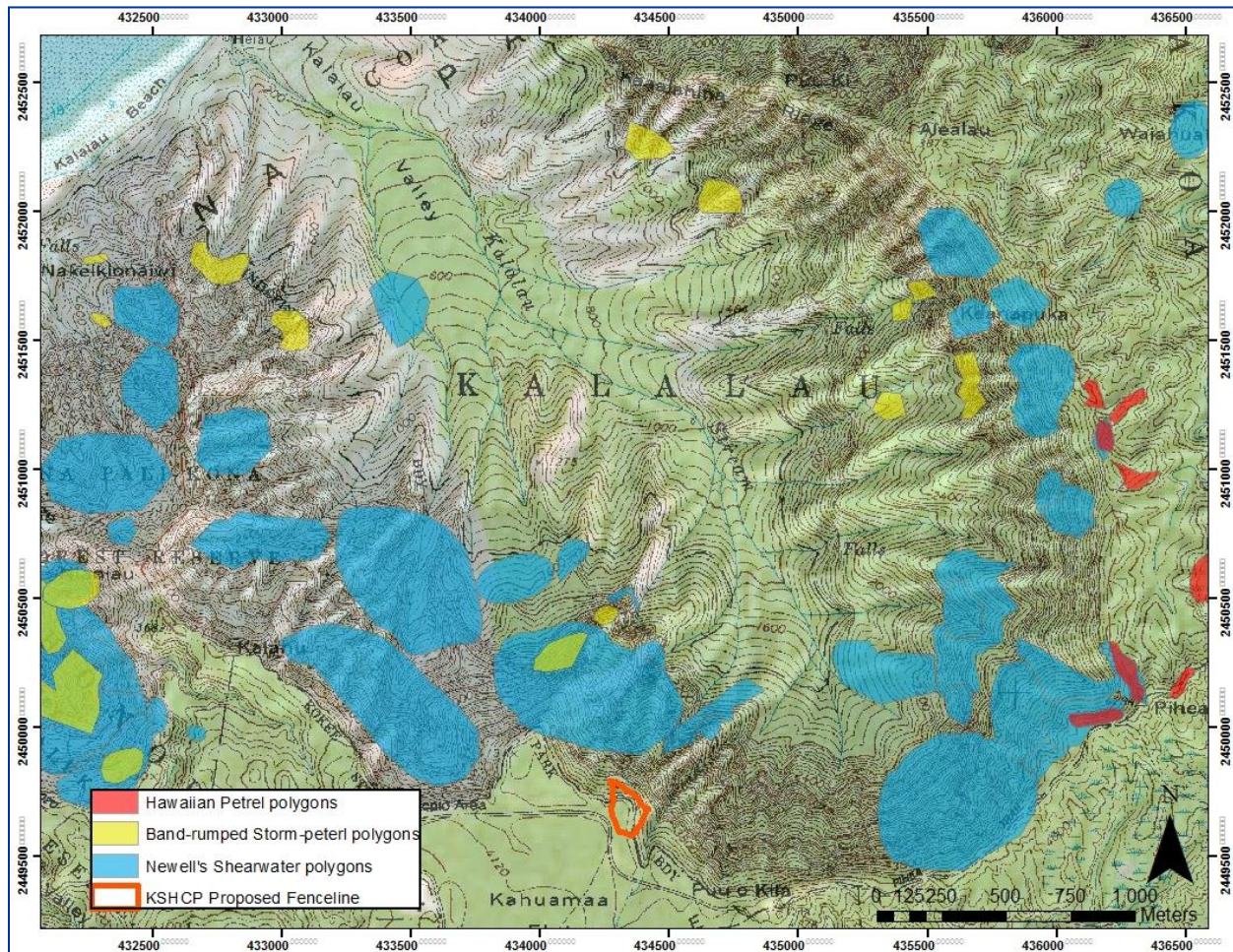
In addition, a song meter recording unit was installed on June 1, 2016 by KESRP staff to record ‘a‘o and ‘ua‘u activity (AUD 1: UTM 0434363 E, 2449690 N). The device was recovered on July 7th, 2016. Data was analyzed by KESRP and Conservation Metrics. ‘A‘o calls were detected almost nightly throughout the survey duration, with a site call rate of 0.3 calls/minute. This call rate is almost an order of magnitude lower than rates detected within a large monitored ‘a‘o colony in Upper Limahuli Preserve but is roughly comparable to lower-activity sites in Pohakea.

Although call rates were low at the survey site, compared to large monitored colonies of this species on Kaua‘i (such as Upper Limahuli Preserve), the fact that they were recorded on almost all nights suggests that potentially, a small number of pairs are breeding within or near to the site itself. The results also indicate that individual birds are flying around the area vocalizing on most nights, which could be drawn in by social attraction. Based on years of surveys by KESRP,

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it is clear that the wider area (Kalalau Valley and Nā Pali coast) has large breeding populations of both species (as seen in Section 6.2 and 6.3). Thus there are potential source colonies nearby that could be attracted into the site itself through social attraction (Raine et al. 2016).

Only 6 'ua'u calls were recorded by the song meter. No barn owl calls or 'akē'akē calls were recorded.



**Figure 7.3. Map of location for the Kahuama'a Seabird Preserve showing 'hotspot' polygons for the Covered Seabirds in surrounding area.**

As a mitigation project for incidental take of 'a'o by KSHCP participants, the Kahuama'a Seabird Preserve will play an important part in protecting the species over the 30-year lifespan of the project. The habitat in the area is already of high quality for the species and management action at Kahuama'a will optimize this habitat. The site will become a stronghold for Newell's by providing a predator proof sanctuary, enhancing reproductive success.

Moreover, the remote northwest region of the island offers an opportunity to conduct conservation away from the threats of light attraction and utility line collisions. Kahuama'a is

known to be relatively free of artificial light both at the site and also on the flyway to and from the ocean.

It should be noted that in 2015, a light attraction event resulted in a large number of downed seabirds at the Kōke'e Airforce base (Raine 2015a, Raine et al. 2015). The Air Force has since signed an agreement with USFWS to minimize lights at this base during the seabird season, and to monitor for any fallout that may occur.

## **8.2 KSHCP Studies**

On the basis of KESRP findings in the broader Kalalau valley area, further work was undertaken at the Kahuama'a Seabird Preserve by the KSHCP team. In 2016 and 2017, preliminary auditory surveys were conducted to assess flyover patterns and confirm any seabird activity in and around the site, including any ground calling activity. The objective of auditory surveys is not to obtain an exact estimate of the number of seabirds breeding or present within the survey, but to generate average call rates to allow for a quantitative estimate of the species in comparison with other survey areas.

### **2016**

Fourteen surveys in four locations were carried out for 'a'o from May 31 to June 3, 2016 by KSHCP staff. Data recorded included presence of birds calling on the ground with distance to the observer, presence of birds transiting over the site with elevation and distance and number of calls over time. The surveys followed a standardized protocol developed in 2006 by KESRP (see Appendix 1), such that the KSHCP data will serve as a baseline, compatible with KESRP data across years and sites.

For 'a'o, the surveys found that no evidence of ground activity at the site itself (birds being present on the ground may be indicative of burrows nearby) but did record ground calling at a distance of approximately 200m. Birds were detected transiting over the site, which indicates a high potential for them to be attracted to playback. No burrows were found in the site but the survey did not include a specific search for burrows. Continuous calling by 'a'o was recorded at a distance of >500m within the Kalalau Valley, corroborating some of the KESRP polygons in the area ([Figure 7.3](#)), and confirming presence of 'a'o in densities that could serve as source colonies for the site. The maximum number of 'a'o calls detected in one survey was comparable to KESRP observations at Wainiha which is noted as a 'Medium-activity site' with "ground calling or other signs of potential nesting behavior detected" (Raine and Banfield 2015).

### **2017**

Six surveys in two locations were carried out from August 28-30. Since the proposed fence location has changed since 2016, only one survey site was repeated and the other survey location covered a location within the new fenceline. The majority of the calls recorded came from outside the project site, confirming presence of NESH in densities that could serve as source colonies for the proposed social attraction project. When data for calls within the site itself (0-200m range) was analyzed separately, the 'calls per hour average' was, as expected,

low. Nonetheless, almost 200 calls were recorded in one session within this distance bracket, indicating a good number of birds circling or transiting over the site. This is encouraging, suggesting that the site is in an excellent location to attract prospecting birds once social attraction commences. In addition, several calls were heard that might have indicated ground calling, although these calls were not persistent enough to confirm the presence of breeders on site.

The presence of barn owls during three separate sessions indicates that barn owl control is likely to be of great importance at the site once social attraction starts as these introduced birds are known to be aerial predators of Newell's Shearwaters.

The results of the surveys, combined with the KESRP acoustic monitoring survey indicate that the installing a social attraction site at Kahuama'a has a high likelihood of success due to the presence of transiting birds, the presence of ground calling birds in the near vicinity and the fact that nearby source colonies have a suitable density of 'a'o which will supply new birds to the site.

Note that the social attraction component of the management plan will not be targeting 'ua'u directly because the applicants for the light attraction HCP have very low numbers of incidental take for 'ua'u which are being mitigated for by barn owl control in the Kalalau Valley. However, if 'ua'u choose to breed in the site, it will be an added conservation benefit.

## 9. OBJECTIVES

The objectives of the Kahuama‘a Seabird Preserve mirror those of the KSHCP in Table 9.1.

**Table 9.1: KSHCP Objectives**

Goal 2: Mitigate authorized take of the Covered Species and provide a net gain in recovery for each of the Covered Species.	2.A. Construct a predator-proof fence and install social attraction equipment (nest boxes, speakers) within the fenced area at the mitigation site in Year 1 of KSHCP implementation.
	2.B. Remove predators from within the fenced enclosure with monitoring confirmation of their absence, and activation of the social attraction equipment by Year 2; predator eradication within fenced enclosure maintained for the life of the project.
	2.C. Ground activity by Covered Seabirds documented at the mitigation site by Year 4 of KSHCP program implementation.
	2.D. Breeding activity by Covered Seabirds documented at the mitigation site by Years 5-7 of KSHCP program implementation.
	2.E. Cumulative upward trend in Covered Seabird breeding documented at the mitigation site by Years 10-12 of KSHCP program implementation.
	2.F. Continued cumulative upward trend in Covered Seabird breeding documented at the mitigation site by Year 20 of KSHCP program implementation.
	2.G. Maintain high quality seabird habitat at the mitigation site by removal of habitat modifying invasive plants in Year 1 and annually throughout the 30-year duration of the KSHCP.
	2.H. Protect nesting birds inside mitigation fence and in nearby source colonies by implementing predator control of 1) barn owls within the area surrounding the fenced enclosure and the Kalalau Valley, and 2) feral cats at ingress points to source colonies in the Kalalau Valley, beginning in year 1 and annually throughout the 30-year duration of the KSHCP.

## 10. ACTIVITIES

### 10.1 Activities Overview

Achieving the objectives of the Kahuama‘a Seabird Preserve will require a series of actions over the duration of the project (30 years). For each specific activity within the Management Plan,

the activity and methodology is described in the following sections. The approximate chronology of actions is as follows:

- Obtain permits
- Final confirmation of fence alignment
- Pre-construction surveys
- Fence Construction
- Predator Eradication
- Commence social attraction at site
- Vegetation management (invasive species removal)

Monitoring at the site will be ongoing and is a critical part of project success. All data will be collected digitally in the field to facilitate swift analysis into a database at the office. The Project Manager and Technician will work together to analyze data, produce appropriate monitoring documents and carry out all project management activities.

Section 17 outlines the Best Management Practices (BMPs) that will ensure that listed and / or rare species are not compromised by any of the activities.

## 10.2 Obtain Permits

Permits from the relevant authorities should be obtained in advance and will be outlined before the project begins. Permits may be required as follows:

Action	Permit / Permission
Fence construction and habitat enhancement	Develop MOA and secure any related approvals from DLNR
Invasive plant removal and pest control	Secure permits as required from DOA, USDA, USFWS and DLNR
Research and monitoring	Secure permits as required from DLNR and USFWS
All	NHPA Section 106 and ESA Section 7 consultation as required

## 10.3 Fence Alignment and Pre-Construction Surveys

OBJECTIVE 2A – Construct a predator-proof fence and install social attraction equipment (nest boxes, speakers) within the fenced area at the mitigation site in Year 1 of KSHCP implementation.

### 10.3.1 Initiate Bids Process. Select and Hire Contractor

The relationship with the fence contractor is extremely important to ensure that Best Management Practices are followed during construction and that the outcome of a terrestrial predator-free enclosure is successfully achieved. As soon as the IE takes over management of the Kahuama'a Seabird Preserve, a fence contractor with a proven track record, capable of working in the terrain, will be engaged through a bids process.

#### **10.3.2 Establish Sling Load Drop Zones, Final Fence Alignment**

The chosen contractor will meet on site to establish the final fence alignment and sling load drop zones with IE staff, the regulatory agencies and any other stakeholders considered necessary.

Following the onsite meeting, a document will be drawn up with a map showing the exact location of the fence and sling-load drop zones. The contractor will be asked to commit in writing to this document.

#### **10.1.1. Pre-construction Surveys**

Prior to work commencing on site, a series of surveys will be carried out and the results used to guide construction work and to ensure that all damage to listed species is completely avoided. These surveys are detailed in the following sections.

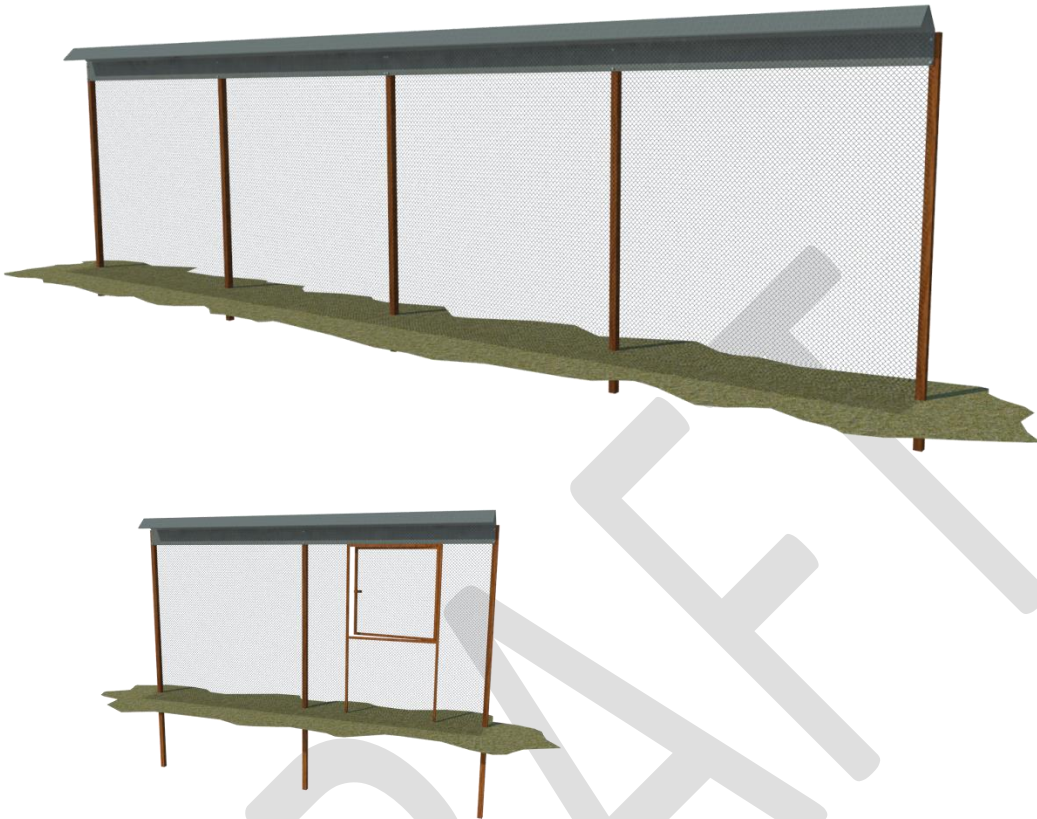
- Burrow surveys – Section [12.3.1](#)
- Auditory survey – Section [12.3.4](#)
- Bat survey – Section [17.1.3](#)
- Candidate and listed forest bird & pueo survey – Section [7.5](#) & [17.1.4](#)
- Archaeological survey – Section [17.1.6](#)
- Plant Survey – Section [12.2](#)

#### **10.4 Fence Construction**

OBJECTIVE 2A – Construct a predator-proof fence and install social attraction equipment (nest boxes, speakers) within the fenced area at the mitigation site in Year 1 of KSHCP implementation.

In order to establish a safe breeding sanctuary for the Covered Seabirds, a predator-proof fence will be constructed on site as follows.

#### 10.4.1 Fence Design



**Figure 10.1. Technical Drawings of the Fence and Pedestrian Gate (PRC 2017)**

The fence (Figure 10.1) will enclose approximately 2ha and will incorporate the following characteristics or similar (Young and VanderWerf 2014):

- Height of 2m
- All fence materials made of the same material (stainless steel)
- The fence base or frame should be constructed using 2.7m long posts spaced at approximately 2m intervals along the fence length. Spacing in areas of high winds along ridge lines should be closer
- Stays (diagonal braces placed behind the posts at a 45° angle) should be used on average every 4 posts and every 2 posts in high wind areas and on steep slopes. Stays must be placed only on the inside (pest-free) side of the fence.
- Stainless steel single strand wires should be tensioned to 150kg horizontally between the posts or poles and be fixed to each pole or post using stainless steel fastenings.
- Fine-aperture mesh will be applied that will exclude any terrestrial animal larger than a 2-day-old mouse. The face of the fence and the horizontal skirt extending out from the base of the fence should be marine grade “316” stainless steel mesh with an aperture no larger than 7mm by 25mm. The mesh should be fixed to the posts and post framework using stainless steel fittings.

- A mesh skirt will be added extending out and down approximately 0.5m to prevent digging, secured to the ground with pins or cement and not loose in any location, with its leading edge covered with topsoil or filled to a depth of approximately 45cm, and not scoured out or eroded under in any way
- Rolled hood will be added to allow animals to escape the enclosure, but not to jump inside. The hood should be of the same material as the rest of the fence and should be braced with brackets at each post and fixed to the fence frame using stainless steel fittings.
- The area immediately outside of the fence (i.e., the pest side) should be completely free of any objects or structures within two meters of the fence at all heights that an animal could use as a base for jumping over the fence
- The main body of the fence should be constructed in such a way that there are no gaps wider than 7 mm to exclude juvenile mice
- No fence corner should turn more sharply than 45 degrees off the line of the previous fence section (Figure 10.2).



**Figure 10.2. Fence corner diagram**

- Single, half-door design lockable pedestrian access gate will be located along the fence edge nearest to the road, not at ground level, requiring stepping over to reduce the chance of predators entering if the gate is accidentally left open (Figure 10.3). Gate sealed to the main body of the fence in a pest proof manner with no gaps greater than 7mm along more than one dimension, with a mesh skirt or solid concrete footing beneath the gate entrance that extends out from the gate by no less than 350mm
- An extra 5% of materials has been included in the budget to serve as “overage” in case there is variance from the estimated fence length or damage to some materials during transport. The extra materials also can be used for repairs after construction is complete.
- This design minimizes the risk of reinvasion as long as monitoring and maintenance procedures are in place (Day and MacGibbon 2007).



**Figure 10.3. Example of pedestrian gate design that does not extend to ground level (Young and VanderWerf 2014)**



**Figure 10.4. Similar predator-proof fence at Hutton's shearwater colony, Kaikoura, New Zealand. A Raine.**

#### **10.4.2 Earthworks (Young and VanderWerf 2014)**

- The fence platform should be formed as a gentle mound (when viewed in cross-section) so that drainage water cannot pass through the line of the fence.
- The earthworks and substrate in and around the fence should not have any channels or gaps continuously greater than 7mm across more than one dimension that extends from the ground surface on the outside (pest side) of the fence to the ground surface on the inside of the fence.

- The fence platform and ground conditions in the vicinity of the fence should be such that there is no immediate risk of slumping or erosion that may cause damage to the fence or compromise any of the standards outlined above.

#### **10.4.3 Fence Construction Methods**

Fence construction will ensure that the risks of predator incursion are minimal. Constructions will consist of:

- Fencing material will be flown in and landed on the agreed upon sling load drop zones (see section [10.3.2](#)). Fence contractor will agree to a timetable for completion and all BMPs in writing.
- Clearing of fence-line (removing vegetation from a 4m wide swath, with machinery if possible or else by hand with chainsaws / hand tools) following the BMPs outlined in section [17.1](#) and [17.2](#)
- Removal and maintenance of all woody vegetation from the outside the fence line to a distance of 3.7m to prevent incursion from predators. This may be less where there is an upwards slope away from the fence. Rats have a horizontal jumping capacity of 3.66m and a vertical jumping capacity of 1.8m (L. Young, 2017, pers. comm.). Grass may remain.
- Fence platform formation (earthworks, drainage works and culverts) with use of heavy equipment, such as a bobcat, if possible.
- Base fence erection (installation of posts, anchor poles, braces, 5 base wires);
- Attachment of mesh (including ground pinning/cementing);
- Attachment of cat-proof hood sections;
- Installation of waterway and access components.
- Removal of all waste upon completion.
- Due to the presence of tall canopy forest surrounding the fence, a solar powered tree fall response system (a metal wire that sits above the hood and is triggered if a branch falls on it) will be included in the fence construction process.

#### **10.4.4 Delays in Fence Construction**

Fence construction delays could result in additional costs. Some delays are avoidable; for example, in the case of permits, the KSHCP team will work with the agencies in advance, on the basis of the management plan, to ensure that the agencies issue permits before work commences and that any problems are flagged by the agencies early enough to be solved.

Fence construction must start during the period December to April, i.e. outside the breeding season. Fence construction may only commence during this period if it is reasonable to expect that the work that would affect seabirds will be completed on the sloping sections of the fenceline before the seabird breeding season commences, namely vegetation clearance, installation of initial posts and other ground disturbing work.

However, work may continue into the breeding season to complete the fence provided it is either on the flat areas of the site or does not include work noted above that would damage potential burrows or birds in burrows.

Since this means that missing the appropriate window could result in a delay of a year, the fence contractor will be asked to commit to deadlines such as ensuring that materials are in place in advance (see section [10.4](#)). The contract will stipulate per-day monetary penalties beyond the specified deadline for contractor delays, regardless of weather. Intensive efforts will be made by the IE to avoid delays.

#### **10.4.5 Confirm Fence Construction Complete**

The target for completion of fence construction is end of Year One to fulfil KSHCP requirements. IE staff will confirm that this target has been met with a final fence inspection including photographs.

If it becomes clear during the course of construction that this target will be missed, IE staff will consult regulatory agencies and initiate adaptive management (outlined in [section 16](#)) if required.

#### **10.4.6 Long term Fence Monitoring and Maintenance**

Even a well-built predator exclusion fence using proven materials will require a regular monitoring and maintenance program to be effective in the long term. Accidents, vandalism, and acts of nature are likely to damage the fence at some point, potentially resulting in pest reinvasions. A good maintenance and monitoring program will detect the damage quickly, will have people and resources in place to make emergency repairs, and will reduce the likelihood of animals entering when a breach occurs (Young and VanderWerf 2014).

Maintenance will be carried out as follows:

- The contractor will be required to provide a complete parts list, including item description, material, manufacturer and part number in a spreadsheet.
- They should also provide a written maintenance manual, repair kit parts list and one day of on the ground training for managers and staff.
- Based on discussions with other predator fence project managers, annual maintenance cost for materials is estimated to be 1% of the initial cost of the fence, plus labor.
- The fence will be monitored bi-monthly (this can be combined with other monitoring activities, such as predator control) following completion to avoid fresh incursions by predators. Personnel will check for holes, breaches, vandalism, and other damage throughout the life of the project. Ad hoc monitoring will occur after storm events or high winds to ensure no damage was sustained. Gates will be tested for functionality.
- When inspecting, there are four components to look at: hood, posts and stays, skirt and mesh. The hood should be examined for excess lichen growth which can facilitate cats climbing over, corrosion at seams, attachment points, bends and for scratches indicative

of cats attempting to jump over. If scratches are noticed, the area should be examined to determine if there are jump points. Posts and stays should be examined for corrosion and loose attachments. Mesh should be examined for breaks in welds or links, corrosion or abrasion and separation at the seams or attachment points. The skirt should be examined to ensure that there aren't any punctures, it is secured to the ground, not eroded underneath and that the lip is not curling up and allowing pests to dig under.

- Where scratches are seen, feral cat trapping outside the fence will be intensified (see section [11.1.2](#))
- A risk analysis will be carried out after construction, to identify possible areas of weakness. This analysis should identify possible reinvasion sites, such as at natural barriers like adjacent overhanging trees, steep slopes, areas prone to high winds or rock falls, or areas where public might try to access.
- To assist in having breaches reported in a timely manner, signs could be placed at high-risk areas and access points that provide contact information for whom to call in the event that a breach is noticed. Fence posts will be tagged with a unique number so that anyone reporting a breach can identify the location easily (e.g. fence panel #180). These can either be engraved into the fence posts, or added as separate metal tags.
- All project staff will carry a small tool box of patch materials and tools at all times during site visits.

#### **10.5 Intruder Detection**

Predator intrusions will be identified through the regular deployment of tracking tunnels inside of the fence line. See rodent removal section [11.1.1](#).

#### **10.6 Predator Defense Zone Around Fenceline**

To reduce the likelihood of pests entering through a fence breach, a zone of low, non-woody vegetation will be created and maintained around the perimeter of the fence. Predator eradication will also occur in this zone (and up to 50m beyond) because several species, particularly feral cats, have been noted using a fenceline as a transit trail within their territory (A. Raine, 2017, pers. comm.) and regularly patrol it, increasing their chances of finding a breach before it is repaired. See rodent and feral cat removal section [11.1.1](#) and [11.1.2](#).

#### **10.7 Fence Crisis Response to Reduce or Eliminate the Risk of Predator Incursion**

A tree fall response system will be installed along the fence which will issue an alert to a mobile phone if the fence is damaged by falling vegetation.

Following such an alert or a storm event and / or hurricane, staff will check the fence as soon as practically possible (ideally within 2 hours, if safe to do so). If a major breach is discovered, e.g. a tree falling on the fence and / or the fence being blown down or partially destroyed by a hurricane, staff will initiate a 'fence crisis procedure' as follows:

- Upon discovery of a major breach or serious damage, IE staff will alert the regulatory authorities (DOFAW, DLNR, USFWS) and the KSHCP participants
- Where possible and safe to do so, staff will make an effort to repair the breach themselves for damage limitation
- Where the breach is too large, staff will retain the services of a fence contractor as soon as practically possible to repair the breach.
- If the breach occurred outside the breeding season for covered seabirds, staff will deploy ink card tracking tunnels, visual surveys and cameras to assess the likelihood of predators having entered the Kahuama'a Seabird Enclosure. If predators are found to be present, IE staff will initiate the predator removal procedures outlined in this management plan in section 11.
- If the breach occurred during the breeding season, IE staff will initiate the predator removal procedures immediately to avoid injury or death to the covered seabirds.
- IE staff will also check and repair any damaged artificial burrows following a storm event, as well as the social attraction equipment, cameras, Goodnature (or similar brand) traps and any other hardware relevant to the site.
- The KSHCP includes a contingency fund to pay for incidents of this nature. IE staff will draw upon the fund as required to repair the breach.

## **11. OPERATION OF PROJECT SITE**

### **11.1 Predator Eradication at Project Site**

OBJECTIVE 2.B. Remove predators from within the fenced enclosure with monitoring confirmation of their absence, and activation of the social attraction equipment by Year 2; predator eradication within fenced enclosure maintained for the life of the project.

There are many precedents for successful predator removal in fenced seabird enclosures. In Hawai'i, these include the Nihoku Ecosystem Restoration Project at Kīlauea Point National Wildlife Refuge in Kaua'i in 2015, Makamaka'ole Seabird Preserve in Maui in 2013 and Ka'ena Point Natural Area Reserve on O'ahu in 2011.

Kahuama'a Seabird Preserve, predator eradication will target rodents, namely Black rat, Norway rat and Polynesian rat. House mouse is likely to be eradicated as part of the process. It will also target feral cats, ungulates, pigs (although these are expected to leave of their own accord due to the levels of disturbance during construction) and barn owls.

#### **11.1.1 Rodent Eradication Methods**

Predator removal will be achieved through a grid of mechanical trapping (rodent snap traps, self-resetting rodent Goodnature traps or similar brand) and stationary rodenticide (diphacinone) bait stations. Monitoring will include the counting and collection of carcasses, monthly deployment of ink card tracking tunnels which show predator footprints, camera

monitoring and bait-take monitoring (this is dealt with in section [12.1](#)). Eradication within the fence is expected to take 3 months (Young et al. 2013) but may be longer.

There will also be a secondary line of rodent removal defense just outside the project fence in a 50m predator defense zone consisting of Goodnature (or similar) and snap traps which will remain there permanently. This will help to prevent the ingress of rats and mice into the site by removing them before they reach the fence; research suggests that reinvasion by rodents occurs within 24 hours of a breach (Connolly et al. 2009).

Project staff will be trained by predator eradication experts based on Kauai. To remove rodents inside the fence enclosure, trained and certified technicians will set up the following grids using a GPS:

**Self-resetting rat traps (Goodnature A24 traps or similar)**

These traps house a captive-bolt system in a narrow opening, positioned vertically to the ground. These traps result in almost instant euthanasia, and can remove multiple rats between servicing.

- Goodnature traps will be set along the fence, spaced every 50m along the fence- the average home range size for Black Rats ((Young et al. 2012) - on a grid inside the fence, mounted on trees or roots. If no other support is available, a pole can be used. Traps will be at least 12cm off the ground. They will remain for the duration of the project.
- Traps will be checked monthly, strike counter noted, CO<sub>2</sub> canister tested and changed if required and trap re-baited if necessary. Check frequency may be reduced over time if the automatic lure pump proves effective.
- For further set up and management details see <http://www.goodnature.co.nz/support>. Similar brands may also be used.

**Enclosed rat "snap" traps (Victor, DOC 250 or similar)**

- Inside the fence, a grid of up to 75 "snap traps" or similar (placed inside a bird-safe housing to prevent non-target capture) may be set up (if needed depending on predator level) with 50 spaced approximately every 25m inside the fence and 40 in the 50m predator defense zone outside the fence.
- These will be used throughout the initial eradication (expected to last three months) and then may be removed except in case of a reinvasion by predators and stored by project.
- Options include the Victor Rat Traps and the DOC250.
- Traps will be placed in a bird excluding box designed to exclude non-target species, guide target species, and maintain the integrity of the trap from weather (Mosher et al. 2010). Plans can be found at <http://www.doc.govt.nz/Documents/conservation/threats-and-impacts/animal-pests/doc250-predator-trap.pdf> (Peters 2017). See Figure 11.1. Alternatively,

Tupperware boxes can be used with holes cut in the side of them to exclude birds from the traps, based on a design by Kyle Pias.

- While in use during initial eradication, traps will be checked every two days, carcasses removed and disposed of off-site and bait replaced if required.



**Figure 11.1. Bird Excluding Box for DOC 200 Snap Traps from Makamaka'ole Project, Maui**

#### **Rat bait stations.**

Rodent bait stations will be placed inside the fence. Stations are designed to prevent access by birds or non-target species.

##### **Interior rat bait stations**

- A grid of approximately 50 tamper-resistant Protecta<sup>®</sup> plastic bait stations or similar will be placed every 25m inside the fence, secured to the ground with metal rebar stakes and plotted by GPS.
- Stations will be baited with 11 1oz Ramik mini-bars<sup>®</sup> containing 0.005% diphacinone or similar product approved for conservation of endangered species (Young et al. 2013).
- For the initial bait application, stations will be re-baited twice a week for one month. In month two, stations will be baited once per week; in month three to six, stations will be baited every two weeks; thereafter, stations will be baited once a month until sign disappears (by zero bait take or teethmarks and zero presence on ink cards).
- Bait take 'hot spots' will be mapped, where additional trapping / baiting would be of benefit.
- Once ink card tracking tunnels and bait stations show zero signs of take, predator eradication work and monitoring will continue for a further three months (the average reproductive cycle of a female rat) to ensure that a new litter did not survive. Detailed records of the level of bait take for each station will be kept.
- Bait stations may be re-utilized at any time during the project based on a suspected breach or rodent evidence found via tracking tunnels, cameras, or other detection methods following the above protocol until rodent signs disappears. They will therefore remain in place even when not in use.
- Baiting will be done by staff certified as applicators of restricted-use rodenticide.

- Signs indicating diphacinone bait is being used will be placed on the pedestrian entrance to the fenced area.

Even when rodent eradication inside the predator-proof fence is complete, permanent rodent control (snap traps in bird excluding boxes and Goodnature traps or similar) immediately outside the fence will be maintained (traps left out and maintained) to keep animal densities low and prevent immigration into the fenced area.

To facilitate rapid response to a breach, unarmed snap traps and unbaited bait stations will remain in situ inside the fence so that they can be easily redeployed in an emergency.

#### **11.1.2 Feral Cat Eradication, Biosecurity Methods Inside Kahuama'a Seabird Preserve Fence**

2.B. Predators removed from within fenced enclosure with monitoring confirmation of their absence, and activation of the social attraction equipment by Year 2; predator eradication within fenced enclosure maintained for the life of the project.

It is anticipated that feral cats (*Felis catus*) will leave the interior area prior to completion of the fence, due to the disturbance caused by construction activities. This will be confirmed by the deployment of 2 live traps and 5 camera traps inside the enclosure for three months or until social attraction commences (these cameras will later be used for burrow monitoring). If needed, removal can be completed by spotlighting at night using a firearm or high-powered air rifle.

##### **11.1.2.1 Feral Cat Reinvasion**

If cats are detected inside the predator proof enclosure after completion, through any means (for example visually, on a camera or through the appearance of a bird carcass that is likely to have been killed by a feral cat, scat, footprints or other signs), they must be urgently removed, following strict BMPs (see [Section 17](#)). A trapping protocol to be determined by the Prime Contractor will be implemented until the area is cat-free.

##### **11.1.2.2 Feral Cat Control Methods (outside fence)**

Feral cats are observed on the road to Pihea by NARS staff on a near-weekly basis, and NARS camera data reflects significantly higher numbers of cats moving along trails and fence lines than along densely vegetated areas (K Pias, 2017, pers. comm.). It is worth noting that a predation 'a'o was documented in 2014 in very close proximity to the Kalalau Lookout (A. Raine, 2016, pers. comm.).

At the Makamaka'ole Seabird Preserve, cats were noted prowling the exterior of the fenceline, apparently attracted by seabird calls played on the speaker (S. Engler, 2017, pers. comm.). This presents a risk of reinvasion by cats in the event of a breach and also an opportunity to remove cats which might prey on neighboring source colonies. Therefore, feral cat control along the fenceline will be carried out as follows:

Live feral cat traps

- Live feral cat traps (30" and 36" Tomahawks or similar) will be deployed around the fence. These will be a mixture of baited traps and un-baited trail set traps (double door tomahawks). Traps will likely be equipped with monitoring technology that sends a text or video notification when a trap is triggered.
- Traps will be locked open in place with added bait between trapping efforts to encourage regular visitation by cats. This technique has been observed to greatly increase capture rates (G. Reid, 2016, pers. comm.).
- Cameras will be used outside the fence to monitor for cat presence (see section 11.1.1 for methods)

### 11.1.3 Mongoose

The establishment of Indian mongoose (*Herpestes javanicus*) is uncertain on the island of Kauai (Phillips and Lucey 2016). Two mongoose have been caught on Kaua'i in recent years and Kaua'i Invasive Species Committee (KISC) receives multiple "credible" sightings annually. If a mongoose is detected or suspected at the site at any time, the project team will advise the regulatory agencies and seek advice from KISC within 12 hours of the animal being detected and will reinstate the baiting and trapping protocol.

### 11.1.4 Ungulates and Pigs

Site visits during the project development stage have indicated a high degree of goat disturbance, as well as some pig sign. Black-tailed deer may also be present. However, due to the relatively small size of the enclosure, a need for feral pig, feral goat and deer trapping is not anticipated as large ungulates typically avoid the kind of loud human disturbance that will occur during construction.

Scheduled fence monitoring and maintenance (Section [10.4.6](#)) will ensure any ungulate or pig fence damage is noted and repaired.

Scheduled camera checks for cats and rats (Section [11.1](#)) will ensure that any ungulate or pig presence inside the fence is noted. In the highly unlikely event that an ungulate or pig is found inside the enclosure, a firearm-certified technician will be remove them as soon as practically possible. Snares / legholds may be deployed if necessary.

## 11.2 Barn Owl Control

Objective 2.H. Protect nesting birds inside mitigation fence and in nearby source colonies by implementing predator control of 1) barn owls within the area surrounding the fenced enclosure and the Kalalau Valley, and 2) feral cats at ingress points to source colonies in the Kalalau Valley, beginning in year 1 and annually throughout the 30-year duration of the KSHCP.

Barn owls are a non-native species and known predators of seabirds (Thomsen and Kroeger 2015, Raine et al. 2017c). They cannot be completely excluded from the reserve as they are aerial predators and their home ranges can vary considerably in size from 1.5km<sup>2</sup> to 31km<sup>2</sup> depending on habitat and prey availability (Martin et al. 2014). Therefore, barn owl reduction methods will be deployed in and around the site to ensure that seabirds are not predated at the preserve. This predator control will begin in Year 1 and is expected to continue for the 30-year duration of the Program. The barn owl control will enhance adult survivorship and the reproductive success of ‘a‘o, ‘ua‘u and ‘akē‘akē breeding in the affected area (USFWS 2017b).

This is particularly the case for those populations nesting along the Nā Pali Coast such as Honopu Valley (where large numbers of ‘a‘o are known to nest) and along the Pihea side of the Kalalau rim (where large numbers of both ‘a‘o and ‘ua‘u are known to nest (Raine et al. 2016)).

‘Akē‘akē have also been documented vocalizing from cliff bands within the Kalalau Valley and are present in large numbers in the slot canyons of the Nā Pali coast, including nearby Honopu (KESRP, unpublished data). While they are not expected to breed in the social attraction site, they will benefit from barn owl control as, based on evidence from Lehua Island monitoring by KESRP and the propensity of barn owls to be attracted to ‘akē‘akē calls in Kaua‘i, they are likely to be heavily impacted by this predator. An ‘akē‘akē predated by a barn owl was found in nearby Nuaolo Aina in 2014 (A Raine 2017 pers. comm.).

Once an individual or a mating pair of barn owls are removed, new individuals will move into the territory over time. Observers in nearby locations on Kaua‘i have noted a lapse of about 3-12 months between removal of original individuals from a territory and detections of new individuals (G. Reid, 2016, pers. comm.). This underscores the need for ongoing control.

### 11.2.1 Barn Owl Reduction Methods – Trapping

- 6 Bal-chatri prey traps or Swedish Goshawk-style trap will be employed outside the enclosure approximately 4 nights per month or as needed at various points along the Kalalau Rim. These points will be moved as required.
- The owls will be electronically lured into the area using owl or prey calls. Traps may be baited using decoys (a moving toy and playback to mimic the presence of a mouse/rat, or with a live rat/mouse). When the owl pounces on the Bal-chatri trap to get at the decoy, their talons will become entangled in the snares set on top of the trap and the trapped owl dispatched humanely.

- Traps will be set at night and closed each morning to ensure humane treatment of both bait and potential target species, and to ensure that non-target species (such as pueo) can be safely released if caught.
- Trapping will continue for the 30-year duration of the project, and may be modified to utilize technologies that become available over the term of the project.

#### **11.2.2 Barn Owl Reduction Methods – nighttime shooting**

- Aerial control will occur 4 nights per month or as-needed (as determined by auditory surveys and field observations) for the duration of the 30-year Program at locations based on auditory data and visual sightings.
- Timing will be at and just after sunset, and at or just prior to sunrise, subject to change based upon observed activity patterns, moonlight hours, and weather patterns (barn owls head back to dry roosts during heavy rains). Total hunt times should average 5 hours per night but may vary depending on barn owl activity.
- Barn owls will be lured to the area using playback (such as the noise of a squeaking mouse or an 'akē'akē call). Predator control staff will be trained by KESRP staff to distinguish between non-native barn owl and the native pueo. They will also be well-versed in seabird identification. Shooting will only occur when a 100% positive ID has been achieved. If seabirds or pueo are in the immediate environs, no shooting will occur.
- Barn owls will first be spotlighted. One person will operate a spotlight, while the other will operate a shotgun with an effective radius of ~37m. Staff will listen and visually scan the area using single-tube night-vision goggles. When spotted, one person will illuminate the individual with a spotlight while the other person confirms the identification and then dispatches the barn owl.
- Traps and shooting locations will be a minimum distance of 50m from all public facilities (parking lots, trails, roadways, and facilities), operating only during dark hours (sunset to sunrise). All shotgun shells will be retrieved after shooting and non-lead ammo will be used. Areas will be checked for human presence prior to shooting. If members of the public are present, shooting operations will be stopped immediately.
- If a barn owl is detected outside of planned trapping periods, a rapid response contingency plan will be in place, and the individual(s) will be hunted on the same night if possible or as soon as practically possible.

#### **11.3 Feral Cat Removal at Ingress Points to Source Colonies in the Kalalau Valley**

Objective 2.H Protect nesting birds inside mitigation fence and in nearby source colonies by implementing predator control of 1) barn owls within the area surrounding the fenced enclosure and the Kalalau Valley, and 2) feral cats at ingress points to source colonies in the Kalalau Valley, ongoing throughout the 30-year duration of the KSHCP.

Feral cats are using the roads and trails in the vicinity of the Kahuama'a Seabird Preserve as ingress points to prey upon nearby established colonies in the Kalalau Valley and Rim, Pihea (part of the Hono O Nā Pali NARS) and Honopu, expected source populations for the Kahuama'a Seabird Preserve. Feral cats are having a very serious negative effect on fledging success in these areas - KESRP have recorded numerous incidents of cats eating fledglings and a cat kill of an 'a'o was recorded at a parking area near the Honopu colony, which is close to the Kahuama'a Seabird Preserve (A. Raine, 2017, pers. comm.). Data from cameras and predation records at various colonies in Kaua'i show that a cat that is targeting seabirds can predate a series of burrows in a single night, killing multiple adult and juvenile seabirds (A. Raine, 2017, pers. comm.).

The Kahuama'a Seabird Preserve Management Plan therefore includes feral cat removal at ingress points to source colonies in the Kalalau Valley. This will include at least 2km of linear trapping lines off roadways between the Kalalau and Pu'u O Kila lookouts, as well as trapping lines along likely cat trails into neighboring colonies and ad hoc trap placement as appropriate based on camera data.

This predator control effort will reduce the impact of feral cat predation on source colonies for the Kahuama'a Seabird Preserve by removing individual cats that are migrating towards the colonies, and reducing feline breeding in the area. It will also serve as a line of defense, removing cats which might attempt to enter the Kahuama'a Seabird Preserve.

This action will begin in Year 1 and is expected to continue for the 30-year duration of the Program.

#### **11.3.1 Feral Cat Removal Methods**

Feral cats will be targeted as follows:

##### **Live feral cat traps**

- Feral cat traps (30" and 36" Tomahawks or similar) will be deployed at least 10 nights a month. These will be a mixture of baited traps and un-baited trail set traps (double door tomahawks) and will be spaced approximately every 100m along at least 2km of trap lines from Kalalau Lookout to Pu'u O Kila Lookout and along likely cat trails into neighboring colonies. Using camera data as a guide, a further 10 live cat traps may be used in a roving capacity for maximum efficacy.
- Live traps will be locked open in place with added bait between trapping efforts to encourage regular visitation by cats. This technique has been observed to greatly increase capture rates (Reid 2016 pers. comm.). Traps in public locations will be removed or hidden between trapping efforts to avoid vandalism. However, their locations can still be baited with cat lure between trapping efforts to encourage habitual visitation by cats and increase trapping success when they are reopened.

Conibear feral cats traps:

- Conibear traps (with appropriate seabird excluding box) will be deployed approx. 150m apart along trapping lines, with an additional 10 being used in a roving capacity. Harm to seabirds will be prevented by mounting the traps in boxes and setting them approximately 20-25cm off the ground. Boxes will be cut in half so the bait is visually attractive to predators. Conibear trap baits will alternate between food-based, glandular, and olfactory lures. Traps will be checked and rebaited twice a month.

Leg Holds:

- 20 Leg holds may be deployed as "blind" sets, i.e. not baited and set in a manner that requires little behavioral modification on the part of the target animal. Traps will only be set on trails / locations where a feral cat has been observed during the previous week, and when there is imminent danger to seabirds from a feral cat, and when regular manual or continuous wireless monitoring is available. They will be deployed well away from any established tourist areas or trails.

Camera Traps

- Camera traps will be used to monitor trails for predator activity. Camera monitoring provides managers with data on the number and distribution of cats present, allowing them to make informed management decisions on the placement and types of traps to use at particular times. 20 cameras will be set at various locations on the 2km of feral cat removal trails, as well as other ingress points to provide observations on feral cats, including the exact time an animal is seen and the direction it is headed. The data from each trail camera will be collected and photos will be checked approximately every two weeks. All data will be reviewed in the field, and notable photos stored.
- Recent advances allow traps to be equipped with cameras and radio transmitters, advising technicians by text when the traps are triggered and showing the predator caught. This technology saves a great deal of staff time and reduces human presence and scent along trails. If used, the budget for monitoring cameras for feral cats will be partially transferred to this technology.

Additional Protocols

- Other traps may be used as appropriate, particularly if new technology becomes available.
- In public use areas, care will be taken to place all traps out of the way, hidden within vegetation.
- Feral cat carcasses may be necropsied and stomach contents examined for evidence of seabird predation.
- If a feral cat is detected outside of planned trapping periods, the next trapping period will be brought forward to start as soon as practically possible.
- Non-target pest species (e.g. rats) that are caught in the live traps will also be dispatched.
- Technicians will receive firearm training to dispatch trapped animals humanely.

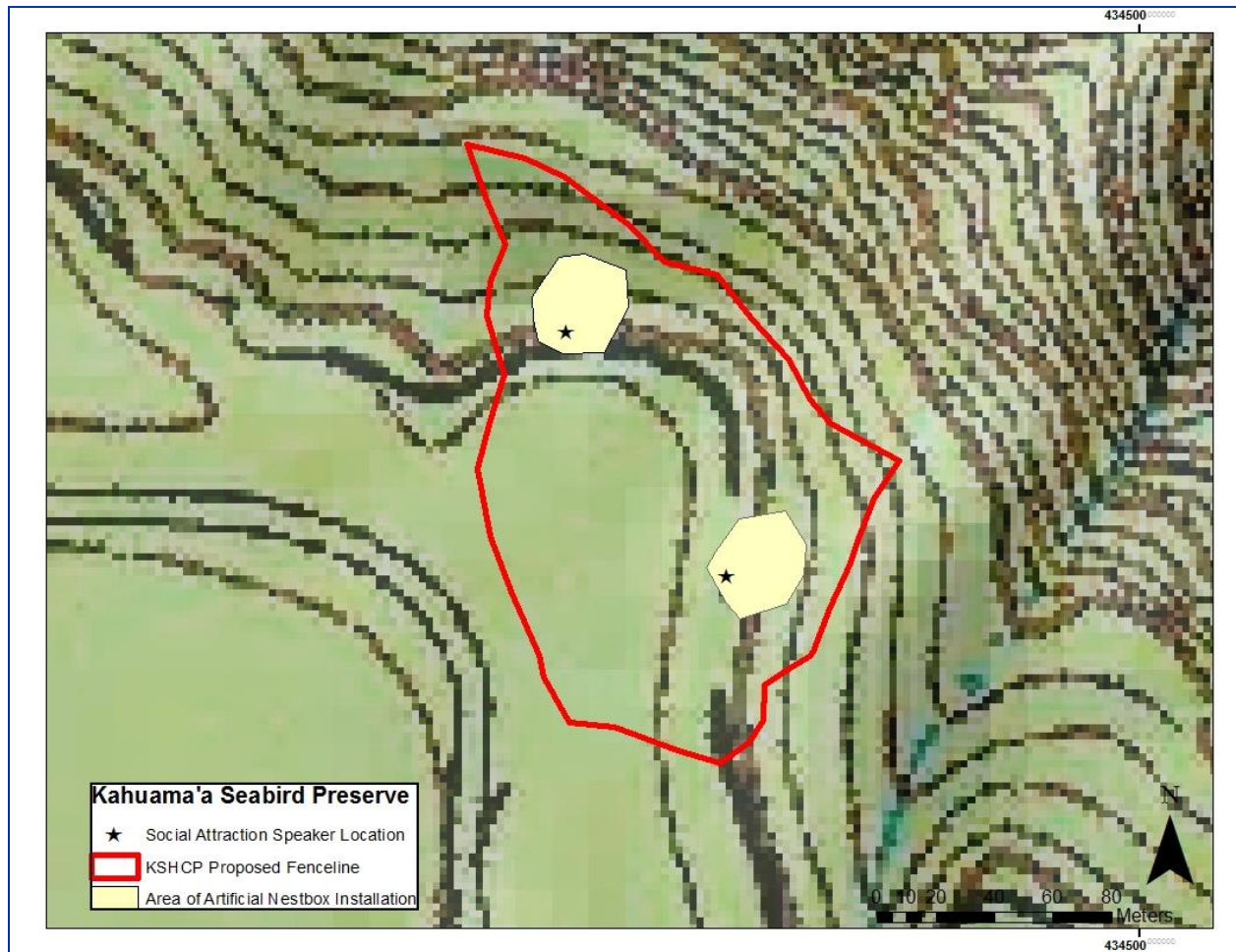
- All predator control activities performed by IE staff will include the necessary training and permitting.

#### 11.4 Creation of Social Attraction Site

2.A. Permanent, predator-proof fence constructed and social attraction equipment (nest boxes, speakers) installed at the mitigation site in Year 1 of KSHCP program implementation.
2.B. Predators removed from within fenced enclosure with monitoring confirmation of their absence, and activation of the social attraction equipment by Year 2; predator eradication within fenced enclosure maintained for the life of the project.
2.C. Ground activity by Covered Seabirds documented at the mitigation site by Year 4 of KSHCP program implementation.
2.D. Breeding activity by Covered Seabirds documented at the mitigation site by Years 5-7 of KSHCP program implementation.

Establishing a seabird breeding colony in a terrestrial predator free fence enclosure through the broadcasting of breeding calls is an effective and proven conservation tool (Gummer 2003, Sawyer and Fogle 2010, McIver et al. 2016). Seabirds, especially prospectors, transiting to and from their natal colonies, are drawn to the apparent activity at the site and, when they choose to breed there, are protected by the predator proof fence, increasing their breeding and fledging success considerably (Young et al. 2012).

An integral part of best management in a social attraction site is the provision of artificial burrows to optimize seabird habitat (Bourgeois et al. 2015) and expedite the process of establishing breeding at a new site - burrow excavation by a newly established breeding pair can take a year or more (Bancroft et al. 2004). Artificial burrows are used in almost all the successful social attraction sites documented in the literature. Not only does this increase the likelihood of earlier success at the social attraction site and increase the density of nesting pairs in an area (Podolsky and Kress 1992), it also makes the monitoring of nests much easier and less likely to cause disturbance to burrows and birds. Since monitoring of nests and nesting success is an important part of mitigation for the KSHCP, artificial burrows are key in this project. Since the vegetation understory at the site is already damaged and disturbed in the areas where burrows will be installed, the installation of artificial burrows will not affect a pristine habitat, based on observations by botanists at the site, who noted high levels of invasive species in the understory and little ground cover. It should be noted that other areas at the site provide excellent habitat for natural burrows). Artificial burrows will be located in two main areas (Figure 11.2).



**Figure 11.2. Map of Speaker System and Artificial Burrow Locations**

#### **11.4.1 Social Attraction – Call Broadcast Methods**

The social attraction element of the Kahuama'a Seabird Preserve will be implemented as follows:

- Two speaker systems will be installed and maintained (the location is shown in Figure 11.2), consisting of 2 or 4 (as required) weatherproof, omni-directional outdoor speakers, mounted on the fence and / or poles inside the fence line and powered by 12v sealed solar powered batteries (see an example from New Zealand, Figure 11.3).
- Digital recordings will be obtained of 'a'o colonies taken within 2km of the site. Recordings will be of multiple birds (simulating a large colony) and using a complete set of typical colony sounds to attract the most birds (Podolsky et al. 1998).
- The speakers will turn on at sunset and continue to play species-specific calls until sunrise, drawing prospecting birds to the site to establish nesting within the predator-free area. Broadcasting will be timed to begin with the first arrival and courtship dates

(01 Apr) until the 15<sup>th</sup> Sep (by which time the majority of non-breeders have left the colonies (A. Raine, 2017, pers. comm.).

- Because the Covered Seabirds are nocturnal, decoys are not anticipated to be needed (Jones and Kress 2012); However, if additional conservation actions are needed to enhance productivity at the site (e.g. if there is no ground activity by year 3), custom fabricated decoys will be placed on the ground as was done at the Makamaka'ole Seabird Preserve social attraction site on West Maui (Wind 2014, USFWS 2016).



**Figure 11.3. Social attraction speaker system and nest boxes at Hutton's shearwater colony, Kaikoura, New Zealand. A. Raine**

#### **11.4.2 Social Attraction – Artificial Burrow Installation Methods**

- The area for artificial burrows inside the Kahuama'a Seabird Preserve will be thoroughly searched for natural burrows (active or inactive) to prevent damage or destruction during artificial burrow installation (no surveys for burrows have been carried out to date).
- IE staff will be trained on burrow installation and operation.
- 100 artificial nest boxes will be purchased and installed. A proposed design is shown in Figure 11.4 but other alternatives will also be reviewed before purchase. Artificial burrows will likely consist of a box with a locking lid for convenient inspection and segments of drain pipe as the entry point.
- Two optimal locations (Figure 11.2) have been selected within the site based:
  - Slope - Shearwaters use wind and updrafts in addition to vigorous flapping to provide lift during takeoff (Elkins 1983, Yoda et al. 2017). A moderate to steeply sloped site greater than or equal to 29° facing into the prevailing winds (A. Raine, 2016, pers. comm.) is preferred to facilitate flight and landing. A sloping site far enough away from the lower fenceline (>50m) also helps prevent the risk of collisions with the fence during landing and take-off.
  - Low vegetation, such as grasses, which will facilitate installation of nest boxes.
- Invasive vegetation will be removed (see [Section 11.3](#) Vegetation Restoration and Monitoring).

- Each artificially installed burrow will be assigned a nest ID, be clearly marked, labeled and mapped using GPS.
- Wherever possible, artificial burrows should be shaded by vegetation (Carlile et al. 2012).



**Figure 11.4. Possible design (by David Wingate) of artificial seabird burrow to be used**



**Figure 11.5. Vegetation and slope in the “bowl” section of the site, where part of the artificial burrows will be installed.**

#### **11.4.3 Social Attraction Site – Confirm Installation Complete**

The target for the installation of social attraction equipment (playback speakers and nest boxes) is end of Year One to fulfil KSHCP requirements. IE staff will confirm that this target has been met with a final inspection and a report including photographs (presented in the annual report).

If it becomes clear during the course of construction that this target will be missed, IE staff will consult regulatory agencies and initiate adaptive management outlined in the KSHCP if required.

#### **11.4.4 Social Attraction Site – Maintenance**

Before the beginning of each breeding season, the social attraction site will be maintained as follows:

- Visually inspection of each burrow in Jan or Feb. Repair damaged burrows (old nesting material should be left in situ as a scent marker), ensure access.
- Test loudspeakers. After Year 4, test song meter / loud speaker alternation system.

#### **11.5 Vegetation Management**

OBJECTIVE 2G: Maintain high quality seabird habitat at the mitigation site by removal of habitat modifying invasive plants in Year 1 and annually throughout the 30-year duration of the KSHCP.

##### **11.5.1 Background**

The Kahuama'a Seabird Preserve predator proof fence is expected to benefit native vegetation and rare plants as they are currently being adversely affected by rats, pigs, goats and deer. The habitat at the site is dominated by native vegetation, but certain invasive plants are proliferating, especially within the understory. There is very little forest regeneration due to ungulate trampling and grazing, which is also encouraging swathes of thick, non-native invasive plants and grasses. Rat damage, consisting of chewing of stems, leaves, and fruit/seed predation has been observed at the site. Exclusion of these feral animals will have an immediate beneficial effect, especially when combined with the removal non-native invasive plants, some of which out-compete native plants in the understory and modify microhabitat suitable for seabirds.

Seabird habitat suitability mapping exercises consistently identify native vegetation as a critical component for successful nesting (Troy et al. 2014). Conversely, habitat modification by invasive plant species has been correlated with a reduction in seabird breeding. When compared to active breeding colonies, inactive breeding colonies were found to contain a higher proportion of non-native, invasive vegetation cover (Holmes and Troy 2008, Holmes et al. 2009). A suite of invasive plant species that have been identified as significant seabird habitat modifiers (Table 11.1) are present at the Kahuama'a Seabird Preserve.

**Table 11.1. Seabird Habitat Modifiers**

Common Name	Scientific Name	Priority
Strawberry Guava	<i>Psidium cattleianum</i>	1
Himalayan (Kahili) Ginger	<i>Hedychium gardnerianum</i>	1
Australian Tree Fern	<i>Sphaeropteris cooperi</i>	1
Blackberry	<i>Rubus argutus</i>	2
Banana Poka	<i>Passiflora tarminiana</i>	2
Bush Beard Grass	<i>Schizachyrium condensatum</i> , <i>Andropogon spp.</i>	2
Koster's curse	<i>Clidemia hirta</i>	2
Daisy Fleabane	<i>Erigeron karvinskianus</i>	3
Air Plant	<i>Kalanchoe pinnata</i>	3

This list may be expanded during the project if new and important invasive seabird habitat modifiers are discovered in the area.

Vegetation work on site will focus on three key areas:

- Eradication or effective suppression of seabird habitat modifiers, focusing particularly on priority 1 & 2 species.
- Vegetation management during construction and operation of the fence (along fenceline and around artificial burrows and speaker system)
- Monitoring of vegetation to ensure that habitat quality targets are being met across the site.

It is important to note that the primary purpose of the Kahuama'a Seabird Preserve is to fulfil the obligations of the KSHCP by providing mitigation for take of the Covered Seabirds. The key requirement towards this process is the removal of seabird habitat modifiers and monitoring to ensure that the habitat remains suitable for seabird breeding.

To ensure that listed plants are not harmed during management on site, detailed BMPs have been prepared (see [section 17](#)).

Outplanting of rare species within the preserve is not in the remit of this management plan. Nonetheless, the Preserve presents an opportunity for other entities to outplant rare species on the flatter areas that will be protected within the predator proof fence and the regulatory authorities (USFWS and DLNR) have expressed strong support for this. In addition, this will be the first predator proof fence constructed on Kaua'i in an area that is primarily native habitat. This provides an opportunity to study forest and ecosystem response to removal of rats and ungulates, and to the influx of seabird derived marine nutrients. The IE will seek partnerships with universities and other interested research organizations who may desire to capitalize such opportunities.

### 11.5.2 Eradication / suppression of seabird habitat modifiers

Vegetation work at the Kahuama'a Seabird Preserve will focus primarily on removing invasive plants that negatively affect the ability of seabirds to nest (see [Table 11.1](#) - Seabird Habitat Modifiers). Non-native vegetation can impede breeding activities such as take-off and landing, prospecting, courtship and burrow excavation. For example, fast growing Strawberry Guava (*Psidium cattleianum*) thickets reduce the burrowing habitat available (Penniman 2010, VanZandt et al. 2014) and their fruit have a synergistic interaction with non-native mammals (Nogueira-Filho et al. 2009). Plants such as Himalayan (Kahili) Ginger (*Hedychium gardnerianum*) and Blackberry (*Rubus argutus*) can also form a dense thicket of roots and stands that prevents burrow excavation; Australian Tree Fern (*Sphaeropteris cooperi*) outcompetes native plants that shade burrows and provide shelter from predators, and can rapidly take over entire hillsides; and Banana Poka (*Passiflora tarminiana*), Bush Beard Grass (*Schizachyrium condensatum*, *Andropogon spp.*<sup>3</sup>), Koster's Curse (*Clidemia hirta*), Daisy Fleabane (*Erigeron karvinskianus*) and Air Plant (*Kalanchoe pinnata*) form mats that might impede take-off and landing or have spikes which deter birds from the area.

Conversely, native vegetation is likely to offer suitable appropriate vegetative structure to facilitate breeding (Asner G.P et al. 2008, Duffy 2010), while the structural root components of native trees provide burrow stability (Gilham 1961, Ainley et al. 1997, Underwood and Bunce 2004). Native trees also provide a launch pad for take-off (Ainley et al. 1997, Sullivan and Wilson 2001).

For the 30-year duration of the Program, IE staff will remove habitat modifying plants ([Table 11.1](#)) from within the fence enclosure, with the goal of removal of habitat modifying invasive plants in Year 1 and annually throughout the 30-year duration of the KSHCP (ingress of these species will be ongoing due to the seedbank / seeds blowing in from outside the fence).

#### 11.5.2.1 Methods

- The presence, location and abundance of the above seabird habitat modifiers will be mapped prior to removal using GPS and GIS. The priority one species (Strawberry Guava, Himalayan (Kahili) Ginger and Australian Tree Fern) are the most important to remove as they are likely to be the most damaging for seabirds.
- An initial removal effort will occur in a one-time targeted event during fence construction, carried out by a suitably qualified contractor. All three priority species will be targeted in this first pass, but subsequent maintenance will focus on priority 1 & 2 species first.

<sup>3</sup> There is some taxonomic confusion about these species in Hawai'i; they are frequently misidentified and can co-occur. Ecologically they are, however, similar with regard to their invasion biology. (A Williams, 2017, pers. comm.)

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- For all plants, both for removal method as well as maintenance (except for blackberry), hand pulling for small/young individuals will often be the first method, with chemical used on larger plants that can't be hand pulled. As the project goes on, the use of chemicals will decline, with hand pulling increasing, as long as regular maintenance is occurring and new weeds are being found when still in seedling stage. [Table 11.2](#) gives more detail on different methods for each modifier.
- During the initial removal of seabird habitat modifiers, groundcovers and low grasses will be left to reduce erosion.
- If appropriate, biodegradable erosion control cloths and / or weed control cloths will be laid down during the phase where large areas of non-natives are removed. The Kōke'e Resource Conservation Program has found this to be more cost effective than weeding afterwards (K. Cassel, 2017, pers. comm.)
- The entire site will be monitored annually for seabird habitat modifiers in [Table 11.1](#). See [Section 11.3](#).
- Additional removal and ongoing control of seabird habitat modifiers will then occur annually, outside the breeding season according to [Table 11.2](#), with additional spot treatments carried out based on ad hoc sightings of concern. Technicians will also look for new species of concern. If found, a suitable eradication plan will be drawn up and carried out.

**Table 11.2. Seabird Habitat Modifiers, Removal Methods, Maintenance and Harm Avoidance**

Seabird habitat modifier	Scientific Name	Removal Method	Maintenance	Harm Minimization
Strawberry Guava	<i>Psidium cattleianum</i>	Trees "frilled" (notched girdling technique). Fill cuts with Garlon application using lab squirt applicator bottle / brush or use tool to pry strawberry guava < 2.5cm in diameter out of ground.	Drizzle spray Garlon on reemerging plants (TNC, 2015) (Trees currently not in large groves)	1) Careful application with squirt bottle or brush in dry weather only 2) no herbicide use with 10m of rare / listed plants or burrows 3) To be carried out by trained staff not volunteers 4) staff to be aware that <i>Myrsine knudsenii</i> might be mistaken for Strawberry Guava 5) No trees above 4.6m will be cut during bat pupping season June 1 – Sept 15.
Himalayan (Kahili) Ginger	<i>Hedychium gardnerianum</i>	Manually cut and spot-treat with Escort using a cut stump technique with a lab squirt applicator bottle	Pull out small shoots. Cut larger shoots and treat with Escort using lab squirt bottle (ginger mainly at edges of site and not currently in large clumps)	1) Careful application with squirt bottle or brush in dry weather only 2) no herbicide use with 10m of rare / listed plants or burrows 4) to be carried out by trained staff not volunteers
Australian Tree Fern	<i>Sphaeropteris cooperi</i>	Manually remove by chopping with a machete and crushing the apical meristem	Should not resprout but follow up removal will be required due to presence of spores and new individuals	
Banana Poka	<i>Passiflora tarminiana</i>	Manually remove by pulling up with roots	Entire vine will die from uprooting but seeds are long-lived so ongoing uprooting required.	

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Blackberry	<i>Rubus argutus</i>	Manually cut and treated with Garlon cut stump treatment. Foliar applications Garlon or Imazpyr	Follow up will be required as blackberry will come back if not maintained. Manually cut and treat with cut stump treatment. Foliar applications Garlon or Imazpyr	1) Careful application with squirt bottle or brush in dry weather only 2) no herbicide use with 10m of rare / listed plants or burrows 4) when plant is killed, dead stalks will be left in situ to inhibit growth of other invasive species and reduce removal effort 5) erosion / weed control cloths may be required. 4) to be carried out by trained staff not volunteers
Bush Beard Grass	<i>Schizachyrium condensatum</i> , <i>Andropogon</i> spp.	Spray application of Roundup Pro	Spray application of Roundup Pro	1) Careful application in dry weather only 2) large areas could be removed a little at a time and / or erosion / weed control cloths may be required 4) no herbicide use with 10m of rare / listed plants or burrows 5) to be carried out by trained staff and not volunteers
Koster's Curse	<i>Clidemia hirta</i>	Manually cut and treat with Garlon cut stump treatment. Attempt not to spread seeds during cutting	Manually cut and treated with Garlon cut stump treatment. 100% of seedling need to be killed to eradicate population so maintenance will be indefinite (DeWalt 2006)	1) Careful application with squirt bottle or brush in dry weather only 2) every effort to control spread of seeds such as seed collection during cutting, black bagging immediately rather than carrying in open off site 3) erosion / weed control cloths may be required 4) no herbicide use with 10m of rare / listed plants or burrows. 5) to be carried out by trained staff and not volunteers
Daisy Fleabane	<i>Erigeron karvinskianus</i>	Manual Removal. Foliar applications Garlon	Manual Removal. Foliar applications Garlon	1) Careful application with squirt bottle or brush in dry weather only 2) every effort to control spread of seeds such as seed collection during cutting, black bagging immediately rather than carrying in open off site 3) erosion / weed control cloths may be required 4) no herbicide use with 10m of rare / listed plants or burrows. 5) to be carried out by trained staff and not volunteers
Air Plant	<i>Kalanchoe Pinnata</i>	Foliar application of Roundup. Manual removal and bagging	Foliar application of Roundup. Manual removal and bagging	1) every effort to control spread of seeds such as seed collection during cutting, black bagging immediately rather than carrying in open off site Leaves will need to be bagged too, each leaf can produce several individuals 2) erosion / weed control cloths may be required

### 11.5.3 Vegetation Management during Construction and Operation of the Fence

There are three main actions in this project that will require the removal and / or ongoing control of vegetation:

- Fence construction
- Maintenance of a 4m zone outside the fence that is free of woody vegetation (this is within, but not the same as, the predator defense zone).
- Installation of artificial burrows and speaker system

#### 11.5.3.1 Methods

- Following fence construction, restoration within the fence terrestrial predator defense zone will be carried out by means of replanting appropriate native grass and / or Aalii (*Dodonea viscoa*) to prevent the regrowth of seabird habitat modifiers. Alternatively, DOFAW has been looking into a ‘low growing and low maintenance slurry’ (W. Kishida, 2017, pers. comm.) made up of native ferns and grasses for use along road ways where a high incidence of nēnē ‘take’ happens. The slurry is still in development, but might be an option along the fence by construction. All planting will be vulnerable to grazing and trampling by pigs, goats or deer (A Williams, 2017, pers. comm.) but these options offer the best possibility of establishing some cover.
- No woody vegetation higher than 0.5m will be allowed to grow within the 4m zone along the fence line, to prevent reinvasion by predators. The height of vegetation will be kept low by means of trimming, scything, mowing or any other appropriate methods. Loose logs and vegetation will be moved off the mesh skirt area to prevent rodents using logs etc. as a solid edge to dig against (Day and MacGibbon 2007).
- Control of seabird habitat modifiers will be important in the cleared area outside the fence to ensure that this area does not become an ingress point for invasive plants. This will be carried out using the methods outlined in [Table 11.2](#). Staff will conduct a monthly walk through of the zone (in conjunction with efforts to keep vegetation below 0.5m above) and conduct simplified veg plots (5 plots of 3x3m where the % of seabird habitat modifiers only is assessed) to confirm that the percentage of modifiers is not increasing.
- In the case of the artificial burrows, after installation it is expected that native vegetation will regenerate naturally. If this does not occur, or if seabird habitat modifiers invade the area, weeding (see [Table 11.2](#)) and / or outplanting will be considered. Vegetation will be managed to shade burrows to prevent heat stress to the seabirds. This may include some planting.

#### **11.5.4 Targets for Removal of Habitat Modifiers**

Objective 2G (Maintain high quality seabird habitat at the mitigation site by removal of habitat modifying invasive plants in Year 1 and annually throughout the 30-year duration of the KSHCP.) requires targets in order to measure success. These are shown in Tables 11.3 and 11.4.

**Table 11.3: Targets for Removal of Seabird Habitat Modifiers**

Action	Target Year 1	Target Year 5	Target Year 10	Target Year 15	Target Year 20	Target Year 30
% of Tier 1 & 2 seabird habitat modifiers removed across site (vs baseline)	≤50% cover	≤20% removed	≤5% cover of these species	≤5% cover of these species	≤5% cover of these species	≤5% cover of these species
% of Tier 1 & 2 invasive plants per veg plot	Target to be set once baseline established	Target to be set once baseline established	Target to be set once baseline established	Target to be set once baseline established	Target to be set once baseline established	Target to be set once baseline established

Note – Tier 3 Habitat Modifiers will be removed time permitting or if they are found to be affecting the burrowing ability of seabirds.

### 11.3.1 Consideration of PEPP and Endangered Plants

There are several PEPP and Endangered Plants at the site as shown in [Table 7.1](#). However, extensive discussion and site visits with USFWS and DOFAW botanists has confirmed that the only plant that might be considered at risk from construction and operation is *E. remyi* var. *remyi*. [Section 17](#), Best Management Practices, describes how damage will be completely avoided for this plant in particular as well as other PEPP and Endangered Plant species.

## 12. MONITOR EFFECTIVENESS OF KAHUAMA'A SEABIRD PRESERVE & FERAL CAT / BARN OWL CONTROL AS MITIGATION FOR TAKE OF 'A'O

Effectiveness monitoring at the Kahuama'a Seabird Preserve will be carried out by the IE. Monitoring is intended to ensure that the objectives of the Kahuama'a Seabird Preserve and thus the KSHCP are met. Effectiveness monitoring will cover three main areas:

- Monitoring that predators have been removed and do not reinvade the site
- Monitoring barn owl Control
- Monitoring that Seabird Habitat Modifiers have been removed / suppressed
- Monitoring the Response of Covered Seabirds to management actions (Predator Removal, Vegetation Management and Social Attraction Components).

To assist with monitoring to ensure that objectives 2, C, D, E and F have been met, these are further defined in Table 12.1.

**Table 12.1: Definitions of KSHCP Objectives.**

	Objective	Definition
2C	2.C. Ground activity by Covered Seabirds documented at the mitigation site by Year 4 of KSHCP program implementation.	Ground activity is defined as presence of one or more 'a'o individuals on the ground within the project enclosure as documented by an observer or a Reconyx camera trap. "Presence" includes guano, feathers, ground calling bird heard by observer / captured on camera and confirmed as being within the fence, as well as physical sightings.
2D	2.D. Breeding activity by Covered Seabirds documented at the mitigation site by Years 5-7 of KSHCP program implementation.	<ul style="list-style-type: none"> <li>• Egg, chick, or incubating adult noted within the site</li> <li>• Breeding attempts in natural or artificial burrows are observed (such as copulation, digging a burrow, entering the burrow with nesting material, sitting in the burrow).</li> <li>• Signs of digging/trampling, feathers, guano, or an egg shell</li> <li>• Evidence of predation or nest failure</li> </ul>
2E	2.E. Cumulative upward trend in Covered Seabird breeding documented at the mitigation site by Year 10-12 of KSHCP program implementation.	Increased number of active burrows (artificial or natural) compared to years 5-7
2F	2.F. Continued cumulative upward trend in Covered Seabird breeding documented at the mitigation site by Year 20 of KSHCP program implementation.	Increased number of active burrows (artificial or natural) compared to years 10-12

## 12.1 Monitoring of Predator Removal

### 12.1.1 Monitoring of Rodent Removal

Rodent removal will be monitored as follows:

- **Camera Traps:** predators will be monitored using 10 remote camera traps (Reconyx or similar) placed strategically at known ingress routes, along trails, along interior fencelines and at other appropriate locations. Camera will be checked monthly during initial eradication (more frequent checks make camera failure more likely). After rat eradication is completed in year one, cameras will be moved to focus on seabird ground

and burrow activity, but will still be able to pick up any predator activity. They will be checked monthly at this point.

- **Ink-card tracking tunnels:** 25 tracking tunnels will be set out on a 50m transect (Gillies 2013). They will be placed on flat ground with the ends unobstructed, baited with a peanut butter lure (see snap traps) and monitored for three nights. This will be repeated bi-monthly until technicians feel confident that rodent eradication has been achieved (no rodent sign for one month). Thereafter, they will be deployed once a month for one night during breeding season (Apr to Dec). If reinvasion is suspected, the tunnels can be redeployed at any time.
- If, after the initial rodent eradication, **rat signs are noted again** on the ink card tracking tunnels, snap traps and stationary bait boxes (if necessary) will re-deployed, until all signs of rodents inside the fence cease. If rodenticide is considered necessary, it will be used for the minimum time possible.
- **Formal routine fence checks** will be carried out to discover potential biosecurity breaches monthly but technicians will also check fence while rebaiting traps outside the fence and in the course of other duties. In the case of a reinvasion, a more thorough fence check will be carried out to determine the ingress point of the predators and necessary maintenance action taken to prevent further breaches. Detailed records will be kept of breaches and reinvasion records. Technicians will also look for collision events (feathers, carcass).
- Goodnature traps have a counter (purchased as an add-on) which indicates the number of 'firings'. They will be checked weekly during initial eradication to ensure they are working and monthly thereafter with results noted on iPad. However, it should be noted that traps can fire on their own (e.g. through tree fall, wind etc..) so do not necessarily indicate the presence of predators. Where firings are noted, additional ink card tracking tunnels will be deployed and rat eradication action taken inside the fence. Similar brands can be used.
- Snap traps in a bird excluding housing will be checked daily during initial eradication to ensure they are working and remove any carcasses with results noted on iPad. They will remain in situ even when zero signs of rodents has been recorded for four weeks in case of reinvasion.
- Technicians will record and remove any carcasses from Goodnature (or similar) and snap traps daily during the initial eradication and weekly thereafter with results noted on iPad.
- Technicians will record number and species of predators present, location of predators and possible ingress pathways utilized, number of predators killed and caught by a monitored trap, fence integrity. Results noted on iPad.
- Monitoring frequency is summarized in Table 12.2.

**Table 12.2: Summary of Predator Monitoring Frequency**

Biological Objectives	Monitoring Frequency During Normal Operation
2.B. Remove predators from within the fenced enclosure with monitoring confirmation of their absence, and activation of the social attraction equipment by Year 2; predator eradication within fenced enclosure maintained for the life of the project.	<ul style="list-style-type: none"> <li>- Camera traps checked monthly.</li> <li>- Monthly Goodnature check</li> <li>- Monthly ink-card tracking</li> <li>- Twice weekly snap trap checks 50m predator defense zone</li> </ul>

### **12.1.2 Cat Removal Monitoring at fenceline**

#### **Camera Traps**

- Monitoring of cats will be ongoing using 4 camera traps along the fenceline, located on the outside of the fenceline, (in addition to the 20 burrow monitoring cameras around the project site. They can be moved as appropriate depending on trapping results, visual sightings and predation events. They will be checked monthly.

### **12.1.3 Barn Owl Control Monitoring**

The objective of barn owl Control is to protect birds nesting inside the fence as well as in nearby source colonies. Complete eradication is not possible due to the propensity of new owls to fill an empty territory, however suppression of the population will have a beneficial effect. This objective will be monitored as follows:

- The technician will provide an annual report detailing how many barn owls were seen versus how many were shot during barn owl control operations (detailed in section 11.2). In addition, the technician will keep note of all ad hoc sightings of barn owls and Barn owl calls during the course of other duties.
- Predation events (presence of carcasses, camera sightings or visual sightings) by barn owls inside or adjacent to the fence will be documented (barn owls may carry carcasses outside the fence). If a predation occurs, additional barn owl control will be undertaken (more shooting and trapping nights) and new techniques will be investigated

### **12.1.3 Feral Cat Control Monitoring**

The objective of feral cat control is to protect birds nesting at nearby source colonies in the Kalalau Valley and to present the risk of reinvasion of cats into the predator proof fence. Complete eradication is not possible due to the propensity of new cats to enter the territory, however suppression of the population will have a beneficial effect. This objective will be monitored as follows:

- The technician will provide an annual report detailing how many feral cats were removed during control operations and where this occurred. In addition, the technician will keep note of all ad hoc sightings of cats (visually or on camera) during the course of other duties and will use both sets of information future feral cat removal work.
- Predation events by feral cats in the vicinity of the fence will be documented by project staff. In addition, managers of source colonies of the Kalalau Valley / Pihea / Honopu / Hono O Nā Pali) will be asked to supply data on predations in their area. If a predation occurs, additional feral cat control will be undertaken (more shooting and trapping nights) and new techniques will be investigated.
- Technicians will keep up to date on latest feral cat removal technology and employ new techniques as appropriate to increase efficiency.

#### **12.1.4 Seabird Carcass Discovery**

- Once seabird breeding is established, any bird carcasses found will be assessed for cause of death. Depending on the predator, the following action will be taken:
  - All: Camera traps will be checked to look for predators
  - Rodent: interior snap traps redeployed. Interior bait stations will be rebaited with diphacinone until all signs of predators (further deaths, ink-card tracking tunnels, camera sightings) end.
  - Feral cat: 8 live feral cat traps will be opened inside the fence. Firearm-certified technician will attempt to humanely remove feral cat with firearm. Fence will be checked for breaches.
  - Barn owl: additional shooting nights will be arranged as soon as practically possible after the discovery. New techniques will be investigated for barn owl removal.
  - Pig: firearm-certified technician will remove the pig

### **12.2 Monitoring of Vegetation Management**

To ensure that the quality of native habitat remains optimal for seabirds (i.e. that basic structure of native vegetation is stable or improving and that the ingress of seabird habitat modifiers is not occurring), a vegetation monitoring project will be initiated.

#### **12.2.1 Methods**

- IE staff will be trained in plant identification
- A baseline plant inventory will be carried out by a suitably qualified consultant (with the assistance of IE staff for training purposes) within the fence line and 50m zone outside the fence to determine a plant inventory as a baseline (including status and abundance of each species) and species composition. The survey will also map the location of listed or rare plants to ensure their protection. This will take place before construction commences and will also cover the fenceline itself.
- Federally listed, endangered and threatened plants will be noted, flagged and mapped. This will be carried out by an appropriate consultant.

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- To monitor vegetation composition and change over time, a plant survey will be conducted every five years to document improvements in desired habitat conditions to maximize seabird production. This will be achieved by “broad brush” monitoring of five randomly selected vegetation plots (50m x 50m) inside the fenced enclosure (if a plot is selected in an area with a PEP or listed plant, or an area which is unsuitable for surveying due to steepness or safety concerns, another plot will be generated). Compass bearings will be used to ensure that the lines are straight.
- The following data will be collected: Coordinates, dominant aspect, estimated slope, habitat classification (V1: Highest Quality Native Ecosystems; V2: Predominantly Native; V3: Considerably Disturbed; V4: Badly Degraded), Average Canopy Height Class. For the canopy and Understory, % Cover, % Native Species Cover, Max Height of Cover will be recorded. Bare ground will be recorded by %.
- Within each 50m plot, two smaller random 2m<sup>2</sup> plots will be used to measure other vegetation (using a square of PVC pipes to form the size of the plot) in which the following will be monitored:
  - native woody vegetation cover, tree density, and species richness
  - seedling number, %, age class, stem diameter and cover
  - presence, %, cover and composition of seabird habitat modifiers
  - presence, % cover and composition of any other non-native species
- DOFAW and PEPP already monitor listed and rare species on the site. This will remain in their remit. (It should be noted that some of the rare and listed plants on site are already in decline due to factors outside the control of the project such as insects, wood boring beetles etc.)
- Targets in Table 12.3 will be set at the beginning of the project, once a baseline has been established.

**Table 12.3: Targets for Vegetation Monitoring**

Action	Target Year 1	Target Year 5	Target Year 10	Target Year 15	Target Year 20	Target Year 30
% and composition of native plants per veg plot	Target to be set once baseline established	Target to be set once baseline established	Target to be set once baseline established	Target to be set once baseline established	Target to be set once baseline established	Target to be set once baseline established
% and composition of seabird habitat modifiers per veg plot	Target to be set once baseline established	Target to be set once baseline established	Target to be set once baseline established	Target to be set once baseline established	Target to be set once baseline established	Target to be set once baseline established
Listed plants - damage from project	0	0	0	0	0	0

### **12.3 Monitoring of Seabird Response to Management**

Monitoring seabird response is a critical part of the social attraction site, not only to ensure that biological goals are met in terms of attracting the Covered Seabirds to breed and providing the right conditions to ensure breeding success, but also to fulfill the requirements of the KSHCP to provide mitigation for the take of these seabirds by KSHCP participants who are financing the project.

Effectiveness Monitoring will be carried out through the following means (listed in order of importance):

- Burrow Monitoring
- Camera monitoring
- Chick banding
- Auditory surveys with night vision
- Acoustic bird call monitoring (song meters)

The KSHCP supports the use of the best available, most cost-effective scientific tools and techniques for monitoring. Methods used may change based on new technological developments, site conditions and effectiveness in the field. For example, automated bird detection and monitoring technologies may be used to increase monitoring efficiency and accuracy. Any proposed changes will be discussed with the regulatory agencies in advance and with the KSHCP participants (and other stakeholders, if appropriate).

#### **12.3.1 Burrow searching and monitoring**

Burrow searching and monitoring of natural and artificial burrows is a critical part of seabird response monitoring. Technicians will search for burrows using established techniques outlined below. Once burrows are found, burrow checks will be undertaken to assess the status of any breeding attempts (e.g. is there an egg, chick or adult present). This data will be compared to data from the cameras to collect information which can be used to extrapolate results to unmonitored burrows on site.

Burrow monitoring fulfills, in part, Objective 2D – Breeding activity by Covered Seabirds documented at the mitigation site by Years 5-7 of KSHCP program implementation and Objective 2E & F – Cumulative upward trend in Covered Seabird breeding documented at the mitigation site by year 10-12 and 20.

##### **12.3.1.1 Methods for locating and monitoring natural burrows**

- Auditory surveys with night vision will occur twice a night for 4 nights per month (Jun – Aug) split over two observers (i.e. 2 nights a month each) to help guide burrow searching by indicating ground-calling hotspots.

- This will be supplemented with diurnal “cold searching” where staff actively search vegetation for burrow cavities with signs of seabirds (e.g., scent, feathers, guano, etc.). Burrow searching will happen a minimum of once a month for one day from Jun-Sep. (before incubation, burrow searching is too difficult due to a lack of clear signs of use, and requires unnecessary disturbance to vegetation). More searching could result in damage to vegetation.
- Active breeding can be distinguished from ground activity (Objective 2.C) if breeding attempts in natural or artificial burrows are observed (such as copulation, digging a burrow, entering the burrow with nesting material, sitting in the burrow), or an egg is laid.
- Natural burrows will have “stick fences” placed at their entrances after each inspection (these are toothpicks or short sticks placed in a ‘fence’ configuration i.e. in a row). Any activity by birds will knock down the sticks, alerting technicians to the possibility that the burrow is in use and triggering further monitoring through Reconyx camera traps and / or inserting push button cameras (such as Olympus Stylus Tough TG4) into burrow to capture image of end of burrow and / or use of endoscope.
- During burrow searching, any predator presence will also be assessed (such as scat, owl pellets or carcasses).
- Any burrows found will be marked with an identification tag and burrow locations will be recorded with a handheld global position system (GPS).
- Once burrow sites are located, they will be monitored, along with artificial burrows, once a month to determine occupancy, status changes over the course of the breeding season (abandonment, death of chick etc.), signs of predation and timing of breeding attempt.

#### **12.3.1.2 Methods for monitoring artificial burrows.**

- Each artificial burrow will be checked to make sure it is in working order and repaired if necessary before the breeding season commences and the entrance and tunnel will be cleared of obstructing vegetation.
- Each artificial burrow will be checked a minimum of once a month during the breeding season between April and October to monitor for signs of seabird activity around the entrance and inside the burrow chamber. Temperature and humidity will be monitored.
- Variables measured include number of active burrows, species present, signs of predator presence, evidence of predation, and nest success.
- A subset of 20 artificial burrows will be equipped with Reconyx camera traps to document visits by prospectors and / or breeders.
- Burrows occupied by breeding pairs will be monitored by Reconyx camera traps and checked monthly by IE staff through the breeding season to estimate breeding success (egg laying, chick rearing and fledging) and any predator incursions.

### 12.3.1.3 Methods applicable to both artificial and natural burrows

- Document internal burrow contents with visual observations or a handheld digital camera,
- Burrows will be identified to species (if possible) and classified as follows:
  - Inactive
  - Prospecting birds (birds observed to be visiting a nest with no further evidence of breeding. Examples include fresh excavations in a previously inactive burrow, a single visit to a previously inactive burrow, bird(s) found in a burrow where both adults were confirmed killed in the previous year, or a seabird present at a preliminary burrow excavation)
- Burrows are assessed for breeding activity by monitoring for signs of activity in and around the burrow, including:
  - Presence of an egg, chick, or adult in or near the burrow
  - Signs of digging/trampling, feathers, guano, or an egg shell
  - Evidence of predation or nest failure
  - Scent
  - Ability to see back of burrow
- Nesting outcomes for active nests are recorded as “success”, “failure”, or “outcome unknown” as follows:
  - Success is indicated by a successfully fledged chick. In the absence of a Reconyx burrow-monitoring camera, this is determined by a chick confirmed in the burrow until the typical fledging time (late September to early December, peaking in October), down outside the burrow entrance indicating that the chick was exercising, and no signs of predation or predator presence.
  - An active nest is recorded as a failure if it did not fledge a chick. Evidence of failure is recorded when observed.
  - “Outcome unknown” is assigned to an active nest where breeding was confirmed but no follow-up visits were made, final visit was too early in the season, or signs were inconclusive. Very few, if any, burrows should fall into this category.
- All data collected in the field is digitized at the end of each trip with individual burrow locations, evidence of predation, and/or predator presence mapped using a GIS.

(Methods developed by KESRP)

### 12.3.2 Camera Monitoring

A camera trap is a remotely activated camera that is equipped with an infrared sensor. Camera trapping allows researchers to photograph birds or predators at a burrow and has been used in ecological research for decades.

At the site, camera traps will allow for ground activity to be observed on a continuous basis. Cameras will be initially placed near the speaker system where birds are most likely to land when responding to social attraction playback. They will also be used on burrows to record ingress of prospectors, breeding attempts and success of the egg, chick and fledging stage and predator interactions.

The cameras will provide data pertinent to Objective 2C – Ground activity by Covered Seabirds documented at the mitigation site by Year 4 of KSHCP implementation and Objective 2D – Breeding activity by Covered Seabirds documented at the mitigation site by Years 5-7 of KSHCP implementation, and will be ongoing throughout the lifetime of the project as the data will also be used to measure Objective 2E & F – Cumulative Upward Trend in Covered Seabird breeding documented at the mitigation site by Year 10 & 20.

The proposed models are a Reconyx Hyperfire PC900 camera trap (Figure 12.1) and a Reconyx Ultrafire XR6 (capable of also taking high definition video but using more memory and therefore requiring more frequent checks). However, if improved technology or another brand is found to be more effective or cost efficient, they will be selected instead.



**Figure 12.1. Reconyx Camera Trap**

#### **12.3.2.1 Methods for Camera Monitoring**

- IE staff will monitor artificial and / or natural burrows of 'a'o (and 'ua'u if they also arrive at the site) at mitigation sites using Reconyx Hyperfire PC900 or similar cameras.
- After the first year (cameras will initially be used to monitor predators only), 20 of the 100 artificial burrows will be monitored by cameras. Burrows closer to the speaker system are likely to be occupied first and so cameras will be placed there initially; they will also be able to pick up ground activity in that area.
- Artificial burrows or natural burrows (these will be mapped as they are found, either through burrow searching or auditory surveys) will be surveyed monthly during the

breeding season and toothpicks placed in the entrance. Any that show signs of use (toothpicks falling, scent, guano etc.) will have a camera placed on them (moved from an inactive site).

- Cameras may be strategically placed in other areas within the fence enclosure to document ground activity not associated with specific burrows.
- Camera Monitoring will occur throughout the pre-breeding season, starting when the sub-adult prospectors and adults arrive (01 Apr). (Note that while most birds return in early Apr, cameras should be operational from mid-Mar to ensure that early birds are not missed)
- Variables measured include number of visitations (ground activity), number of burrows with breeding activity, number of active burrows with a chick that fledges, predator visitation rates and predation events.
- Cameras will be mounted on stakes 1-3m from the burrow entrance to record species, seabird activity and nesting outcome. Cameras will be triggered by movement and are set on a rapid-fire setting.
- All secure digital (SD) memory cards will be changed monthly, batteries changed as needed and all camera locations will be recorded using a handheld GPS unit. SD cards are to be viewed in the field to briefly assess activity levels and presence/absence of seabird predators at burrows. They will be reviewed fully in the office.
- Cameras will be checked monthly.
- All data collected in the field (i.e. on the number of images on the camera, date of SD card and battery switch out etc.) is digitized at the time on the iPad. Data will be downloaded to the server in the office. Camera viewing will take place in the office at the end of each trip and will be digitized.

### **12.3.3 Bird Banding**

Banding is an important part of the SAS project and an established best practice monitoring technique for seabird colonies, providing data on sub-adult and adult survival rates, nest site fidelity, age at first breeding, ratio of birds recruited via social attraction versus natal philopatry and breeding probability. Morphometric measurements allow for inter-annual comparisons and could be used to indicate the general health of seabirds breeding at the mitigation site from one year to the next. This data will also contribute to the body of knowledge on 'a'o (and 'ua'u if found at the site) throughout the Island and the State.

This social attraction site was chosen because of the lack of artificial light in vicinity. It is thought that birds from this colony will not be subject to light attraction when fledging due to the orientation of the site, the dark conditions on the obvious flyway out to the ocean and a lack of visible artificial lights from the site. However, banding birds on site means that any birds that are downed by artificial lights can be identified back to the project site and mitigation measures taken to reduce any light attraction.

#### **12.3.3.1 Methods for Banding Chicks and Adults**

- Biologists conducting banding of seabirds will be required to be covered under Bird Banding Lab banding permits and be authorized by the DLNR to band or otherwise handle seabirds on Kaua'i.
- Chicks will not receive bands until approximately 4 to 2 weeks from fledging, which occurs late September to early December, peaking in October.
- Banding will take place during burrow checks and opportunistically, if birds are found on site.
- IE staff will carry banding kits at all times during colony site visits in the breeding season and will ensure all caught birds are banded (both adults and chicks).
- A list of bird banding equipment needed to safely band and measure 'a'o and 'ua'u includes:
  - Appropriate shearwater-sized banding pliers;
  - Spreader pliers;
  - Pesola 1000 g scale;
  - 15 clean bird weighing bags;
  - Wing chord ruler;
  - Banding leg gauge;
  - USGS issued bird bands size #4 (50) for 'a'o and 3A (50) for 'ua'u;
  - 15 clean bird handling towels;
  - Pens and pencils
  - Banding logbook or notebook and iPad with custom built banding app (KESRP).
  - Umbrella or tarpaulin in case of rain during banding
  - Antibacterial handwash

Variables measured include individual identification number (USGS band number), species, weight, tarsus length, culmen length, wing length.

#### **12.3.4 Auditory and Visual Surveys**

Auditory surveys are an important part of the strategy for biological monitoring. 'A'o are nocturnal and tend to vocalize within their colonies (and occasionally in transit); therefore, activity and location of these species may be effectively monitored at a distance of up to 1km using an auditory point count survey technique to establish and document ground activity and / or flyovers at the site. 'Akē'akē and 'ua'u are also nocturnal - they may be breeding or transiting within the 1km radius and therefore will be included in the monitoring although they are not expected to breed at the site.

These surveys will measure criteria for Objective 2C. Ground activity by Covered Seabirds documented at the mitigation site by Year 4 of KSHCP program implementation, Objective 2D – Breeding activity by Covered Seabirds documented at the mitigation site by Years 5-7 of KSHCP program implementation. After Year 7, however, Acoustic Song Meters will be a more efficient and accurate way to measure Objective 2 E & F – Cumulative upward trend in Covered Seabird breeding documented at the mitigation site by Year 10 & 20 of KSHCP implementation, so

Auditory Surveys will be reviewed at year 7 and phased out if the success of the project merits it.

#### 12.3.4.1 Methods for Auditory & Visual Surveys

- Auditory surveys will be carried out by trained observers using night vision goggles. The observer auditory range is an estimated radius of 1 km. There will be 4 permanent survey locations.
- A standardized survey protocol and data sheet or iPad page ([Appendix 1](#)) will be used to allow for inter-site and inter-annual comparison and to make data compatible with KESRP surveys.
- Auditory surveys will take place twice a night (PM and AM) for 4 nights a month (1 night at each location). 2 surveyors will cover 2 locations a night for 2 nights.
- Ideally, there will be two observers for the surveys so surveys will take place AM and PM for location 1 and 2 for two nights and then likewise for 3+4 for two nights.
- Surveys will take place during the peak of the breeding season (Jun- Aug; vocalizations dramatically reduce after mid Sep).
- Surveys during full moon (and one week before and after) will be avoided as birds vocalize less during full moon periods.
- Observers will survey during the peak evening and pre-dawn activity period to account for the key calling periods of the Covered Seabirds. Although 'a'o are the primary focus, 'ua'u and 'akē'akē will also be recorded.) 'A'o are more vocal in the morning; 'ua'u and 'akē'akē are mainly vocal in the evening, while.
  - Evening surveys start at sunset and last for 2 hours: 4 x 30 min sessions, with 25 minutes to record seabird calls, and any visual seabird observations (using either naked-eye, binocular or night vision goggles) and 5 minutes allotted for weather data collection
  - Morning surveys start 2 hours prior to sunrise and last 1.5 hours: 3 x 30 min sessions, otherwise methodologically the same.
- Variables measured include number of calls and sightings for each species, breeding activity seen (flight paths, circling, ground calling etc.) distance and direction of each observation from the survey point, weather conditions during survey and habitat characteristics of the survey site. Particular attention will be paid to ground activity, with individual ground calling locations noted on a map.
- Auditory surveys will be used in tandem with static song meters (after year 4) as a method of ground- truthing the song meter data with the intent of locating and mapping calling hotspots, ground activity, and flight corridors for 'a'o (and 'ua'u and 'akē'akē if heard) unless song meters are found to be incompatible with the social attraction element.
- Survey locations are recorded in UTM's.
- At the end of the season the data from the field maps is entered into GIS digitized mapping to create individual breeding activity polygons for 'a'o and 'ua'u.

A standardized field datasheet can be found in [Appendix 1](#) – a digital version will incorporate the same information.

### 12.3.5 Acoustic Bird Call Monitoring (Song Meters)

An acoustic recording device is a sound recording unit that is weather-proof, self-contained and can be used to remotely collect data in the field (Figure 12.2). The proposed models are SM4 Song Meters, made by Wildlife Acoustics.

Acoustic bird call monitoring uses song meters to create a database of calls over time, without observer bias, that can be useful in developing breeding density estimates. This technique is a powerful monitoring tool and is widely used by managers at monitored seabird colonies on Kaua'i. It will be used to provide a baseline of activity at the colony which can be accurately measured to show population changes over the thirty years of the project (Oppel 2014). Calls/hr are relatable to the number of burrows in an area, so if call rates increase over time, one can confidently assume that seabird activity at the site is increasing.



**Figure 12.2: SM4 Song Meter**

Auditory and visual surveys by human observers as well as onsite burrow searching and monitoring will remain important complementary parts of the monitoring strategy to confirm birds on the ground and indications of breeding until year 7. However, not all burrows will be found by observers – song meter data gives a monitoring output for the site as a whole to offset this problem.

The song meters can record seabird vocalizations at a distance of well over 250m. Outputs from the analysis will include call rate per minute, total number of calls and activity by time.

Song meters will provide data pertinent to Objective 2C - Ground activity by Covered Seabirds documented at the mitigation site by Year 4 of KSHCP implementation and Objective 2D – Breeding activity by Covered Seabirds documented at the mitigation site by Years 5-7 of KSHCP program implementation. They will be critical in terms of measuring Objective 2E & F – Cumulative Upward Trend in Covered Seabird breeding documented at the mitigation site by Year 10 & 20.

Song Meter use will only commence in year 4 as they are incompatible with full time social attraction playback, which is most critical in the first few years of the SAS.

In 2016, as part of an assessment of a potential social attraction site on the edge of the Kalalau Valley, KESRP deployed a song meter at a central location within the site to assess whether there was any seabird activity within the site. Both 'a'o and 'ua'u were recorded at the Social Attraction Site (Raine et al 2016). 'A'o were recorded almost nightly (suggesting regular activity of this species in the area), while 'ua'u were recorded on 6 occasions. The results will be used as a baseline at the site.

For the 'a'o, call rates were low at the survey site compared to large monitored colonies of this species on Kaua'i (such as Upper Limahuli Preserve). However, the fact that they were recorded almost nightly during the survey suggests the possibility that a very small number of pairs may be breeding within or near the site itself. Further surveys will be carried out in 2017 and 2018 to look for burrows. Furthermore, individual birds are flying around the area vocalizing on most nights, and could therefore be drawn in by social attraction. Based on years of surveys by KESRP, the wider area (Kalalau Valley and Nā Pali coast) has large breeding populations of both species which will act as source colonies (Raine et al. 2016).

The results of this survey will represent a useful baseline for the site. The same surveys will be repeated annually until the Seabird Preserve is constructed.

#### **12.3.5.1 Methods for Song Meter Deployment**

- A Song Meter IV sensor (<http://www.wildlifeacoustics.com>) or similar model will be deployed within the social attraction site in the same location used by KESRP in preceding years.
- Deployment will commence in Year 4.
- The song meter will be powered by 4 D-cell alkaline batteries and store recordings on a 32GB SD memory card. Sensors will record on two channels at a sampling rate of 22 kHz. The sensor will be mounted 0.3m off the ground on a length of PVC pipe with the omnidirectional microphones oriented horizontally. The location will be selected such that the sensor microphones are sheltered from prevailing winds, well away from moving branches and leaves. Microphones will be weather-proofed with scotch guard and sheltered from above with a length of PVC pipe cut in half. Other compatible technology may be used to compare previously gathered data as appropriate
- 2016 & subsequent years prior to the fence construction will provide a baseline of seabird acoustic activity at or around the site and will be supported by observer data from the auditory and visual surveys to pinpoint the location of the calls.
- To allow for comparison with KESRP data, sensors will be programmed to record 1 minute every 5 minutes for 3 hours after sunset, and 1 minute every 10 minutes for three hours before sunrise. Programming will be undertaken using the SMCONFIG software package.

- Year 1-3: Song meter recording requires social attraction vocalization speakers to be turned off. Therefore, no song meter data will be collected in Years 1-3 of the Program, because the key objective during those years is to attract seabirds through social attraction to fulfil objective 2C in response to mitigation requirements for the KSHCP.
- Year 4 onwards: Song meter will be deployed annually for 2 months (June-July) to monitor long term changes of the seabird populations within or around the site.
- To record calling activity in the absence of social attraction playback, during the above recording schedule, loudspeakers will be temporarily disabled every third night to allow for song meter recording. Electronic timers will be used to achieve this and two nights of testing will be carried out to ensure this works, along with periodic checks by project staff.
- All song meter audio data will be sent off to an appropriate organization for automated analysis (currently Conservation Metrics Inc., Santa Cruz, California).
- Song meter will be checked (cards and battery changed) once a month.
- Seabird response monitoring frequency is shown in [Table 12.5](#).

### 12.3.6 Summary of Seabird Response Monitoring

Table 12.5 outlines the monitoring frequency required to establish seabird response to management.

**Table 12.5: Seabird Response – Monitoring Frequency**

Biological Objectives	Monitoring Frequency
<p>2.C. Ground activity by Covered Seabirds documented at the mitigation site by Year 4 of KSHCP program implementation.</p> <p>2.D. Breeding activity by Covered Seabirds documented at the mitigation site by Years 5-7 of KSHCP program implementation.</p> <p>2.E&amp;F. Cumulative upward trend in Covered Seabird breeding documented at the mitigation site by Year 10 and 20 of KSHCP program implementation.</p>	<p>- Cameras installed by end Mar and checked monthly 01 Apr to 15 Dec</p> <p>- Auditory surveys with night vision: 2 surveys 4 nights monthly (Jun to Aug) (to year 7)</p> <p>- Burrow monitoring monthly 15 Apr -15 Dec</p> <p>- Chicks banded 2-4 weeks before fledging; adults banded whenever encountered.</p> <p>- Song meters from year 4 (May to Jul / Aug)</p>

### 12.4 Annual Reports

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An annual report will be delivered to the agencies by 15<sup>th</sup> April. It will include a detailed section on the project monitoring and results. This will enable USFWS and DLNR to evaluate:

- 1) compliance with terms and conditions of ITP/ITLs issued under the Program;
- 2) effectiveness of KSHCP conservation measures;
- 3) that continuing to authorize the permitted Covered Activities will not appreciably reduce the likelihood of survival or recovery of the Covered Species in the wild;
- 4) that the implementation of the Program results in a net benefit to the Covered Species as required under State of Hawai'i law.

Reports will specifically outline project progress and / or achievement of the Biological Objectives 2A-H.

### 13. TIMELINES FOR ALL ACTIONS AT KAHUAMA'A SEABIRD PRESERVE

Table 13.1 below provides an outline of the pre-construction, construction and initial set up maintenance actions required in the management plan for year one of conservation work at the Kahuama'a Seabird Preserve. The estimated time noted in the table is based on extensive discussions with local experts about their fieldwork. For example, in the case of setting Goodnature traps (or similar), the time taken per trap is multiplied by the total number of traps plus some time allotted for walking between traps. (This table does not include standard fieldwork operations, which are shown in [Table 13.2](#)).

**Table 13.1: Fieldwork Actions and Estimated Staff Resources Pre & During Construction**

Obj	Actions (Pre & During Construction) (additional actions to standard fieldwork during operation)	Frequency in 3 month construction period
	<b>Pre-Construction</b>	
All	Staff training	1
2A	12 return trips to the site (overnight stays at DOFAW cabin or camping)	12
2A	Site meeting contractor	4+
2A	Search entire fenceline & surroundings for seabird burrows	2
2A	Forest bird & pueo survey - baseline & pre-construction & office write up	2
2A	Assist with pre-construction baseline veg monitoring	1
2G	Flag rare plants	1
2A	Assist contractor in removing vegetation along fenceline. Botanist and archaeologist present	1
2A	1 staff present during equipment fly in and entire fence construction to oversee all BMPs	1
2A	Training from contractor on fence maintenance	1

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2A	Risk analysis for fence post construction	1
2A	Order and put up public signage on what to do if public sees a breach	1
2A	Report to confirm fence complete / report to confirm SAS work complete	1
2A, C,D	Install speaker system, test	1
2C-F	Install artificial burrows	1
All	Project management - 17 hours per week	12
	<b>Rodent Trapping Post Construction Actions</b>	
2B	Rodent trapping - Set up <b><u>snap trap grid</u></b> ; 50 inside fence and 40 in 50m zone outside fence.	1
2B	Rodent trapping - Check snap traps (75) removal of carcass, bait and reset - inside & outside fence. Every 2 days for 3 months	45
2B	Rodent trapping - Set up <b><u>bait stations grid</u></b> (50) - inside fence	1
2B	Rodent trapping - Check and rebait bait stations: 50 inside fence twice a week for one month. Frequency can reduce to weekly after one month if appropriate, then twice a month for three months, then once a month thereafter if stations are still required	12
2B	Rodent trapping - Set up <b><u>Goodnature grid</u></b> (25) - inside fence, and 20 outside the fence in 50m predator defense zone.	1
2B	Rodent trapping - Check <b><u>Goodnature grid</u></b> (25) - inside fence, and 16 outside the fence in 50m predator defense zone. Check and zero counter, check CO <sub>2</sub> , rebait monthly	3
2B	Rodent trapping - Set up <b><u>camera traps</u></b> (20) inside fence and outside fenceline (4)	1
2B	Rodent trapping - Check <b><u>camera traps</u></b> (24) check - 2 x month	6
2B	Set up live <b><u>feral cat traps</u></b> (8 outside fence - only outside ones will remain after initial eradication). 2 conibears will also be placed inside the enclosure for the initial eradication.	1
2B	Set up and monitor <b><u>ink card tracking tunnel</u></b> (25) 2 x a month	6
2C-F	Move 20 camera traps from rodent detection to burrow detection	1
All	Project management - 20 hours per week	weekly

**Table 13.2: Ongoing conservation actions during operation and effectiveness monitoring.**

Bio Obj	Action	No. per month	Season
	<b>Fieldwork</b>		
2A	Fence checks (additional checks will happen as part of rodent control outside fence)	1	all
2A	Fence maintenance, crisis response	1	all
All	Return drive to site	4	all
2B	Rodent trapping - Goodnature Check: 25 inside fence, 16 outside fence in 50m zone, rebaiting, counter check, CO <sub>2</sub> check	1	all
2B	Ink card tracking tunnel (25)	1	all
2B	Rodent trapping - Snap trap check (25) removal of carcass, bait and reset - 50m zone outside fence	2	all
2H	Feral cat trapping – fenceline (8) - opening & closing traps	2	all
2H	Feral cat trapping – fenceline (8) - checking & rebaiting	8	all
2H	Feral cat trapping – fenceline - camera trap (4) check (change cards and batteries) - occur at same time as cat trap checks	1	all
2H	Barn owl reduction - trapping (6)	4	all
2H	Barn owl reduction - shooting	4	all
2H	Feral cat control Kalalau valley - opening & closing traps, 30 live feral traps, 24 conibears, 20 legholds	2	all
2H	Feral cat control Kalalau valley 30 live feral traps, 24 conibears, 20 legholds - checking once open & rebaiting	8	all
2H	Feral cat control Kalalau valley - camera trap (20) check (change cards and batteries)	1	all
2G	Vegetation monitoring (veg plots), seabird habitat modifier removal, outplanting of native species if required	1/year	outside seabird season
2G, 2B	Maintain low vegetation in predator defense zone	2	
2C-F	Seabird monitoring - auditory surveys with night vision 2 x a night (am and pm), 4 locations, 4 nights	4/month x twice a day	inside breeding season only, Jun-Aug
2C-F	Seabird monitoring - camera traps (20) cards and battery changed	1	inside breeding season only, 15 Mar – 15 Dec

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2C-F	Seabird monitoring - song meter (1) cards and battery changed.	1	Jun 01 –Nov 30 only
2C-F	Seabird monitoring - burrow searching (incubation to fledging)	1	Jun - Nov
2C-F	Seabird monitoring - burrow monitoring (100 artificial, tba natural), annual cleaning	1	Mar - Dec
2C-F	Seabird monitoring - chick banding (during burrow monitoring, 2-4 weeks before fledging only; also adhoc banding of any adults encountered.)	1	Oct - Dec
2A,C, D	Check speaker system & song meter alternation system	1	Mar - Dec
	Office		
2B	Rodent trapping - Log results from Goodnature (transf. from iPad) / analysis	1	all
2B-F	Camera traps - watch cameras (20) and log data (30 mins per camera) / analysis	1	all
2B	Ink card tracking tunnel (25)	1	all
2H	Feral cat trapping - log results (transf. from iPad) / analysis	1	all
2H	Feral cat trapping – Reconyx camera trap - watch cameras and log data (20 mins per camera) / analysis (included with rodent work)	2	all
2H	Barn owl reduction - trapping (6) - log results (transf. from iPad) / analysis	1	all
2H	Barn owl reduction - shooting - log results (transf. from iPad) / analysis	1	all
2G	Invasive plant monitoring and removal - log results / analysis	1	outside breeding season
2G	Vegetation monitoring - veg plots and transect - log results (transf. from iPad) and analysis	1	outside breeding season
2C-F	Seabird monitoring - auditory surveys. Log data (transf. from iPad) and analysis	1	during breeding season only
2C-F	Seabird monitoring - song meter (1) cards to CM, review results	1	Jun 01 –Nov 30 only
2C-F	Seabird Monitoring - burrow searching. Log results (transf. from iPad) and analysis	1	Jun-Nov

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2C-F	Seabird monitoring - burrow monitoring (100 artificial, tba natural). Log results (tranf. from iPad) and analysis	1	Mar - Dec
2C-F	Seabird monitoring - chick banding (during burrow monitoring, 2-4 weeks before fledging). Log results (tranf. From iPad) and analysis	1	Oct - Dec
	Project management, including annual reports, progress reports, stakeholder management, staff management, budgeting	4	
	Permit & certification renewals (e.g. pesticide, rodenticide, firearms)	1	
	RCUH training / first aid etc.	1	
	ESCR presentations – one per year		
	Other admin	1	

### 14. MAXIMIZE PROJECT EFFICIENCY

In order to ensure that the deliverables are met to provide mitigation for incidental take as outlined in the KSHCP, it is important that the Kahuama‘a Seabird Preserve is run efficiently. Staffing is a key part of that. Final decisions on the staffing or contractual consultant required to complete all Management Plan tasks will be decided by the IE, but a possible outline is provided below.

Staff will be recruited in the first quarter of the first year and will be appropriately trained and equipped. Both staff members will be trained as a conservation firearm specialist (training provided).

#### 14.1 Staffing - Program Manager

The Program Manager is the lead staff member implementing the KSHCP on behalf of the Participants. This is likely to be a part-time position. The responsibilities for this position include implementing the Management Plan for the Kahuama‘a Seabird Preserve but also encompass other KSHCP duties. The incumbent will have expertise in conservation biology as well as proven project management experience. Position will be both field and office based.

Duties will include overall project management, budget management, hiring IE staff members, personnel supervision compiling data and writing annual reports on project progress, ensuring that mitigation goals are achieved, implementing adaptive management if required, co-ordinating with SOS (or other qualified veterinarian) as needed, presenting at ESRC and other professional conferences, serving as a liaison between the mitigation project, regulatory

agencies and participants. Field duties include working with fence contractor, supervising technicians and overseeing / carrying out monitoring fieldwork and predator removal efforts.

#### **14.2 Staffing - Technician**

The Technician is a field position posted primarily at the Kahuama'a Seabird Preserve. The Technician will have experience in conservation, field work, monitoring and reporting. Primary duties will also include effectiveness monitoring for mitigation work, monitoring breeding of covered species on site, long term biosecurity at the mitigation site, feral cat and barn owl predator control and non-native plant removal.

#### **14.3 Staff Training**

Staff will receive training as follows:

- Wilderness First Aid
- Firearms
- Vegetation monitoring
- Seabird monitoring, management and predator control

#### **14.4 Equipment and Office**

IE will purchase and maintain appropriate equipment. For a full list of equipment, see budget Appendix H in the KSHCP.

IE will source appropriate office space. Options include moving into an agency office.

#### **14.5 Stakeholder and Partner Management**

IE will ensure cooperation amongst stakeholders by:

- Maintaining a website
- Setting up a Facebook page for the project which will be updated quarterly, and encouraging stakeholders to follow it.
- Answering stakeholder queries as they arise.

IE will manage any conflict between stakeholders, project and other users of the area and employ stakeholder conflict resolution techniques if required.

#### **14.6 Fulfill Reporting Obligations**

IE will initiate regular reporting schedule to participants and regulatory agencies, including financial reporting.

#### **14.7 Fulfill Accounting Obligations**

IE will keep a full accounting record of the project.

### 14.8 Review and Revise Management Plan Every 5 Years

IE will review and revise (as needed) the management plan every 5 years, in conjunction with the agencies.

## 15. BUDGET SUMMARY

The budget is a key section of the Management Plan, outlining project expenditure and income for every category and action. However, the budget for the Kahuama'a Seabird Preserve is also important for the KSHCP as income is dependent upon Applicant take. For that reason, itemized estimates have been included as an appendix to the KSHCP (Appendix G). An introduction and explanation of Management Plan costed items can be found there.

## 16. ADAPTIVE MANAGEMENT SOLUTIONS

The adaptive management process for the KSHCP is outlined in Section 6.9 of that document. The biological objectives of the KSHCP set triggers for initiating adaptive management by specifying actions that must be accomplished by target years. If these targets are not met, the actions described in this Management Plan may be altered to better achieve program outcomes.

While it is not possible to consider every alternative, Table 16.1 lists potential adaptive management solutions, though other solutions may be more appropriate at the time of implementing adaptive management. Across all actions, if alternate technology becomes available that is within stated budget and will achieve objectives more efficiently or cost effectively, this may be employed. Costs associated with potential solutions below are presented in Appendix H of the KSHCP.

**Table 16.1. Adaptive Management Scenarios**

<b>KSHCP Objectives</b>	<b>Scenario requiring adaptive management</b>	<b>Potential Solutions</b>
2.A. Construct a predator-proof fence and install social attraction equipment (nest boxes, speakers) within the fenced area at the mitigation site in Year 1 of KSHCP implementation.	Fence construction. delayed by unforeseen event	Additional funds to contractor - 15% more labor @ low cost
	Fence design not adequate to exclude predators & repairs needed	Additional materials & labor needed to rebuild fence
	Additional rare plants found, work delayed	Additional funds to contractor - 15% more labor

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	Archaeological remains found, work delayed	Additional funds to contractor - 15% more labor
	No suitably qualified fence contractor available in US to build fence in year one	Fly team from NZ or elsewhere
2.B. Remove predators from within the fenced enclosure with monitoring confirmation of their absence, and activation of the social attraction equipment by Year 2; predator eradication within fenced enclosure maintained for the life of the project	Predator removal unsuccessful at 1st attempt	Double trapping efforts inside fence - equipment
		Fly in and/ or consult with predator control expert
	Fence breach from tree fall, predators enter	Repair fence
		Repeat trapping effort inside fence
2.C. Ground activity by Covered Seabirds documented at the mitigation site by Year 4 of KSHCP implementation.	Monitoring insufficient	Increase camera trap effort by 20%
	Birds not attracted to site	Double speaker system & change soundtrack
	Birds not attracted to site	Fly in and/ or consult with expert from NZ
	Birds not attracted to site	Install decoys
2.D. Breeding activity by Covered Seabirds documented at the mitigation site by Years 5-7 of KSHCP implementation.	Monitoring insufficient	Increase camera trap effort by 20%
	Birds not breeding at site	Add new artificial burrows within fence
	Birds not breeding at site	Fly in and/ or consult with expert from NZ
	Birds not breeding at site	Survey for additional invasive plants that may be modifying habitat to make it unsuitable
	Birds not breeding at site	Replace all artificial burrows

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2.F. Continued cumulative upward trend in Covered Seabird breeding documented at the mitigation site by Year 20 of KSHCP program implementation.	see 2D	
2.G. Maintain high quality seabird habitat at the mitigation site by removal of habitat modifying invasive plants in Year 1 and annually throughout the 30-year duration of the KSHCP.	Initial pass at habitat modifier removal fails	Repeat
	Additional invasive plant found	Removal effort
	Habitat modifiers persist despite technician maintenance work	Repeat removal pass
	Removal work is more expensive than predicted due to e.g. presence of additional rare plants	Additional funds
2.H Protect nesting birds inside mitigation fence and in nearby source colonies by implementing predator control of 1) barn owls within the area surrounding the fenced enclosure and the Kalalau Valley, and 2) feral cats at ingress points to source colonies in the Kalalau Valley, beginning in year 1 and annually throughout the 30-year duration of the KSHCP.	No barn owls removed	Additional shooting nights
		Alternative trapping/luring techniques
	Barn owls kills still occurring in preserve	Additional shooting nights / new techniques

### 17. BEST MANAGEMENT PRACTICES

To avoid any adverse effects to species and habitats of conservation concern, Best Management Practices will be employed at all times at the project site for the following species and specific concerns:

- **Covered Species** – 'A'o, 'ua'u and 'akē'akē. The benefits to these species of the Kahuama'a Seabird Preserve have been outlined above. See individual BMPs on each activity for further details on how harm will be completely avoided.
- **Ōpe'ape'a:** This is a listed species (Federal and State). It could be present at the Kahuama'a Seabird Preserve. Overall, the creation of the Preserve will provide a potential benefit to the 'ōpe'ape'a through conservation of the native habitat and control of non-native predators. The amount of disturbance that will occur while conducting conservation measures is minimal, temporary, and of limited duration. See individual BMPs on each activity for further details on how harm will be completely avoided.
- **Forest Birds:** Several candidate and listed native forest birds and pueo may use the Preserve as territories and / during the breeding season Jan to Jun (see section 3.1.4). Overall, the creation of the Preserve will provide a potential benefit to forest birds and pueo through removal of non-native habitat and control of non-native predators - both are identified as primary threats to native forest bird species in Hawai'i (VanderWerf 2012). The amount of disturbance that will occur while conducting conservation measures is minimal, temporary, and of limited duration. See individual BMPs on each activity for further details on how harm will be completely avoided. It should be noted that KESRP located a pueo nest that had been predated by cats in Pihea in 2015, indicating that cat control will be beneficial to this species.
- **Listed or Rare Plants and native plant habitat:** Several listed or rare species of plant have been observed in the project area. Overall, conservation activities in the Kahuama'a Seabird Preserve are anticipated to result in dramatically improved habitat and reduced habitat modification that could otherwise occur from the negative effects of non-native animals and plants (see Section 12 - Vegetation Restoration - for a fuller explanation). The preserve's proximity to the road, and proximity to lookouts frequented by high numbers of tourists, presence of feral animals such as pigs and rats and current habitat degradation means that the area is already exposed to the risk of invasive species. Specifically, botanists have reported that the fence will be of direct conservation benefit to one individual of *Myrsine knudsenii* (E, PEP), four individuals of *Exocarpos luteolus* (E), one *Lobelia yuccoides* (SOC), one *Polyscias flynnii*, and a large occurrence (unknown number of individuals) of *Euphorbia remyi* var. *remyi* (E) (A. Williams, Pers. Comm.) Plant monitoring will not be limited to endangered species; changes to more common plant species that form the bulk of the native habitat will also be monitored. See individual BMPs on each activity for further details on how harm will be completely avoided.
- **Soil Erosion:** In the longer term, with re-vegetation and removal of ungulates, soil stability is expected to improve. Improved soil stability is expected to reduce erosion in the mitigation area which will reduce surface water runoff and water turbidity. In the short term, however, erosion might compromise the exclusion of predators from the fence as well as affecting Listed and Rare Plant species. See individual BMPs on each activity for further details on how harm will be completely avoided.

- **Rapid 'Ōhi'a Death (ROD)**, a fungal disease, is currently attacking and killing 'ōhi'a (*Metrosideros polymorpha*), the most abundant native tree in the state of Hawai'i. On Hawai'i Island, hundreds of thousands of 'ōhi'a have already died across thousands of acres from this fungus, called *Ceratocystis fimbriata*. It is currently not in Kaua'i but its arrival would devastate the native forest. See individual BMPs on each activity for further details on how harm will be completely avoided.
- **Cultural Resources:** There is currently no evidence of archaeological remains at the Kahuama'a Seabird Preserve as noted in section 7.2. In 1997, prior to the construction of the nearby Kalalau Rim Endangered Plant Enclosure, State Park archaeologists conducted a reconnaissance survey in the area of the Kahuama'a Flat and did not encounter archaeological sites or features. Nonetheless, archaeologist guidelines will be followed as specified in the BMPs for individual actions. See individual BMPs on each activity for further details on how harm will be completely avoided.

KSHCP conservation program activities in the Management Plan for the Kahuama'a Seabird Preserve will not result in take under section 10(a)(1)(B). The DLNR (IE) will operate under the existing Section 6 Agreement when implementing the Management Plan. If the work will be performed by another entity other than DLNR, then it will be conducted by an individual holding a research/enhancement take permit pursuant to section 10(a)(1)(A) and a State permit.

To ensure that BMPs are followed during construction, a suitably fence qualified contractor will be engaged through a bids process. As part of the contract, contractor will agree orally and in writing to all BMPs. Contractor will be made aware that failure to follow BMPs may result in legal and financial penalties. Contractor and his team will receive training from IE staff on BMPs. A concrete timeline for the delivery of the fence will be established in the contract. A construction deadline will be established during contract negotiations with monetary penalties.

The following sections outline in detail how BMPs will be used to avoid causing harm to listed species and to habitats. All staff, including biologists and technicians, entering the enclosure will be trained and follow the BMPs or will not be permitted to enter the enclosure. Any visitation to the mitigation area will be limited to what is absolutely necessary to accomplish objectives of the management plan and for compliance monitoring.

## 17.1 SEABIRDS

### 17.1.1. BMPs – Seabird Protection During Pre-construction & Construction

Pre-construction monitoring is critical to ensure that no seabird burrows are damaged during fence construction and sling-load drops. No burrows were found in 2016 or 2017 during auditory surveys, but no active burrow searching was carried out on site. Further surveys will be carried out in 2018.

If burrows were to be present, risks to covered seabirds through clearing of vegetation, increased risk of soil erosion, increased human presence, low altitude helicopter traffic and equipment drops could be:

- Damage to or destruction of burrows
- Disturbance to breeding seabirds (potentially leading to abandonment of nesting sites)

Impacts will be completely avoided using BMPs as follows:

- Work most likely to damage seabird burrows will occur during the period December to April, i.e. outside the breeding season, namely vegetation clearance, pole installation and other ground disturbing work. Fence construction may only commence during this period if it is reasonable to expect that work that could affect seabirds will be completed on the sloping sections of the fenceline (i.e. those most favourable to seabird colonization) before the seabird breeding season commences. If the project is delayed for any reason, the second phase of construction will only go ahead if it does not affect the covered species.
- However, work may continue into the breeding season to complete the fence provided it is either on the flat areas of the site or does not include ground disturbing work noted above that would damage potential burrows or birds in burrows. If construction occurs during the breeding season, 8 auditory surveys will be carried out in advance (see section 12.3.4) within 10m of the fenceline to ensure that there is no ground activity in the immediate area of the fenceline.
- The proposed fence lines and sling load drop zones will be thoroughly searched for seabird burrows by trained personnel before or during the onsite meeting. Training will be provided by KESRP or other qualified trainers. Staff will check all tree roots within 10m of the fence line. Any suitable holes within 10m of the fence line will be checked for guano, scent, feathers, eggshell, digging.
- Any burrows located will be marked on a GPS, cattle tagged and obviously flagged.
- If burrows likely to have been recently active (within last breeding season) are found along the proposed fence alignment route, the fence will re-routed if practically possible or the fence installation will work around burrows so that they are not destroyed.
- Buffer zone between the burrow and the fence will depend on the angle of the burrow and the slope that the burrow is situated upon, but is expected to be no less than 5m and up to 20m if near a possible take-off zone. If a burrow is present in a proposed sling-load drop zone, the zone will be relocated.
- A seabird biologist will be present during all vegetation clearing by the contractor.
- After vegetation has been removed along the fence line, a further burrow search will be carried out. Vegetation removal should not be necessary on sling load drop zones.
- A pre-construction monitoring report will be completed outlining how the above conditions have been satisfied.
- As the fence is being installed, an IE staff member will be on site at all times to monitor the immediate environs to ensure that no seabird burrows are present. They will look for suitable holes and will also note the presence of seabird signs such as guano,

footprints, scent, presence of feathers, down or eggshell and nesting material that might have appeared since the pre-construction surveys. They will also check all tree roots as these are often the site of burrows.

- It is highly unlikely, given the provisions in the pre-construction section, that burrows will be located along the fence line by the IE monitor once construction commences. If this occurs, however, IE staff will consult with the regulatory agencies and the fence contractor so that impacts to the burrows are avoided.
- Sling load drop zones will most likely not be used post construction, but if required, they will be re-assessed for burrows before each post-construction use.
- All personnel (including the fence contractor) working in the mitigation sites will be trained to follow the seabird protection BMPs and given oral and written instructions. Training will be provided by the KESRP or other qualified trainers. Both project staff and fence contractors will be required to carry paper and / or GPS maps showing the locations of any known burrows and will know how to recognize burrow tagging.

#### **17.1.2. BMPs - Seabird Protection during Rodent Eradication (inside fence)**

The eradication of predators is likely to have a highly positive effect on breeding success once the Kahuama'a Seabird Colony is colonized. However, risks to covered seabirds could be:

- Damage to or destruction of burrows during monitoring of traps
- Disturbance to breeding birds (potentially leading to abandonment of nesting sites)
- A bird being killed or injured by a trap

Impacts will be completely avoided using BMPs as follows:

- Goodnature traps were designed to be used in seabird colonies. They are difficult for birds to trigger when placed 12cm off the ground and in addition, are not attractive to birds (Goodnature 2017). It is exceptionally unlikely that a seabird would be killed by a Goodnature and in 5 years of using this method in Kaua'i by KESRP and other projects, no seabird deaths have been recorded (A Raine, 2017, pers. comm.) Other brands can be used provided they will not affected listed species.
- Snap traps have the potential to cause harm or death to Covered or Listed Species. This will be prevented by enclosing the trap in a boxed housing that cannot be accessed by the seabirds. Boxed housings will be inspected and repaired immediately prior to a planned trapping effort.
- Stationary bait boxes are designed in such a way that they cannot be accessed by seabirds. Poison bait may be removed by rats and left outside the box, however the bait is not appealing to seabirds and therefore the risk of ingestion is considered to be zero.
- All field workers and technicians will receive training to recognize potential seabird breeding burrows, (both active and inactive) and recognize burrow markers and program them into a GPS. They will be required to have a map of burrows and / or GPS points on them at all times at project site. Any burrows will be reported to KESRP.

- Workers will route trails around burrows and place traps and bait stations at least 10m away from known breeding burrows to avoid inadvertent trampling (and predator attraction from the scent of the bait) during the course of setting and checking traps and bait stations.
- Training will emphasize the use of due caution when walking off trail to avoid the trampling of burrows, particularly in areas which look suitable for seabird breeding activity.

#### **17.1.3. BMPs - Seabird Protection – Collision Avoidance**

The curved hood of the predator-proof fence is prominent and likely improves visibility. Similar projects for petrels and shearwaters in New Zealand have not encountered any problems related to seabirds colliding with the fence (SWCA 2011). Nonetheless, risks to covered seabirds could be:

- Injury or death due to collision with conservation fencing during the hours of darkness
- Downing of adult birds resulting in an ability to take off; this could lead to starvation of parent and chick
- Impeding take-off ability of chicks, leading to starvation

Impacts will be completely avoided using BMPs during construction work as follows:

- The fence will not be erected within 20m of a known seabird burrow
- Fencing will be installed without barbed wires, or similar sharp pieces, which could snag the birds (Hodges and Nagata 2001).
- A stripe of white reflective paint will be applied to increase the visibility of the fence to incoming and outgoing seabirds (Swift 2004). Commercial bird reflectors will be hung every 20m if appropriate.

#### **17.1.4. BMPs – Seabird Protection during Cat Control**

Cats will be removed from inside the fence before social attraction commences and the trapping of cats outside the fence (in the predator defense zone) will reduce the risk of reinvasion. However, as live feral cat traps sit on the ground, the risk to covered seabirds could be:

- A bird being caught, injured or killed by a trap

Impacts will be completely avoided using BMPs as follows:

- Live trap placement will be  $\geq 25\text{m}$  away from known seabird burrows
- Conibears will be placed in bird excluding boxes
- All field workers and technicians will receive training to recognize potential seabird breeding burrows, (both active and inactive) and recognize field markers. They will be required to have a map of burrows and / or GPS points on them at all times at the site. Any burrows will be reported to KESRP.

- Live Traps will be checked every 24 hours.
- In the rare and unlikely event that a seabird does become caught, the live traps are well concealed and spacious enough that a seabird will not become harmed from exposure or damage from the trap itself. If a bird is found in the trap during daylight hours, then it will be released into the nearest potential seabird burrow where it has sufficient space to hide for the rest of the day (i.e., workers will not release birds into vegetation or attempt to get a bird to fly away).

#### **17.1.5. BMPs - Seabird Protection during Barn Owl Trapping and Shooting**

The trapping / reduction of barn owls is expected to have a positive effect on breeding success in the preserve and the source colonies for the Kahuama'a Seabird Colony as this species is a known seabird predator on Kauai. However, the risk to Covered Species could be:

- Damage to or destruction of burrows during monitoring of traps
- Disturbance to breeding birds (potentially leading to abandonment of nesting sites)
- A seabird being caught, injured or killed by a trap
- A seabird being mistaken for a barn owl and shot

Impacts will be completely avoided using BMPs as follows:

- Existing paths will be utilized as much as possible to minimize local impact and barn owl trapping will be combined with other predator control activities to reduce trips.
- Barn owl control will maintain a greater than 25m distance from known nesting seabirds to avoid impacts to the birds. IE staff will be required to carry a map and / or GPS points with known burrow locations.
- There is potential that Covered Seabirds could be mistaken for barn owls and shot. This risk will be completely avoided by 1) providing appropriate training to technicians 2) using a spotlight at all times 3) requiring positive identification before shooting

#### **17.1.6. BMPs - Seabird Protection during Monitoring Work**

Risks to listed seabird species could be:

- Injury during banding
- Trampling of natural burrows during burrow searching
- Trampling of natural burrows or crushing of birds during auditory and visual surveys

Impacts to Covered Species will be completely avoided by following BMPs as follows:

##### **Banding**

- Biologists conducting banding of seabirds will be required to be covered under Bird Banding Lab banding permits and be authorized by the DLNR to band or otherwise handle seabirds on Kaua'i.

- Chicks will not receive bands until approximately 4 to 2 weeks from fledging.
- Only individuals trained in seabird handling and banding will be allowed to touch birds, unless an emergency occurs in which a bird requires rescuing.
- The amount of time a bird is handled during banding will be kept to a minimum, typically less than 2 minutes.
- If harm to an individual seabird does occur, due to an unexpected event or an accident while conducting the conservation measures, the regulatory agencies will be notified within 24 hours or as soon as practically possible, and a report filed within 3 days. Technicians and field workers will deliver injured birds to the Save Our Shearwaters (SOS) project or other qualified veterinarian or rehab center immediately for rehabilitation and potential release.

#### **Burrow searching**

- If burrows are located along the fenceline post construction, locations will be clearly marked with flagging and an individually numbered cattle tag, and the fence-monitoring trail will be re-routed to avoid unnecessary disturbance to burrows during regular fence maintenance activities.
- Staff will be trained to look for and recognize burrows (active and inactive) as they are searching the site to ensure that they do not inadvertently trample a burrow. If this occurs, staff will excavate the burrow and ensure that any bird inside was not injured (if injury occurs, see point above). Staff will attempt to repair the burrow using any means possible to ensure that it is still usable, whether or not a bird is inside. Burrow locations will be programmed into a GPS and shared with all other project staff. Staff will be required to have a map of burrows and / or GPS points on them at all times at the site. Any burrows will be marked with a cattle tag and reported to KESRP.

#### **Auditory and Visual Surveys**

- To avoid damage to seabirds at night by trampling during auditory and visual surveys, staff will stay in one place as much as possible and when moving, will take care to avoid stepping on birds. Training will be supplied by KESRP or other qualified body.

#### **17.1.7. BMPs – Seabird Protection during Restoration and Monitoring**

Risks to listed seabird species could be:

- Trampling of or damage to natural burrows during invasive species removal and nature vegetation restoration
- Presence of herbicide residue near burrows

Impacts will be completely avoided through BMPs as follows:

- Vegetation removal and restoration activities will not occur during seabird breeding season (01 Apr to 15 Dec)

- Herbicides will not be used within 3m of a known burrow.
- Where shrubs and / or trees need to be removed within 10m of a known burrow, the burrow will be inspected first to see if removal might compromise the structural integrity of the burrow. If the burrow is known to have been used, it may be appropriate to simply trim the invasive plant species rather than risk damaging the burrow through removal. Where the burrow has shown no signs of recent use (guano, feathers, excavations, eggshell, scent) every care will be taken to prevent burrow damage and the shrub/tree removal will go ahead.
- Existing paths will be utilized as much as possible to minimize local impact
- All personnel working on invasive species removal and vegetation restoration must be trained to follow the seabird protection BMPs and given oral and written instructions. Training will be provided by KESRP or other qualified trainers.
- All staff will be required to carry a map and / or GPS showing the seabird burrows located in the Kahuama'a Preserve and to take particular care not to crush them. Known burrows will also be clearly marked with a cattle tag and reported to KESRP.

## **17.2. BATS**

### **17.2.1. BMPs – Bats – Pre-Construction, Construction & Operation**

Risks to 'ōpe'ape'a from activities such as tree trimming, removal of woody plants greater than 4.6m, fence construction and invasive species removal could be:

- Inadvertently harming or by disturbing roosting sites during the roosting and pup-rearing season (June 1 through September 15).

Impacts will be completely avoided using BMPs during pre-construction work as follows:

- The proposed fence lines will be thoroughly searched for trees which would be suitable for bat roosts (4.6m or above).
- Where trees over 4.6m need to be removed for construction, a Fluke Ti400 thermal imager (or similar) will be used to scan the tree or a contractor will be hired, in conjunction with an acoustic survey using bat detectors and a visual survey to ensure that no bats with pups are present.
- If there are trees 4.6m or above in the proposed sling load drop zones they will be scanned for bats as above and only removed outside the pupping season.
- Tree trimming and invasive species removal / vegetation restoration will take place outside the roosting and pup-rearing season (June 1 through September 15). If this is not possible, a Fluke Ti400 thermal imager (or similar) will be used to scan the tree, in conjunction with an acoustic survey using bat detectors and a visual survey to ensure that no bats with pups are present. If bats or pups are found, work will stop and the regulatory agencies will be consulted.
- All personnel (including the fence contractors) in the mitigation sites must be trained to follow the bat protection BMPs and given oral and written instructions.

### 17.2.2. BMPs - Bat Protection during Barn Owl Control

Barn owls are known to prey on bats in other locations (Speakman 1991) so it is possible that they may be a predator of the 'ōpe'ape'a. Therefore, their trapping or suppression is likely to be beneficial or neutral to bats. Since bats fly at night however, the risk to them could be:

- Accidental shooting

This risk will be completely avoided using BMPs as follows

- providing appropriate training to technicians
- using a spotlight at all times
- requiring positive identification before shooting
- no shooting when bats are seen flying in the immediate environs (i.e. within 500m)

The activities carried out in the rodent eradication, cat trapping, and monitoring work are expected to have no potential to negatively affect the 'ōpe'ape'a.

### 17.3. FOREST BIRDS AND PUEO

#### 17.3.1. BMPs – Forest Birds and Pueo – Pre-Construction and Construction

Forest birds are known to be in the area, including i'iwi (*Drepanis coccinea*) (a candidate for federal listing under the ESA), 'āpanane (*Himatione sanguinea*), Kaua'i 'elepaio (*Chasiempis sandwichensis*), Kaua'i amakihi (*Hemignathus Kaua'iensis*) and 'ānaniau (*Magumma parva*). 'Ānaniau and Kaua'i 'amakihi were observed singing which may be an indication of breeding in the area. The pueo, a native Hawaiian Owl, has also been sighted several times in the area. Pueo have relatively wide home ranges and as such, it is possible that the Kahuama'a Seabird Reserve is part of the range several pueo.

Risks to listed forest birds and pueo through tree trimming and fence construction, could be:

- Disturbance of breeding birds and nests
- Removal of nesting habitat and feeding habitat in the form of large trees, especially ōhia.

Impacts will be completely avoided using BMPs during pre-construction work as follows:

- Consultation with KFBRP will occur before the start of construction to exchange the most current information on the distribution and status of candidate and listed forest birds at the site.
- All personnel (including the fence contractors) working in the mitigation sites must be trained to follow BMPs and given oral and written instructions.
- A baseline survey will be completed to establish use of the area by forest birds during the breeding season January through June and to locate any nests. Pueo nest throughout the year, so a search for their nests would be necessary all year round.

- Pre-construction, surveys will be conducted at areas proposed for conducting conservation activities including installing fences, creating helicopter landing zones, installing social attraction equipment, trapping and baiting, and monitoring.
- Any candidate or listed forest bird species (trees) or pueo (ground nesters) nests found nesting in the vicinity of these areas must be marked via GPS and identified on maps and the information transmitted to managers, other staff and the regulatory agencies.
- Pueo nests will be given a buffer of 20m that will be marked with flags. No disturbance of these nests should occur in that buffer area and if not already occurring, predator control should be initiated. Trees with forest bird nests will be flagged. (i)Project staff will be required to know these locations and to recognize nest markers in the field.
- Fencing & helicopter sling-load drop zone: For listed forest birds or pueo found nesting along the proposed fence line, the trees supporting nests will be marked and/or fenced off (forest birds) and the ground area of the nest marked and / or fenced off (pueo) and the fence re-routed to avoid impacts to the forest bird species and pueo. Drop zones will be relocated if candidate or listed forest bird nests or pueo are found to be within 50m.
- Workers are required to know the location of marked and identified nests and maintain a 5-meter buffer around the nesting area for candidate or listed forest birds. Clearing and trimming activities are not to occur within this area. For pueo, a 100m buffer would be required. If that is not possible, incubation and nesting is complete within 35-55 days in total and it may be necessary to delay work that would cause disturbance until the birds have fledged.
- Every effort will be made to avoid removing large trees, especially ōhia. However, it is recognized that the benefits of the predator proof fence will outweigh any potential habitat loss for forest birds, since this would be of negligible size.
- It is unlikely, given the provisions of the pre-construction monitoring, that nests will be discovered in the vicinity of the fence line. As a precaution, when the fence is being installed, an IE staff member will be onsite at all time to monitor the immediate environs for candidate or listed forest bird or pueo nests, or breeding pairs in a territory. If nests are found, the tree will be flagged and no activity likely to disturb the nest will take place within a 100m buffer zone or until after fledging. This includes vegetation / tree removal. However, in the case that a nest is empty and birds are not actively breeding (based on expert advice, which will be sought) trees can be removed.
- Little is known about the breeding biology of pueo, but their nests, which are on the ground, have been found throughout the year (DLNR 2005). If nests are found, the nest will be flagged and no activity will take place within a 20m buffer zone. This includes vegetation and tree removal. A mini fence will be erected to ensure that someone does not accidentally step on the nest.
- All personnel (including the fence contractors) working in the mitigation sites must be trained to follow the forest bird and pueo protection BMPs and given oral and written instructions.

### **17.3.2. BMPs - Forest Bird Protection during Predator Control and Invasive Species Removal**

The eradication of predators and vegetation restoration work is likely to have a positive effect on any forest birds that make a breeding attempt inside the Kahuama'a Seabird Colony. However, the risks from project work could be:

- Disturbance of nests.

Impacts will be completely avoided using BMPs as follows:

- KRBPR or other qualified person will provide training to project staff annually or as required on identification of forest birds by call and sight as well as nest finding.
- Any nests will be marked and IE staff will be required to carry a paper map and / or GPS with nests marked.
- Ongoing monitoring of trapping and baiting will occur year-round, encompassing the forest bird breeding season. Areas for trapping and baiting will be surveyed monthly during the breeding season to confirm the presence or absence of forest bird nests. Any nests will be clearly marked and trails used to access traps and bait stations will be re-routed if necessary to avoid disturbance to any nesting candidate or listed forest bird species. Survey results will be reported to KFBPR.
- When placing, setting, and checking traps and bait stations workers are required to know the location of any nesting candidate or listed forest birds and pueo and to maintain a 5m buffer around the nests, each of which will be marked (e.g., with flags and with GPS coordinates).
- When placing, setting, and checking traps and bait stations workers are required to know the location of any nesting candidate or listed forest birds and pueo and to maintain a 10m buffer around the nests for forest birds and 20m for pueo, each of which will be marked (e.g. with flags and GPS coordinates).
- Areas for seabird monitoring will be surveyed monthly during the breeding season to confirm the presence or absence of candidate or listed forest bird and pueo nests. Any nests will be clearly marked (buffer area will be marked in the case of the pueo) and trails used to access traps and bait stations will be re-routed if necessary to avoid disturbance to any nesting forest bird species. Survey results will be reported to KFBPR.
- If burrows need to be checked in the vicinity of a nest, extra care will be taken not to disturb the candidate or listed forest bird or pueo nest, such as keeping noise to a minimum and having only one person check the burrow quickly.
- Cameras will not be placed on burrows within 10m of forest bird nests and 100m within pueo nests as this requires extra disturbance.
- Invasive plant removal and habitat restoration will not take place within 25m of the nest.

### **17.3.3. BMPs - Pueo Protection during Eradication (inside fence)**

Diphacinone is noted to have a 'moderate' risk of secondary poisoning to birds by the National Pesticide Information Centre although large amounts of the poison would need to be ingested. The risk from the predator control work to pueo could be:

- Secondary poisoning from pueo consuming rodents which have ingested poison.

The following protocol will be followed to ensure that impacts are completely avoided:

- Project staff will collect any dead rodents and dispose of them off site. Whenever stationary rodent bait traps are in use, staff will monitor the project site weekly to increase the likelihood of finding carcasses.
- Stationary bait stations will only be used inside the fence and for the minimum time possible to achieve zero rat sign on ink-card tracking tunnels and signs of bait take for three months (slightly longer than the average reproductive cycle for rats).
- Secondary poisoning to animals other than rodents as well as any occurrences of damaged or vandalized bait boxes will be reported to the U.S. Fish and Wildlife Service, DLNR and Pesticides Branch of the Hawai'i Department of Agriculture within 24 hours of being discovered.

### **17.3.4. BMPs – Pueo Protection during Barn Owl Trapping and Shooting**

Since pueo are similar in flight to barn owls, there risk to this species could be:

- Accidental shooting

Impacts will be completely avoided using BMPs as follows

- Providing appropriate training to technicians
- Using a spotlight at all times
- Requiring positive identification before shooting
- No shooting when pueo are seen flying in the immediate environs

## **17.4. PLANTS**

### **17.4.1. BMPs - Plant Protection – Pre-construction and construction**

Removal and disruption to some native plant species will be unavoidable during construction but will be kept to a minimum. It is important to note that the site was specifically selected to minimize damage to listed and rare plants.

Risks to listed or rare plant species during fence construction could be:

- Uprooting, trampling, soil erosion, crushing
- Damage to *E. remyi* var. *remyi* (*E*), (a vining, weakly branched plant whose stems are growing on top of and through the mats of uluhe fern).
- Damage to other PEP plants within the fenceline
- Alteration to native habitat

The only Endangered species that occurs close to the proposed fenceline that might be affected is to *E. remyi* var. *remyi* and appropriate precautions will be taken (as listed below) to ensure that damage does not occur.

Impacts will be completely avoided using BMPs during pre-construction & construction work as follows:

- Prior to fence alignment and sling load drop zone creation, staff (including the fence contractors) will receive training from a botanist (either from the regulatory agencies or a consultant) on identification of rare plants in the area and be given oral and written instructions.
- Pre-construction baseline monitoring will be carried out to identify and / or confirm all listed and rare plants and their locations (see Section 12 – Vegetation Restoration - for full details.)
- A botanist or member of IE staff trained in plant identification for the localized area will be present at all times during alignment and sling load drop zone discussions on site as well as during construction.
- Within the enclosure, unknown number of individuals of *E. remyi* var. *remyi* are growing. This is a vining, weakly branched plant whose stems are growing on top of and through the great mats of 'uluhe fern that dominate the area and as such, is at risk of being cut or trampled during fence construction. During pre-construction surveys, the plants will be indicated by flagging and staff will be provided with a map showing the location, as well as GPS points (these flags will not be left permanently as botanists are concerned that this will incite vandalism or theft, so after construction, nearby plants will be flagged instead to indicate to staff their location).
- If necessary, outplanting of propagules from the same population inside the fenced enclosure will occur. This is likely to be out-sourced to a consultant such as NTBG.
- An example of *Dubautia kalalauensis*, a PEPP plant, occurs well away from the entire project. No fence or project activities will occur in this area.
- A specimen of *Polyscias flynnii* (E, PEP) is safely within the fenceline and will not be damaged during construction. The plant or an adjacent plant will be marked with tape during pre-construction surveys. IE staff and fence contractors will be required to carry, at all times, a map showing the location and / or GPS points. No trimming of the tree will be allowed. A 10m buffer zone around the tree will be observed, with no construction activities allowed in that area.
- A culvert will be inserted into the fence if required in areas that might act as a watercourse during heavy rain, to avoid flooding which might wash out plants.
- BMPs to protect against the ingress of invasive species are outlined in section 17.4.3.
- Proper footwear (spiked/corked boots or tabis) will be worn by personnel (applies to all BMPs)
- There will be strategic placement of wood or plastic boards, webbing, or other simple trail infrastructure in areas where mud pits or slides may form (applies to all BMPs)

#### **17.4.2. BMPs - Plant Protection– Rapid 'Ōhi'a Death (ROD)**

The spread of Rapid 'Ōhi'a Death (ROD) to local 'Ōhi'a trees could lead to a major ecological disaster through Kaua'i. Local trees could potentially contract ROD due to staff or contractors bringing the disease to Kauai through tools or clothes. Impacts will be completely avoided using BMPs during construction work outlined by the College of Tropical Agriculture and Human Resources, UH at Manoa:

- Staff and contractors will not move 'Ōhi'a wood or 'Ōhi'a parts inter-island. If 'Ōhi'a trees need to be removed as part of fence construction, they will be taken to the nearest location suitable for incineration immediately.
- Tools used for cutting 'Ōhi'a will be cleaned with 70% rubbing alcohol, a proven cleaning measure. This is particularly important if the tools may have come into contact with infected trees, but should happen regardless. A freshly prepared 10% solution of chlorine bleach and water can be used as long as tools are oiled afterwards, as chlorine bleach will corrode metal tools. Chainsaw blades will be brushed clean, sprayed with cleaning solution, and run briefly to lubricate the chain.
- Gear (including shoes, packs and clothes) will be cleaned before and after entering forests in a non-forest environment with running water. All soil will be brushed off shoes then sprayed with 70% rubbing alcohol. Clothes will be washed with hot water and soap. This will also help to reduce the spread of invasive species. A buddy system will be initiated where partners check each other's gear.
- Vehicles will be washed with soap after off-roading or after picking up mud from driving. A pressure washer with soap will be used to clean all soil off the tires and vehicle undercarriage.
- If staff have visited infected islands, they will take additional precautions of washing all field clothing, boots and tools in Sterigene before returning to the site. Staff will be asked to sign an agreement to this effect, since the severity of the consequences if ROD reaches Kaua'i.

#### **17.4.3. BMPs - Plant Protection– Invasive Species**

Risks to native plant ecosystems could occur should non-native invasive plants be accidentally introduced/reintroduced by staff or contractors. This could lead to the spread of invasive species to surrounding forested areas.

Impacts will be completely avoided using BMPs during construction work as follows:

- Cleaning boots, clothes, packs and gear between site visits to ensure that seeds are not carried from or to other areas and using a buddy system to ensure that this occurs.
- Keeping soil and vegetation disturbance to a minimum
- Where disturbance is unavoidable, staff will monitor bare ground and ensure invasive species are removed.
- Invasive species monitoring and removal within the fence will happen on a quarterly basis with waste hauled off site and destroyed

- Staff will be trained to recognize invasive species and to report them to project manager so that an action plan can be drawn up if new invasive species are encountered, if necessary.
- Vehicles will be washed with soap after off-roading or after picking up mud from driving. A pressure washer with soap will be used to clean all soil off the tires and vehicle undercarriage.
- Tools used in other areas will be cleaned thoroughly before use in or around the site.

#### **17.4.4. BMPs - Plant Protection during Predator Control**

As noted above, the overall effect on plants of the Kahuama'a Seabird Preserve is likely to be positive. However, the risk to rare and listed plants from the need to enter the preserve to monitor rodent eradication equipment, especially during the initial phase of eradication, could be:

- Trampling, erosion, disturbance
- Alteration to native habitat
- Frequently traveled transects will experience increased disturbance and erosion risk
- Listed or rare plants risk being trampled or disturbed

Impacts will be completely avoided using BMPs as follows:

- Listed or rare plants will be identified and flagged. IE staff will be required to have a map and / or GPS point of listed or rare plants with them at all time while in the field.
- Personnel will be encouraged to tread lightly and to remain on trails rather than cutting through vegetation.
- If listed or rare plants are thought to be at particular risk of trampling because of their location near a trap or bait box, the trap or bait box will be moved. If this is not possible, the plant will be protected by a small fence.
- No live feral cat trapping or barn owl control will occur within 10m of known listed plant species to avoid harm to those species.

#### **17.4.5. BMPs - Plant Protection during Monitoring Work**

Risks to listed or rare plants could be:

- Listed or rare plants risk being trampled or disturbed during burrow monitoring, camera installation and auditory / visual surveys.

Impacts will be completely avoided using BMPs as follows:

- Prior to the commencement of the work, pre-construction surveys will have identified the presence of any rare or listed plants. These will be marked and mapped and staff will be required to carry a map and / or GPS will the location of the plants. If necessary,

protective mini-fences will be placed around specimens to ensure that they are not accidentally trampled.

- Cameras will not be placed on natural burrows within 10m of listed plant species to reduce traffic and disturbance.

#### **17.4.6. BMPs - Plant Protection during Habitat Restoration**

Risks to listed and rare plant species during invasive species removal and vegetation restoration could be:

- Disturbance and uprooting.
- Loss of sediment
- Soil instability
- Erosion
- Risk being trampled or disturbed during invasive plant species removal
- Accidental introduction of additional invasive species
- Bare ground following invasive removal being recolonized by invasive species
- Herbicide affecting native plants
- *Myrsine knudsenii* being mistaken for Strawberry Guava

Impacts will be completely avoided through the following BMPs for erosion control.

- In steep grade areas (>25%), clearance will be conducted by hand rather than with machinery.
- Vegetation clearance will be timed for periods of good weather as far as practically possible.
- To minimize risk of increased erosion in freshly disturbed areas during rainfall events, re-vegetation will occur as soon as possible after clearing and within 3 months, using with suitable native grass outside the fence.
- Clearing will not be conducted during heavy rain.
- If damage to vegetation and substrate is likely to occur during monitoring activities in certain areas, boardwalk sections will be placed over the area.
- Control of key seabird habitat modifiers especially in the maintenance phase will be accomplished by mechanical means (i.e. physically removing) with hand tools over the use of herbicides where possible. Large patches of seabird habitat modifiers will not be removed all at once to avoid leaving large areas of bare soil. Where this is not possible, erosion and weed control cloths will be put down if appropriate.
- Where required, herbicides will be applied following instructions at minimum volumes, rather than broadcast, and during prolonged spells of dry weather where possible and never during periods of heavy rainfall. Whenever possible (expected to be most cases), small volume bottle applicators, which delivers herbicide in very small quantities, will be used
- These identified herbicides are classified as 'general use' and not 'restricted use' but will need to be applied under a herbicide application permit. Personnel conducting these

activities will adhere to all label restrictions and guidelines. Non-native vegetation removal BMPs may be improved or adapted as new technologies become available.

- All plant waste will be black bagged at the point of removal (rather than carrying off site and dropping seeds) then removed and destroyed off site in a lowland facility. Dead blackberry stalks will be left in situ to deter ingress of other non-natives.
- Specific plant locations (e.g., UTM coordinates) will not be revealed in the public review.
- Where invasive species are within 10m of listed plant species, herbicides will not be used.
- Currently, trails at the site are based on botany surveys and lead to rare plants. IE staff will discontinue the use of these trails to avoid rare plants and establish a new route to and around the site.
- DOFAW/PEPP staff will continue to monitor individual plants long term.
- Project staff will be trained on plant identification by State or Federal botanists.
- Care will be taken not to introduce new non-native plants through construction / monitoring activities by cleaning boots, clothes, packs and gear between site visits to ensure that seeds are not carried from other areas
- Vehicles will be washed with soap after off-roading or after picking up mud from driving. A pressure washer with soap will be used to clean all soil off the tires and vehicle undercarriage.
- Tools used in other areas will be cleaned thoroughly before use in and around the site..
- Every effort will be made to ensure that the area remains visually and structurally intact. Soil and vegetation disturbance will be kept to a minimum. Where damage to the ground cover is unavoidable from invasive species removal, replanting with native plants will be carried out.
- Staff will receive training so that they can tell the difference between native / listed plants and invasive plants. Staff will carry an identification guide while undertaking plant work.

## **17.5. WATER COURSE, DRAINAGE & EROSION**

### **17.5.1. BMPs – Watercourse, Drainage, Erosion Protection**

During fence construction, BMPs will be employed to minimize erosion, sedimentation and contamination of aquatic environments (e.g. streams) in the project area.

#### **Contaminations**

The proposed bait for the rat stations is diphacinone. The project site is more than 200m from any known water source and diphacinone in this bait form is almost insoluble in water.

#### **Erosion and Sedimentation**

Figure 17.1 shows the topography at the site which contributes to the risk of erosion.



**Figure 17.1. 3D Map showing topography at the site.**

Risks to listed and rare plant species, listed seabirds and natural habitat could be:

- Disturbance and uprooting.
- Erosion might compromise the exclusion of predators from the fence
- Erosion of soil particles into watercourse could damage fish and other freshwater habitat species
- Bait dragged out of the boxes by rodents could fall into water courses and drainage areas.

Impacts will be completely avoided as follows:

#### Erosion

- In steep grade areas (>25%), fence clearing will be conducted by hand rather than with machinery.
- To minimize risk of increased erosion in freshly disturbed areas during rainfall events, clearing will not occur more than 1 week prior to construction.
- Clearing will not be conducted during heavy rain.
- Prior to disturbance, erosion control devices including (but not limited to) sand bag barriers, trenches, geotextile, filter fabric, vegetation matting, and rubber water guides will be put in place if required. Small trenches ( $\leq 2$  m in length) will be dug from the fenceline during the fence installation process to divert water away from the fence if required.
- Sandbags, trenches, and water guides will be inspected daily during construction activities and monthly for the 30-year duration of the Program.

- Cleared areas will be outplanted within 3 months after construction with native grass.
- BMPs to protect against the ingress of invasive species are outlined in section **Error! Reference source not found.**

#### Contamination

- The minimum amount of bait will be used to achieve additional rat eradication.
- Project staff will remove all bait found outside of the bait stations and either dispose of it or replace it in a bait box
- Bait stations will only be used inside the fence
- Bait will be placed on metal sticks inside the bait boxes
- Fueling of project related equipment (chainsaws) will take place away from the aquatic environment. Absorbent pads should be stored on-site to facilitate clean-up of accidental petroleum spill should a release occur.

### **17.6. CULTURAL /ARCHAEOLOGICAL**

#### **17.6.1. BMPs – Cultural / Archeological – all aspects of project**

Risks to any possible sites could be:

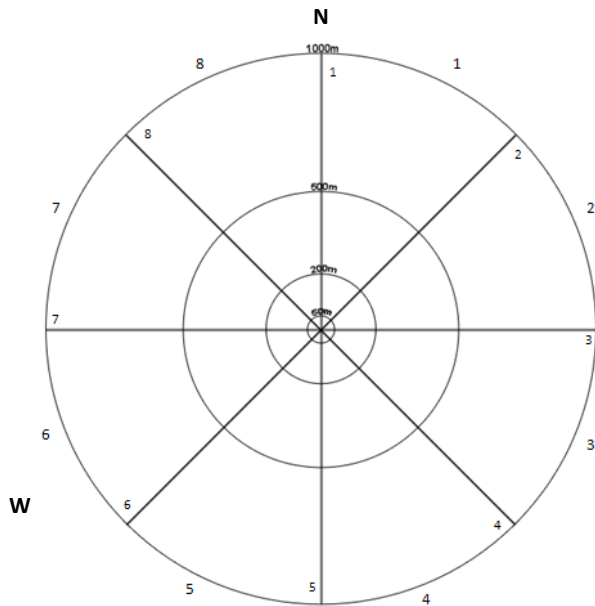
- Damage or destruction to archaeological remains and features

Impacts will be completely avoided using BMPs during pre-construction work as follows:

- An archaeological survey will be commissioned and carried out by a suitably qualified consultant.
- The survey report will be provided to the State Historic Preservation Division. Their advice will depend on the results of the survey. Based on that advice, additional BMPs may need to be added to ensure that cultural resources are not affected.
- Immediately before and after ground clearing activities, a cultural and archaeological monitor will inspect the area.
- Immediately before and after ground clearing activities, a cultural and archaeological monitor will inspect the area.
- If archaeological or human remains are discovered during the construction of the fence or the clearing of non-native weeds, work in the area will cease and the Division of State Parks archaeological staff and / or Burials Program of the State Historic Preservation Division will be immediately notified. They will liaise with project staff on how to proceed.
- All staff (including the fence contractors) will be given oral and written instructions pertaining to archaeological and cultural sites.

## 18. APPENDICES

### Appendix 1: KESRP Data Sheet



**Time start and survey duration:** Dusk surveys start at sunset, and survey duration is 2 hours. Dawn surveys start 2 hours before sunrise and duration is 90 min. Surveys are split into 30 minute sessions, with 5 minutes allotted for weather data, 25 for auditory, and 5-10 for concurrent night vision if available.

**Location:** Use a GPS and record ~ error in m. Create a waypoint for your location with year (2 digits), Julian date (3 digits), initials (2 letters), and time (AM/PM), e.g. **09125JHPM**

**Weather:** Use code descriptions. Use

**F** geographic reference points (how high are adjacent cliffs compared to clouds?) and make comments about cloud activity at height.

**The target circle:** Take 5 min to draw in major

features and bearings. Confirm major directions to geographic features.

**What is a call?** A call is a single **unbroken** note or series of notes. Where there is a pause any subsequent call is treated as a new and separate call (regardless of if you perceive it to be the same bird).  $\geq 2$  birds calling at the same time are treated as separate calls. If a site is so active that it is impossible to accurately count calls/minute, 25 is recorded in the multiplier column and "uncountable" is recorded in the comments.

#### Data to be collected:

- 1. Time:** 2400 clock, min scale. Tally calls with same distance and direction in that minute.
- 2. Quadrat:** One of 8 regions you heard the call based on direction.
- 3. Distance:** The approximate distance from the listener to the caller. Distance is broken into 5 basic categories – 0-50m (1), 51-200m (2), 201 – 500m (3), 501-1000m (4). Distance can also be recorded in 100m (e.g. 1=100). NOTE: *also include 50m as (0.5)*. Data will be treated in 4 basic categories. ***If you find that this scale (i.e. calls up to 1000m) is inappropriate (e.g. birds calling on ground close by) include additional distance estimate in comments.***
- 4. Behavior:** The direction the bird is flying TOWARDS if it is possible to determine. This can become somewhat subjective to determine if the call is  $> 500m$ , or if only partial notes are heard. 1=North, 2=NE, 3=East, etc.. 9=circling, 10=stationary/ground, 11=transit. ***If you hear ground calling, record a bearing!***

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5. **Elevation:** Either below (1), same / approx. equal height to observer (2) or above (3). Leave blank if unknown or indeterminate.
6. **Species:** Leave blank if NESH. If any other species record as 4-letter codes based on first and second names.
7. **Comments:** Based on footnote system – use numbers in cell and record comments in space below.

DRAFT

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## 20. PERSONAL COMMUNICATIONS

- Katie Cassel, 2017, Founder and Manager, Kōke'e Resource Conservation Program.
- Spencer Engler, 2017, Habitat Conservation Plan Compliance Technician for First Wind, Makamaka'ole Seabird Preserve.
- Wendy Kishida, 2017, Kauai PEPP Coordinator, Kauai Plant Extinction Prevention Program.
- Dr. Andre Raine, 2017, Manager, Kauai Endangered Seabird Recovery Project.
- Galen Reid, 2016, Predator Control Specialist, DOFAW.
- Kyle Pias, 2017, Co-ordinator, Hono O Nā Pali Seabird Mitigation Project.
- Adam Williams, 2017, DOFAW.
- Dr. Lindsay Young, 2017, Vice President and Executive Director, Pacific Rim Conservation.

## APPENDIX B: COVERED SPECIES BIOLOGICAL DETAILS

This appendix to the KSHCP contains the biological details on distribution, abundance, population trends, life history, habitat and threats to the Covered Species in the KSHCP. The information presented in this appendix serves to support the conservation actions and assumptions of the Program.

### 1. 'A'o

The 'a'o or Newell's Shearwater (*Puffinus newelli*) is endemic to Hawai'i and most of the current-day population breeds on the island of Kaua'i. The species is listed as 'Threatened' under Federal and State of Hawai'i endangered species laws and 'Endangered' on the International Union for Conservation of Nature (IUCN) Red List of Threatened Species (Birdlife International 2010). The 'a'o belongs to the *Puffinus* genus of small shearwaters which includes the Manx shearwaters (*Puffinus puffinus*) and the Townsend's Shearwaters (*Puffinus auricularus*).

The 'a'o is a small, black and white shearwater with a dark tail (**Figure 1-1**). As with most shearwater species, the 'a'o has a dark narrow bill with a slightly hooked tip. While some taxonomists describe it as a Manx-type shearwater based on size and general plumage similarities, others describe it within the Little/Audubon's group based on the extent of white plumage on the sides of the rump and black upperparts (Onley and Scofield 2007). In flight, the 'a'o displays rapid wing beats, often flies close to the water and with little soaring (Onley and Scofield 2007).



**Figure 1-1.** The 'a'o – Newell's Shearwater. Photo B Spiegel, SOS.

The ‘a’o was thought to be extinct by 1908 but was later rediscovered in 1947. In 1967, the species was confirmed breeding on Kaua’i when a hunter’s dog killed one and brought it to the hunter. He reported it to the authorities. John Sincock and Gerald Swedberg then searched for the birds, finding their burrows and further predations.

In subsequent years, fledglings became attracted to, and disoriented by, an increase in urban lighting and became grounded (King and Gould 1967, Sincock and Swedberg 1969). An effort to decrease mortalities associated with light attraction led to the formation of the “Save Our Shearwater” (SOS) rehabilitation center in 1978 by the U.S. Fish and Wildlife Service and the State of Hawai’i, Department of Land and Natural Resources. Records from the ~30,000 shearwaters to go through SOS from 1978-2016 have been used in population modeling and to understand population trends (Ainley et al. 2001a, Day et al. 2003b, Raine et al. 2017c). Initial colony monitoring was done on low elevation colonies in the early 1980s (Telfer 1986) and some of these same sites were later revisited in the 1990s in studies assessing reproduction (EPRI 1995a, b). Radar surveys began in 1993 to quantify Newell’s movement from sea to land at several locations around the island and are continue to this day.

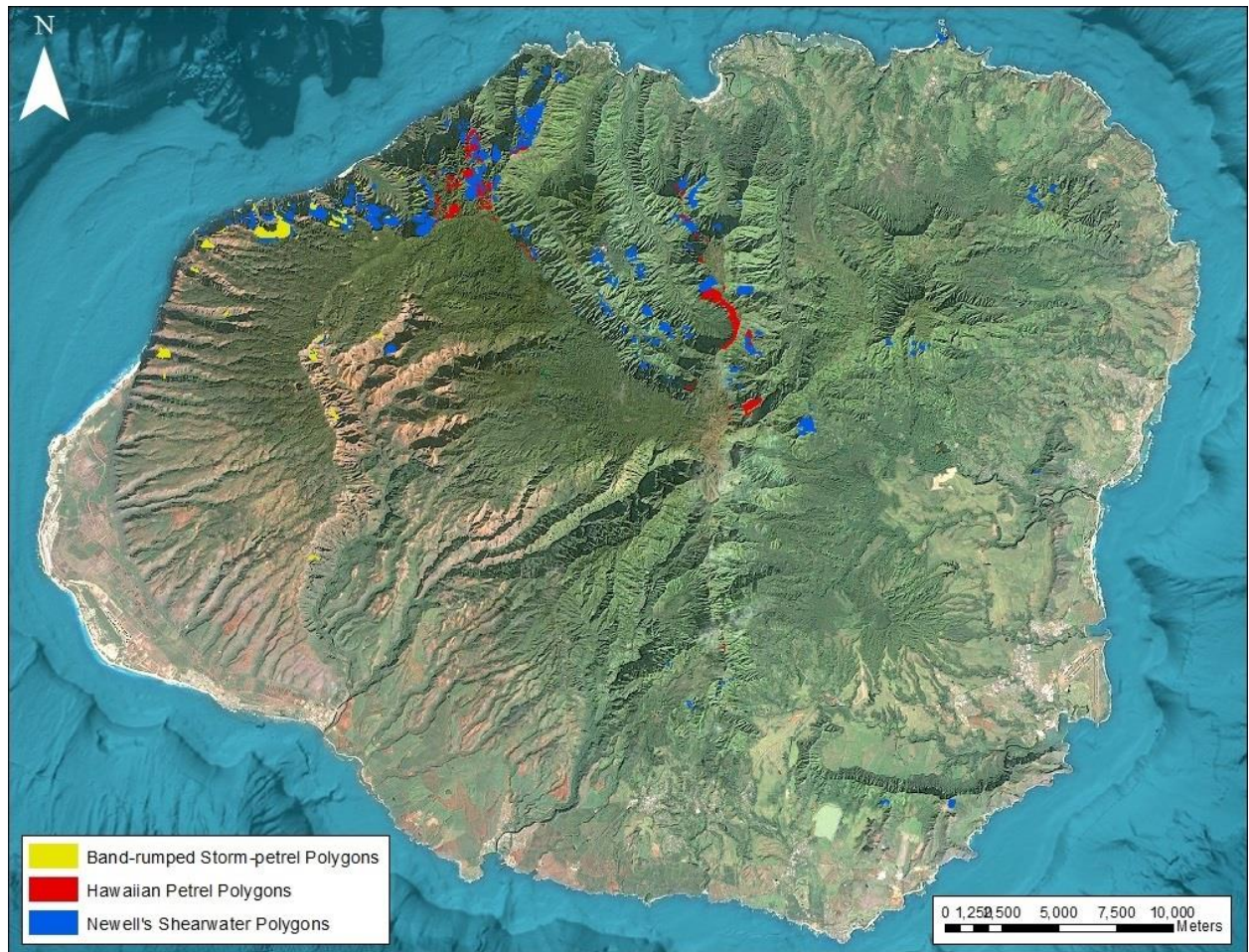
This long-term data set has been used to plot population trends (Raine et al. 2017c). Since 2006, regular auditory surveys, acoustic monitoring, and nest searching by the Kaua’i Endangered Seabird Recovery Project led to the discovery of large colonies of ‘a’o in the northwest mountains of Kaua’i (KESRP, unpubl. data) A large amount of research and monitoring of ‘a’o colonies from 2011 to the present has been funded through the KIUC Short Term Habitat Conservation Plan (HCP), as well as through the National Fish & Wildlife Foundation, State Wildlife Grants and additional funding sources. Through this program, and due to increased focus on species recovery, there has been a significant effort to locate all breeding colonies on public lands and where private landowners allow access. The largest gap in data is on land owned by the Robinson family (~20% of total land mass on the island of Kauai), where no surveys have been permitted.

### **1.1. Distribution, Abundance, and Population Trends of the ‘A’o**

The ‘a’o is endemic to the Southeastern Hawaiian Islands. The island of Kaua’i supports the largest current-day breeding population of the ‘A’o, estimated at up to 90% of the total population (Ainley et al. 1995a, USFWS 2011), while smaller populations are known to breed on the islands of Hawai’i and Maui. O’ahu, Lāna’i, and Moloka’i (Day and Cooper 1995, Reynolds and Ritchotte 1997, Day et al. 2003a, Onley and Scofield 2007, VanderWerf et al. 2007, Natividad Bailey 2009, McKown and Savage 2015).

The Kaua’i Endangered Seabird Recovery Project (KESRP), the program primarily responsible for conducting research on the ‘a’o and ‘ua’u on Kaua’i, has conducted auditory surveys to detect ‘a’o breeding calls and track relative calling densities. This information, in conjunction with identified breeding colonies provides the known distribution of the ‘a’o on Kaua’i. The ridges and

slopes along the northwest coast of Kaua'i display the highest levels of 'a'o breeding activity (**Figure 1-2**) (Banfield et al. 2013, Raine and McFarland 2014b, a).



**Figure 1-2.** Map of ground calling locations, indicating Calling Hotspots and breeding activity on Kaua'i. 'A'o (in blue), the 'ua'u (in red), and the 'akē'akē (in yellow) (KESRP).

The species' pelagic range is not fully understood. During the breeding season the species is typically found foraging on the ocean a short distance to the west and north of the southeastern Hawaiian Islands (Onley and Scofield 2007). 'A'o are observed at sea in warmer areas of the Tropical Pacific with a strong, deep thermocline, more cloud cover, less mixing in the water column and where trade winds are less developed. They are typically found foraging approximately 800 miles south and east from nesting colonies on Kaua'i in the deep-water regions of the Equatorial Counter Current, and more specifically, the Inter-tropical Convergence Zone, to the north (up to 25° N), and east (to about 120°W) of the Hawaiian chain (Spear et al. 1995). Juvenile 'a'o have been tracked after fledging at over 1,400 miles to the southwest of Kaua'i with longer tracks extending to over 2,700 miles to the southwest. Adult 'a'o have been tracked taking differing routes from the fledglings after the breeding season, with one individual following the Northwest Hawaiian Islands, and the other moving southeast of the main Hawaiian Islands (Raine et al. 2015a, Raine et al. 2017a).

At-sea surveys conducted in the central and eastern tropical Pacific between 1980 and 1994 (Spear et al. 1995) estimated the total 'a'o population at 84,000 (95% CI = 57,000-115,000) including juveniles and subadults. An updated assessment based on survey data collected by the National Oceanic and Atmospheric Administration, National Marine Fisheries Service (NOAA-NMFS) Southwest and Pacific Islands Fisheries Science Centers from 1998 to 2011, estimated the total 'a'o population at 27,011 (95% CI = 18,254-37,125) including juveniles and subadults (Joyce 2013). With an approximate 90% of the total population based on Kaua'i, this estimate can be adjusted to 24,310 individuals on Kaua'i. It should be noted that these studies consisted of different data sampling techniques and statistical analyses from each other, therefore the studies are not directly comparable. Each study provides an estimate of the at-sea population of Newell's Shearwaters during the respective sampling periods.

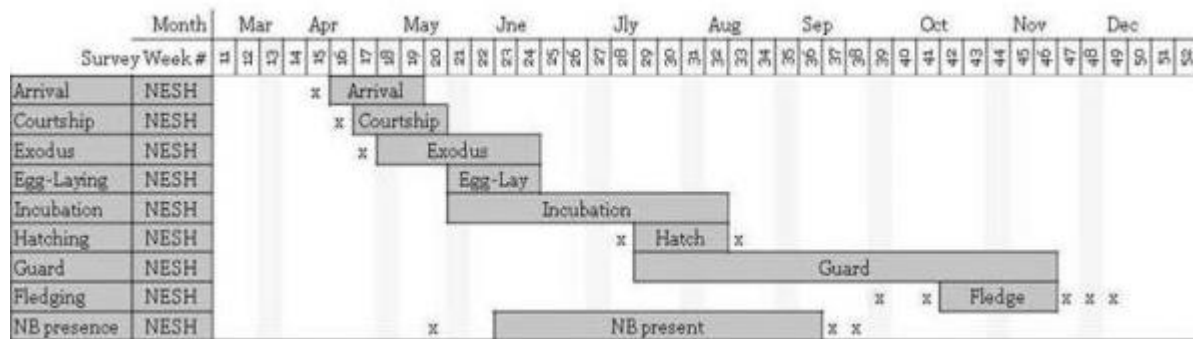
The population of 'a'o is estimated to have declined by 94% (at an average rate of ~13% per year) from 1993-2013 (Raine et al. 2017c) and is predicted to continue to decline (Griesemer and Holmes 2011b). Populations of 'ua'u are estimated to have declined by 78% (at an average rate of ~6% per year) during the same period (Raine et al. 2017c).

In line with these measurements, auditory surveys have confirmed a restriction of the species' breeding range. Surveys have shown significantly lower levels of breeding activity at three previously highly active colonies (Kalaheo, Anahola, and Makaleha), and the probable extirpation of others (e.g., Kaluahonu) (Ainley et al. 1995b, Holmes and Troy 2008)(KESRP, unpublished data).

Reducing the population estimate based on a range of presumed predation rates (see [Appendix E: Social Attraction Estimator Model](#)) yields a current 2016 population estimate of 13,049-17,172 individuals. Assuming a stable age distribution (Ainley et al. 2001b), the population size range presented above would include approximately 8,312-10,938 birds of breeding age.

## **1.2. Life History and Habitat Selection of the 'A'o**

The 'a'o breeding season begins in late March/early April, when birds return to colonies (Ainley et al. 1997a, Zaun 2007, Deringer and Holmes 2009) (**Figure 1-3**). The 'a'o exhibits high site and mate fidelity. Higher rates of 'a'o calling are detected during this period when non-breeding individuals are also concentrating at breeding areas (Deringer 2009).



**Figure 1-3:** Breeding phenology of the 'ua'u (HAPE) and the 'a'o (NESH) on Kaua'i adapted from Deringer (2009). NB = non-breeders. Outlier observations indicated with "X"s.

A pre-egg laying exodus follows in late April, and egg-laying occurs in June. Pairs produce a single white egg with an average incubation period of between 53 and 55 days. Incubation is shared by both parents (Ainley et al. 1997b). After hatching, both parents participate in feeding their chick, with one adult making short foraging trips (every 1-3 days) while the other adult makes long trips (can be away for up to 12 days) (Zaun 2007) (KESRP unpublished data).

Juveniles will not emerge from the burrow until just 12-20 days before fledging. The fledging period ranges anywhere from 81 to 94 days after hatching (Zaun 2007). Fledging occurs between late September through early December with peak fledging levels in October (Ainley et al. 1997b, Raine and McFarland 2014b, a). Fledglings depart nests from after sunset to before sunrise with a peak in the first few hours after dark (KESRP, unpublished data).

Juveniles will spend the majority of time at sea, returning to their natal areas only to prospect for mates and burrow sites between year two to five. 'A'o begin reproducing at 6 years of age (Brooke 1990, Ainley et al. 2001b).

Shearwater reproductive success, measured as the percentage of successful fledglings per eggs laid, per year, ranges between 40-70% in similar species around the world (Brooke 2004). Griesemer and Holmes (2011b) report that the mean reproductive success of burrowing Procellariiformes for studies equal to or greater than three breeding seasons was  $0.32 \pm 0.17SD$  (n=17) in areas where predators were present and was  $0.62 \pm 0.08SD$  (n=9) for areas where predators were eradicated. KESRP conducted a study in Upper Limahuli Preserve, a site in Kaua'i protected by an ungulate proof fence (from 2009) and managed by NTBG, where predator control for rats and cats is taking place. Fledging success for 'a'o went from 54.5% in 2011 to a high of 88.2% in 2015 from nests where breeding was confirmed; 'ua'u breeding fledging success went from 0.01% in 2011 to a high of 64.5% in 2016. The study looked at over 100 nests. During this time period, predator eradication has increased steadily in effort and efficiency (Raine et al. 2017g). In the modeling efforts of Ainley et al. (2001b), a breeding probability of 54.7% was determined. This is low when compared to reported values for other Procellariiformes and it is likely to be caused by mortality from adult predations and powerline collisions (Telfer 1986, Ainley et al. 2001b).

Survivorship of 'a'o has been estimated in population viability modeling efforts at 0.905 (Ainley et al. 2001a) to 0.92 (Griesemer and Holmes 2011a, USFWS 2017b, a). Juvenile (sub-adult) survivorship was estimated at 0.333 by Ainley et al. (2001a) based on long term studies on the Manx shearwater (Brooke 1990) and other species related to the 'a'o.

'A'o capture prey by diving after fish schools and are often seen in association with big predatory fish, such as tuna that cause smaller prey species to swim up to the surface. When under water, 'a'o can swim to depths of over 45m to pursue prey. An analysis of the stomach contents of 'a'o fledglings collected dead beneath power lines showed a composition of 0.1-0.3% shrimp-like crustaceans, 0.1-4% fish, and 96-99% squid, most of which were ommastrephid (flying) (37-57%) and pyroteuthid (fire) squid (7-16%), and exocoetid (flying) fish (<0.1-1.7%) (USFWS 1983, Harrison 1990, Ainley et al. 1997b, Ainley et al. 2014, USFWS 2016b).

Breeding colonies are typically located at high elevations in areas of open native forest dominated by 'ōhi'a lehua (*Metrosideros polymorpha*) with a dense understory of 'uluhe fern (*Dicranopteris linearis*) (**Figure 1-4**). Current-day breeding sites are restricted both geographically and in terms of elevation from what they once were, and historically the 'a'o may have bred at lower-elevation sites (Mitchell et al. 2005, Pyle and Pyle 2009).

Nests, consisting of burrows dug into the ground, are most commonly placed at the base of trees, where the substrate may be easier for the birds to excavate. Some colonies on Kaua'i are located in steep slopes above sheer cliffs (Wood and Holmes 2008), where birds are presumed to nest in rock crevices rather than burrows.

Vegetation at active 'a'o breeding colonies was composed of 25-35% native tree canopy, and 75-85% native shrub and fern layers (Holmes and Troy 2008, Holmes et al. 2009). Studies investigating the microhabitat characteristics of known colonies suggest that sites distinguished by steep slopes, moderately rocky hard soils, and low nonnative vegetation are the most suitable nesting habit (Troy et al. 2014, Troy et al. 2016).



**Figure 1-4:** ‘A’o and ‘ua’u habitat: ōhi’a lehua tree root structure for burrows. Photo: P Belson.



**Figure 1-6:** ‘A’o and ‘ua’u habitat: ‘uluhe fern with burrow. Photo: A Raine.



**Figure 1-5:** ‘A‘o and ‘ua‘u habitat”: intact native montane forest (Upper Limahuli Preserve). Photo: Y Reiss, left. A Raine, right.

### 1.3. Threats to the Continued Existence of the ‘A‘o

The primary threats to the ‘a‘o population include: light attraction; collisions with utility structures predation at their breeding sites by introduced mammalian and avian predators; breeding habitat loss and alteration caused by invasive plants and introduced ungulates; public use; urban development; at-sea factors affecting their prey-base; global climate change; and stochastic events.

Other threats include climate change and its affects to both seabird adult survivorship and recruitment by generally affecting food availability (Oro 2014). Each of these factors is discussed below in more detail in [Section 1.1.4](#).

## 2. ‘Ua‘u

The ‘ua‘u, or Hawaiian Petrel (*Pterodroma sandwichensis*) is endemic to the Southeastern Islands of Hawai‘i. The ‘ua‘u is listed as ‘Endangered’ under Federal and State of Hawai‘i endangered species laws and is classified as ‘Vulnerable’ on the IUCN Red List of Threatened Species (Birdlife International 2007). The ‘ua‘u was once considered a subspecies of the Dark-rumped Petrel (*Pterodroma phaeopygia*) but was split taxonomically based on morphology and breeding range (Brooke 2004, Onley and Scofield 2007). The Dark-rumped Petrel has since been renamed and is now referred to as the Galapagos petrel (*Pterodroma phaeopygia*), a species endemic to the Galapagos Islands.

The ‘ua‘u is a stout, medium-sized petrel with light underparts, dark upperparts, and white feathers on the forehead, around the bill, lower cheeks, chin and throat (**Figure 1-7**). It is one of the larger species in the *Pterodroma* group, with longer, more pointed wings than congeners but with heavier shorter wider wings, shorter deeper bill, and a shorter dark tail than Galapagos Petrel (Onley and Scofield 2007). The grayish-black bill is relatively short and stout, with a sharp, decurved tip. In flight, ‘ua‘u demonstrate characteristic *Pterodroma* dynamic soaring with high-sweeping arcs and a rhythmic rocking “pendulum” motion (Onley and Scofield 2007).



**Figure 2-7:** The 'Ua'u – Hawaiian Petrel. Photo A. Raine, KESRP

### **2.1. Distribution, Abundance and Population Trends of the 'Ua'u**

The 'ua'u only breeds in the Southeastern Hawaiian Islands. It is thought that the species once bred on all the main islands of Hawai'i, except Ni'ihau (Simons 1985, Mitchell et al. 2005). Current-day breeding populations are primarily on the island of Maui, particularly in Haleakalā National Park, and on the island of Kaua'i at high-elevation nesting colonies. Smaller populations breed on the islands of Hawai'i and possibly Moloka'i (this has not been confirmed). There is also a large breeding population on the island of Lāna'i (Day et al. 2003a, Onley and Scofield 2007, Tetra Tech 2008, Holmes and Joyce 2009, Natividad Bailey 2009, Pyle and Pyle 2009, Raine et al. 2017h).

KESRP has conducted auditory surveys on Kaua'i which indicate calling concentrations and breeding locations. This information, in conjunction with breeding colonies identified on the ground provides the currently known distribution of the 'ua'u on Kaua'i. The ridges and slopes along the northwest coast of Kaua'i display the highest levels of 'ua'u breeding activity. [Figure 1-2](#) illustrates calling hotspots and the sites where breeding activity was documented by KESRP (Banfield et al. 2013, Raine and McFarland 2014b, a).

Based on at-sea survey data, Spear et al. (1995) estimated a total 'ua'u population of 19,000 (10,600 – 34,400) individuals and an estimate of 4,500 to 5,000 breeding pairs (Spear et al. 1995, Ainley et al. 1997a). Joyce (2013) estimated a population abundance equal to an average of

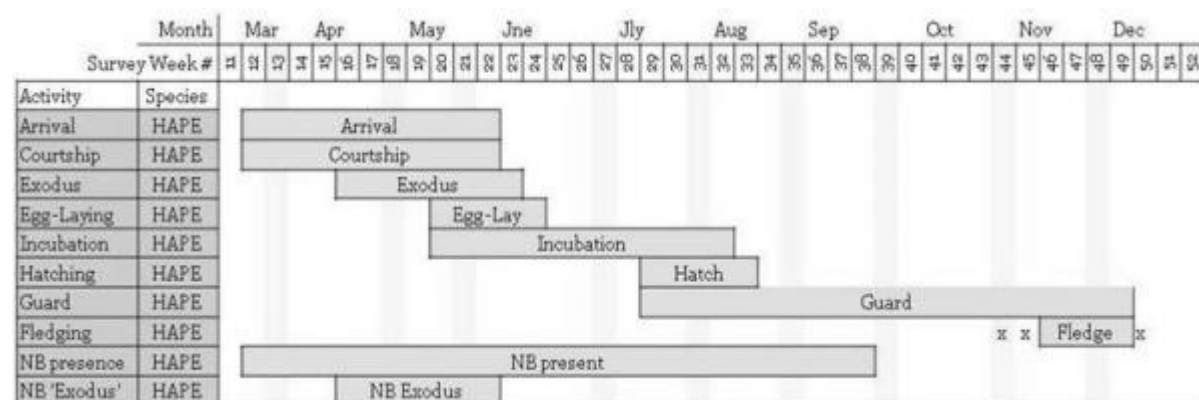
52,000 individuals using at-sea data collected over the more recent sampling period of 1998-2011 (Joyce 2013). The estimates from Joyce (2013) and Spear et al. (1995) are not directly comparable due to difference in survey locations (i.e., longitudinal and latitudinal) and timing in regards to breeding phenology; however, together the studies provide an estimate of the at-sea population of ‘ua‘u at the different time periods.

The Kauai subpopulation was estimated at 1,200 (Pyle and Pyle 2009) to 1,600 breeding pairs (Ainley et al. 1997a). Overall population estimates are currently being revised, but recent data suggests that Kaua‘i may contain a much more significant portion of the world breeding population of the ‘ua‘u than the predicted by early earlier estimates (Raine, 2017, pers. comm).

Studies informing the population trends of the Hawaiian Petrel on the island of Kaua‘i indicate the population has declined. Recent radar data analyses for Kaua‘i indicate a >78% decline in ‘ua‘u numbers during the period from 1993-2013 (Raine et al. 2017c)

## 2.2. Life History and Habitat Selection of the ‘Ua‘u

The ‘ua‘u breeding season on Kaua‘i begins in April when birds return to the island to commence breeding. The ‘ua‘u, like many petrels, displays a high degree of site and mate fidelity; nesting pairs return to the same nesting burrow year after year. They enter and exit their burrows only under the cover of night as a defense against potential predators (Simons 1985). Most pairs visit burrows for just a few nights at the beginning of the season before going on exodus. **Figure 1-8** summarizes the annual breeding phenology for the Kaua‘i population of the ‘ua‘u, adapted from (Deringer 2009); ‘ua‘u is coded as “HAPE” in this figure.



**Figure 2-8:** Breeding phenology of the ‘ua‘u (HAPE) on Kaua‘i adapted from Deringer (2009). NB = non-breeders. Outlier observations indicated with “X”s.

Prior to egg-laying and incubation, adult ‘ua‘u depart the nest for approximately three weeks to build up fat and nutrient reserves prior to egg laying (females) and incubation (males) (Harris 1966, Perrins and De L. Brooke 1976). Parental care from both sexes is necessary to rear a single nestling.

Egg laying begins at the end of April. Breeding females lay a white egg each year. Incubation typically begins immediately after laying and lasts 54-58 days (Simons and Hodges 1998). Both adults take shifts lasting several days at a time, thus relieving the other adult to feed.

Once a chick hatches, in July or August, it remains in the nest and depends on parental care for approximately four months (Simons 1985, Simons and Hodges 1998, Mitchell et al. 2005). Fledgling occurs in the fall months; adults and juveniles depart the breeding colony in late November-mid December, remaining at sea for several months before adults and sub-adults return the following spring. 'Ua'u breeding on the islands of Hawai'i, Maui, and Lāna'i fledge young earlier (early November) than those breeding on Kaua'i (mid November, early December) (Simons and Hodges 1998, Natividad Bailey 2009, Raine et al. 2017h). Fledglings will not return to land for 2-5 years. The Hawaiian petrel begins reproducing at 6 years of age (Simons and Hodges 1998).

Petrel diets typically include squid, fish, crustaceans and plankton found at the surface (Simons and Hodges 1998). Largely nocturnal in their hunting habits, 'ua'u skim the upper surface of the water for prey driven to the surface by other seabirds and marine predators. Studies of breeding petrels at Haleakalā National Park on Maui found ten different prey types obtained from three classes of marine organisms (Simons 1985, Harrison 1990).

The 'ua'u nests in burrows, crevices in lava, and under ferns. Nesting habitat on Kaua'i appears structurally similar to known breeding sites on Lāna'i (Penniman 2010, Wiley et al. 2012). On Lāna'i, 'ua'u burrow primarily in fern beds (VanZandt et al. 2014, Raine et al. 2017h). In comparison, nest burrows on Maui and Hawai'i islands are found at high elevation sub-alpine sites (e.g., at Haleakalā: 3000m elevation and <10% vegetation coverage) between lava rocks. Based on auditory surveys and burrow searching conducted by KESRP on Kaua'i, the 'ua'u burrows at high-elevation sites comprised of predominantly wet montane forest of native vegetation, under Ōhi'a and Lapa lapa trees, similar to that of used by the 'a'o but typically higher in elevation (Holmes and Joyce 2009).

As described by Troy et al. (2016), when compared to 'A'o, 'ua'u burrows are associated with softer soils, lower surrounding vegetation and are closer to wind exposed ridges. 'Ua'u burrows also show a wider range in habitat characteristics. As with other forest-dwelling seabirds around the world, a fern-dominated understory provides a softer landing for petrels, and the interspersed tree roots provide suitable soil structure for burrow excavation (Holmes and Wood 2007).

### **2.3. Threats to the Continued Existence of the 'Ua'u**

The primary threats to the 'ua'u population on Kaua'i include power line collisions, light attraction, predation at breeding sites, breeding habitat loss and alteration, disease, and at-sea

factors affecting prey availability, global climate change, and stochastic events. Each of these factors is discussed in more detail below.

### 3. 'Akē'akē

The 'akē'akē, or Band-rumped Storm-petrel (*Oceanodroma castro*), is a small, highly pelagic storm-petrel of the Family Hydrobatidae. The 'akē'akē is listed as endangered under the Federal ESA, as well as the State of Hawai'i endangered species law. The Hawaiian population of the 'akē'akē was once recognized as a distinct subspecies. However, taxonomists now consider this population as sympatric with various other Pacific Ocean populations (Onley and Scofield 2007).

In 2011, the USFWS, as part of its review of the species for potential listing, determined that the Hawaiian breeding population of the Band-rumped Storm-Petrel constitutes a distinct population segment (DPS) based on geographic and distributional isolation from other Band-rumped Storm-Petrel breeding populations in Japan, the Galapagos Islands, and the Atlantic Ocean. Further, the USFWS determined that the Hawai'i population segment is considered "significant" in that its loss would constitute a significant gap in the range of the taxon (USFWS 2015). The Hawaiian population of the Band-rumped Storm-Petrel is the only population within U.S. borders or under U.S. jurisdiction.

The 'akē'akē is a very small seabird with a total length of about 20cm and weighs 33-67g. The plumage of the 'akē'akē is overall blackish-brown, with a sharply defined narrow white band across the "rump." Its tail is slightly notched and may appear almost squared, unlike most other members of Hydrobatidae, which are more deeply notched (Harrison 1990) (**Figure 1-9**). Its bill is dark and long.



**Figure 3-9:** 'Akē'akē – Band-rumped Storm-petrel. Photo T Anderson, SOS.

### **3.1. Distribution, Abundance, and Population Trends**

The 'akē'akē species is widely distributed, occurring in both the Atlantic and Pacific oceans and in both tropic and sub-tropic waters. However, the Atlantic and Pacific breeding populations are considered distinct and are unlikely to intermingle due to the species' aversion to overland flights.

'Akē'akē populations across the Pacific are isolated from each other. Extensive at-sea surveys of the Pacific near Hawai'i have revealed a broad gap in distribution of the 'akē'akē to the east and west of Hawai'i (del Hoyo et al. 1992, Slotterback 2002, Naughton et al. 2005). The Hawai'i population of the species is considered a distinct breeding population (USFWS 2015).

In addition, KESRP in 2016, KESRP participated in genetic study with the Queens University, Ontario. In the study, 'akē'akē from Kaua'i were compared with other 'akē'akē from around the world. The results suggest that birds from Kaua'i are genetically distinct from other populations (Taylor et al. in prep).

The 'akē'akē is thought to have been common on all the Main Hawaiian Islands when Polynesians arrived about 1,600 years ago (Mitchell et al. 2005, Naughton et al. 2005, Spear and Ainley 2007). As evidenced by abundant 'akē'akē bones found in middens on the island of Hawai'i, and in excavation sites on Lehua, O'ahu, and Moloka'i, 'akē'akē once were numerous enough to be used as a source of food and possibly for feathers (Mitchell et al. 2005, VanderWerf et al. 2007). The arrival of humans in the islands likely contributed to the decline of 'akē'akē populations (Naughton et al. 2005).

The total global population of the Band-rumped Storm Petrel is estimated at approximately 150,000 individuals (Brooke 2004). Kaua'i supports most of the breeding population of Hawai'i although the exact number is unknown. The small size of the birds and the cryptic nature of their burrows, assumed to be on steep rocky cliffs and within the crevices of old lava flows, makes burrow searching through the usual means difficult and has further hampered population estimates (Raine et al. 2017b).

Though no nest has yet to be identified, human auditory surveys, automated acoustic surveys and mist netting data were used by Raine (Raine et al. 2017b) to create a predictive distribution model based on key habitat variables. Based on these and previous survey data, breeding is occurring primarily in the steep, remote cliffs areas of the Nā Pali coast in the northwest region of the island, Waimea Canyon, Hanapēpē Valley, rocky cliff faces of the vegetated valleys of Wainiha and Lumahai, and Lehua Islet (Wood et al. 2002, Raine et al. 2017b). KESRP has captured multiple birds along the Na Pali coast and Waimea Canyon in recent years with brood patches, strongly suggesting multiple breeding colonies on Kaua'i. Additionally, retrieval of downed fledglings on Kaua'i in the fall further points to local nesting locations (VanderWerf et al. 2007, Holmes and Joyce 2009).

There is evidence of potential breeding also on Maui, Hawai'i, Lehua and Kaho'olawe (Johnston 1992a, b, Wood et al. 2002). Breeding has recently been confirmed on the slopes of Mauna Loa on Hawai'i (Galase et al. 2016), and on Lehua Islet a single, mummified fledgling was found in 2002 (VanderWerf et al. 2007). Specimens of the 'akē'akē have been collected from Ni'ihau and Lehua and small numbers of adults (less than 10) have been heard on or seen flying around Lehua in 2002, 2003, and 2004 (Slotterback 2002, VanderWerf et al. 2007). Small breeding populations of unknown size are assumed to exist within barren lava flows at the tops of volcanoes like Haleakalā on Maui and Mauna Loa on Hawai'i (Harrison 1990).

### **3.2. Life History and Habitat Selection**

Breeding phenology of the 'akē'akē on Kaua'i is derived from the same data sources described above for distribution (Raine et al. 2017b). Breeding birds return to nest sites in May and complete egg laying by mid-June, and incubate until the beginning of August (Raine et al. 2017). The incubation period averages 42 days and fledging occurs 70 to 78 days after hatching (Harris 1969). Fledglings typically depart the nest site between mid-September and late November, with peak fledging in October (Raine et al. 2017b). 'Akē'akē reach breeding age in 3-7 years (Ainley 1984, Harrison 1990). Based on acoustic data, adults are believed to leave the nesting grounds in October as well (Raine et al. 2017b).

During the non-breeding season, some birds apparently remain near their breeding islands, while others undertake long-distance movements of unknown extent. The 'akē'akē has been detected west of the Galapagos Islands during spring but not during autumn counts; >620 miles north of Hawaiian Islands during summer surveys; and >990 miles south of Hawai'i in the

Phoenix Islands, as well as the entire distance from the Hawaiian Islands to Japan (Slotterback 2002, Mitchell et al. 2005).

‘Akē‘akē are classified as part of the nocturnal petrel feeding guild that catch prey by dipping into the ocean surface on the wing, or pattering the water with their feet, frequently consuming prey while floating on the water (Harrison 1990). Observations of foraging birds indicate the species feeds at internal wave crests, where prey is caught at or just below the surface (Spear and Ainley 1997, Mitchell et al. 2005). Its preferred foraging habitat may coincide with ocean depth or upwellings based on observations that 90% of individuals and 75% of all occurrences of the ‘akē‘akē were at upwellings (del Hoyo et al. 1992, Mitchell et al. 2005, Naughton et al. 2005). Based on stomach samples, prey includes small fish, squid, and crustaceans. These samples contain prey normally found in deeper water that migrate vertically to the surface at night (Slotterback 2002). Stomach samples from the Galapagos consist primarily of small fish (1.4-1.9 inches long) and squid with few crustaceans. No stomach samples have been collected from ‘akē‘akē of the Hawaiian Islands (Mitchell et al. 2005).

Preferred nesting habitat for the ‘akē‘akē breeding population on Kaua‘i include crevices and holes, often located along protected ledges on sheer cliffs and dry mesic cliffs. (Wood et al. 2002, Raine et al. 2017b). Plant communities in the vicinities of possible nesting areas include shrubs and grasses, common herbs, randomly distributed tree species, and dry mesic cliff species (Wood et al. 2001a, Wood et al. 2001b). Raine et al. (2017b) predicts highest occurrence of breeding in areas with low rainfall, little to no vegetation and greater than 40-degree slopes.

### **3.3. Threats to the Continued Existence of the ‘Akē‘akē**

The primary threats to the ‘akē‘akē population on Kaua‘i include predation at breeding sites, breeding habitat loss and alteration, light attraction and power line collisions, disease, and at-sea factors affecting prey availability, global climate change, and stochastic events that are inherently a hazard to populations with a limited range. Each of these factors is discussed in more detail below.

## **4. Threats Affecting Covered Seabirds**

Present day populations of seabirds in Hawai‘i are much smaller than the previously rich and abundant avifauna that originally evolved on the isolated Hawaiian Islands with no terrestrial predators (Olsen and James 1982, Mitchell et al. 2005). The primary threats to the seabird populations on Kaua‘i include predation on breeding areas, breeding habitat loss and alteration, light attraction and power line collisions, disease, at-sea factors affecting the seabird prey-base, global climate change, and stochastic events. These factors are discussed below. The following sections describe threats that apply to ‘a‘o, ‘ua‘u, and ‘akē‘akē populations on Kaua‘i.

#### 4.1. Predation at Breeding Colonies

One of the most serious threats to the survival of seabirds on Kauaʻi and the other MHI is depredation of adults, eggs, and chicks by introduced predatory species, including rats, cats, mongoose, pigs, and the barn owl (Mitchell et al. 2005, Griesemer and Holmes 2011b, Holmes et al. 2011). Rats prey on seabird eggs and chicks, and populations of storm-petrels in New Zealand and Japan have been completely extirpated due to rat predation alone (Jones and Byrd 1979, Hasegawa 1984). Feral cats, as well as barn owls, are known to kill the adults and nestlings of the endangered seabirds of Kauaʻi (Telfer 1986, Ainley et al. 1997a, Ainley et al. 1997b, Holmes et al. 2011, Raine et al. 2017b). Based on colony monitoring data from several breeding seasons, Ainley et al. (1995) and Telfer (1986) report concluded evidence that cats, rats, and owls were responsible for a decrease in adult and juvenile shearwater survival.

Evidence of seabird predation by rats, cats, barn owls, and pigs was documented at all sites monitored by KESRP from 2011 through 2016 (Raine and Banfield 2015, Raine et al. 2017f, d, g, e, Raine et al. 2017h).

Seabird breeding burrows monitored by KESRP were commonly frequented by rats; in Upper Limahuli Preserve, one seabird burrow was visited by a rat 490 times over the span of 5,015 hours of recording (Raine and McFarland 2014a). Cats frequented seabird burrows to a lesser extent than rat visitations, though individual cats have been documented on cameras preying on the adults and chicks from multiple nests in a matter of days (Raine and Banfield 2015).

Depredation by feral cats at nesting sites on Kauaʻi has been heavily documented on camera by KESRP, with an individual predator able to decimate a nesting colony and lead to colony extirpation, particularly when adults are affected (Igual et al. 2009, Raine and Banfield 2015). Several non-native animals, which can access the dry cliff nesting sites, are thought to prey on the ‘akē’akē. These include feral cats, the small Indian mongoose on the Hawaiian Islands other than Kauaʻi, the non-native barn owl, and both Black and Polynesian Rats. A dead adult ‘akē’akē was discovered in Nualolo Aina in 2014 that had been depredated by a Barn Owl (A. Raine, 2017, pers. comm.). Rat bones were also collected at abandoned ‘akē’akē nest sites on Kauaʻi and storm-petrel species elsewhere in the Pacific have been significantly affected by predation (Wood et al. 2002).

The mongoose (*Herpestes javanicus*) has decimated seabirds and other native fauna on the other MHI and poses a high level of threat to all native fauna on Kauaʻi if the species becomes established on the island. To date, the mongoose has not been reported as present at active seabird conservation sites despite intensive camera monitoring. Historically, a female mongoose was reportedly found dead along a road in 1976 near Kalaheo, and sightings have since been reported intermittently all over Kauaʻi. Until recently it was thought that the mongoose was not established on the island of Kauaʻi. However, in 2012 two mongoose were captured in the vicinity of the Nāwiliwili harbor, with another recently captured at the Lihue airport in October 2016 (<http://www.kauaiisc.org/mongoose/>). The Kauaʻi Invasive Species Committee (KISC) encourages the public to report sightings of mongoose and each year lists multiple sightings as ‘credible’. Early detection of new threats, and management of introduced predators and feral

animals will continue to be vital to the recovery of the 'ua'u, 'a'o, and the 'akē'akē on Kaua'i and elsewhere in the MHI (Hodges and Nagata 2001, Mitchell et al. 2005, Holmes et al. 2011).

Ungulate species such as feral pigs, goats, and deer, roaming forests and mountain slopes, can destroy or damage burrows and the vegetation surrounding them. In addition, feral pigs also eat eggs, chicks, and adults, and destroy the entire burrow in the process of reaching the birds at the end (Raine and McFarland 2014a). These feral species have played a significant role in modifying the breeding habitat of the 'ua'u and the 'a'o populations, and in exterminating seabird colonies in the Pacific and many locations worldwide (Harrison 1990, Le Corre et al. 2002, Igual et al. 2009, Furness 2012).

#### **4.2. Habitat Degradation**

Seabird nesting habitats on Kaua'i and the other MHI have been severely degraded by the presence of invasive plants (Mitchell et al. 2005, Naughton et al. 2005, Holmes and Troy 2008). Plants such as *Cyathea cooperi*, *Hedychium spp.*, *Albizia falcata*, *Psidium spp.*, and *Rhodomyrtus tomentosa* continue to displace and out-compete native vegetation in some of Kaua'i's native mesic and wet forest areas. The presence of feral ungulates facilitates the spread and establishment of invasive plants, and accelerates soil erosion and habitat degradation which can destroy important breeding habitat. Grazing and trampling caused by pigs, goats, and deer both alter the vegetation structure and composition, which then can facilitate the dispersal of non-native predators into new areas following ungulate trails.

Many historic petrel and shearwater nest sites on Kaua'i are no longer active due to both the presence of introduced predators and the alteration of native vegetation structure and composition. For example, the Kaluahonu seabird colony located in southeastern Kaua'i once thrived but is now dominated by nearly pure and impenetrable stands of *Psidium spp.*, *Hedychium spp.*, and *Rhodomyrtus tomentosa*. In the early 1980's this colony was found to be active and was monitored (Telfer 1986, Ainley et al. 2001a). However, a decade later biologists documented a significant drop in the number of breeding pairs at the Kaluahonu (Ainley et al. 2001a). Intensive surveys conducted by KESRP between 2006 and 2008 indicated that the colony has since been extirpated (Holmes and Troy 2008).

Holmes and Troy (2008) report that non-native vegetation cover was greater at inactive seabird colonies colony sites ( $Z=-1.98$ ,  $P=0.047$ ). When habitat composed of native vegetation is invaded by non-native plant species, vegetation structure is often dramatically altered, and shearwaters cannot access the ground readily to undertake breeding activities (e.g., burrow excavation, mate attraction). Non-native vegetation may also be a proxy for higher abundance of pigs, cats, and rats. Invasive plants, such as Strawberry Guava, provide food that support higher numbers of seabird predators. Proximity to human disturbed areas is another factor that accelerates habitat degradation and loss by increasing both light levels and the relative abundance of invasive plants and predators.

### 4.3. Light Attraction

Artificial lights can disorient and alter normal nocturnal flight behaviors in seabirds. This phenomenon, known as “light attraction,” is characterized initially by an alteration in the birds intended flight path and circling of the light source, often ending with “fallout” when a bird is grounded at a location that it normally would not have landed (Reed et al. 1985, Telfer et al. 1987, Hallman and Holmes 2010). Once grounded, birds may experience difficulty taking flight again without clear “runways”, cliffs, and updrafts. Grounded birds can suffer injury, starvation, predation, or collision (e.g., with vehicles).

Petrels and shearwaters around the world are negatively affected by “light attraction,” (Montevecchi et al. 2006) - seabirds have been documented flying towards open fires and lighthouses and colliding with lights and nearby structures for hundreds of years (Avery 1979, Reed et al. 1985, Montevecchi et al. 2006). Fledglings are more affected than adults - most downed birds are fledglings grounded during their first flights from their natal nests towards the ocean (Rodríguez et al. 2017). Light-induced fatality of seabirds is recorded worldwide on at least 47 islands and three continental locations, across all oceans (Rodríguez et al. 2017). At least 56 out of the 113 burrow-nesting petrel species have been recorded grounded by lights (Rodríguez et al. 2017) and twenty-four grounded species are globally threatened according to IUCN criteria. Approximately 21 of 80 species in the order Procellariiformes are reported as being attracted to lights; many of those affected are endangered or threatened petrels and shearwaters (Imber 1975, Reed et al. 1985, Montevecchi et al. 2006). Attraction and disorientation of seabirds at sea have also been reported, primarily on ships using artificial lighting for fisheries purposes, but also at oil platforms (Rodríguez et al. 2017) and at cruise ships (Rodríguez et al. 2015).

On the island of Kauaʻi, seabird fallout from the effects of light attraction has been known to occur for more than three decades (Telfer et al. 1987). In 1978, the State of Hawaiʻi Department of Land and Natural Resources (DLNR) initiated a community-based conservation effort, called Save Our Shearwaters (SOS), in which members of the public are asked to pick up fallout seabirds and turn them into “aid stations” located around the island (Telfer et al. 1987). The effort has continued since, currently funded by KIUC and slated to be continued under the long-term KIUC HCP. SOS has proven successful at engaging the island residents to retrieve fallout seabirds; since its inception, SOS has received some 32,000 seabirds (DLNR 2012). Moreover the SOS has program provided valuable information regarding the patterns and trends of seabird fallout over the years (DLNR 2016).

Of the Covered Seabirds, the ‘aʻo is the species most affected by light attraction fallout and is recovered by the SOS program. ‘Aʻo make up over 90% of downed seabirds found on Kauaʻi each year, but ‘uaʻu are also turned into the SOS program. The petrels are less affected by light attraction, or may be breeding in colonies where their flight path to the ocean does not intersect with bright lights (Raine et al. 2017c). Far fewer ‘uaʻu and ‘akēʻakē are found grounded in comparison to the ‘aʻo (Telfer et al. 1987, Day et al. 2003a, DLNR 2016). Between the years 2000-2015, 24 ‘akēʻakē were recovered on Kauaʻi by SOS, likely from the effects of light

attraction. It is possible that many more are affected since their small size may make them especially susceptible to scavenging and increasingly difficult to find and report after fallout events.

A wide range of light pollution sources can individually and cumulatively affect seabird behavior including those at athletic parks and stadiums, airports, harbors, streets, parking lots, resorts, industrial facilities, cruise ships, individual homes, and car head lights (Reed et al. 1985, Le Corre et al. 2002, Raine et al. 2007).

While cause and effect relationships are complex and not fully understood, some factors appear to contribute directly, indirectly and cumulatively to the relative sensitivity of petrels and shearwaters to artificial night lights. These factors include physiology, nocturnal behavior, behavioral experience (i.e., age), weather, lunar phase, and light intensity (Reed et al. 1985). Light attraction is a complex phenomenon and there may be factors other than those listed above that have yet to be discerned.

#### **4.3.1. Physiology and Nocturnal Behavior**

Nocturnal seabirds often feed on bioluminescent prey, a feeding strategy that is associated with high light sensitivity (Montevecchi et al. 2006). Nocturnal species, like the 'a'o, tend to have larger eyes that contain more rods and rhodopsin than diurnal species, (McNeil et al. 1993). In addition, nocturnal species orient flights with specific star patterns (Reed et al. 1985). Artificial light is thought to reduce or interfere with a nocturnal seabird's ability to navigate using celestial cues.

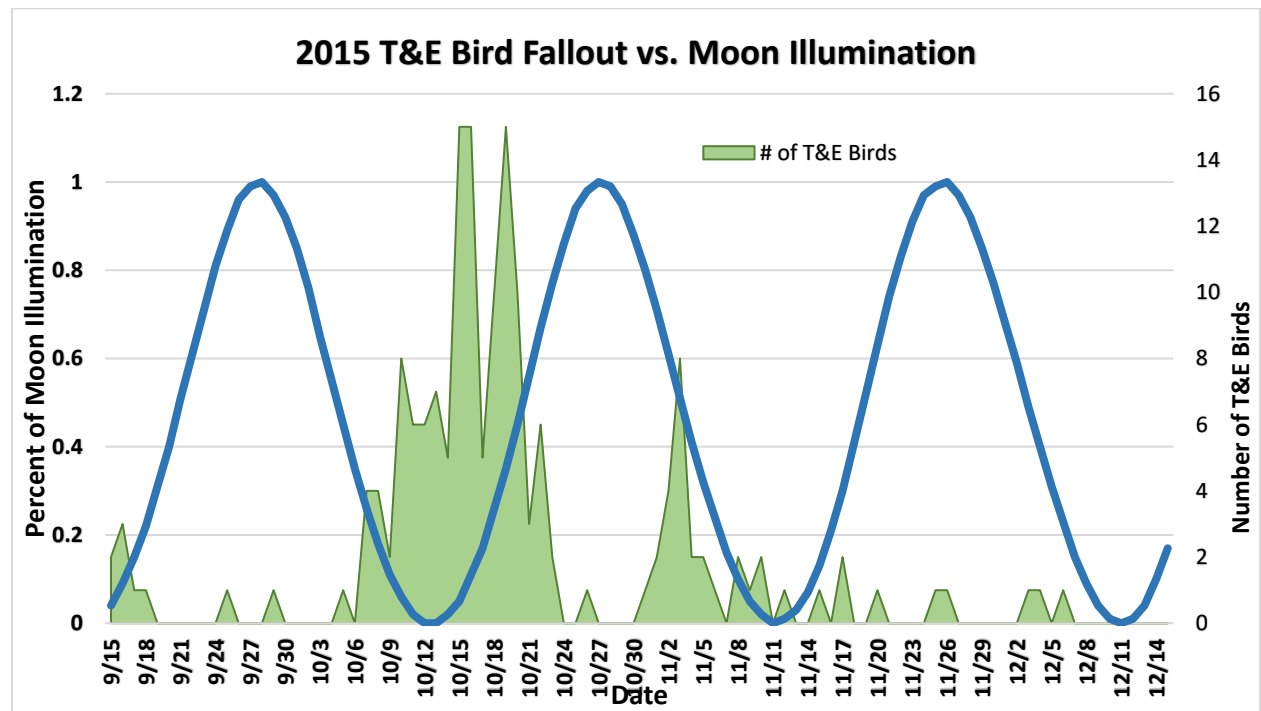
#### **4.3.2. Age**

Fledglings are significantly more sensitive to light attraction than adult seabirds as they take their first flight from nest sites to the sea (Telfer et al. 1987, Ainley et al. 1995b, Le Corre et al. 2002). Adults experience attraction to lights, based on observation of circling birds prior to the fallout season, but there are many fewer adult birds turned into the SOS program, suggesting less fallout from more experienced birds. However, adult seabirds may be more vulnerable to the effects of light attraction when bright lights are present close to breeding colonies, such as the significant fall-out events at the Koke'e Air Force Station in 2015 (Raine 2015, Raine et al. 2015b).

#### **4.3.3. Lunar Phase**

Lunar phase is undoubtedly a critical component of the life history of nocturnal seabirds (Imber 1975, Telfer et al. 1987, Montevecchi et al. 2006, Rodriguez and Rodriguez 2009). Nocturnal departure from nest sites provides a survival advantage for adults and fledglings. However, the presence of artificial lights at night appears to interfere with these natural behaviors. Holmes

(2010) compared SOS program fallout data and moon phase over 30 years showing that moon cycles and SOS program peak fallout levels are significantly correlated. SOS program data indicate that fledgling fallout increases during the new moon phase, when artificial light intensity is higher relative to moon light, and decreases during the full moon phase while the small numbers of adults downed increases during the full moon period (**Figure 1-10**; DLNR 2012, (Telfer et al. 1987, Rodriguez and Rodriguez 2009, DLNR 2016).



**Figure 4-10:** 2015 Threatened and Endangered (T&E) seabird fallout and moon illumination.

#### 4.3.4. Light Intensity

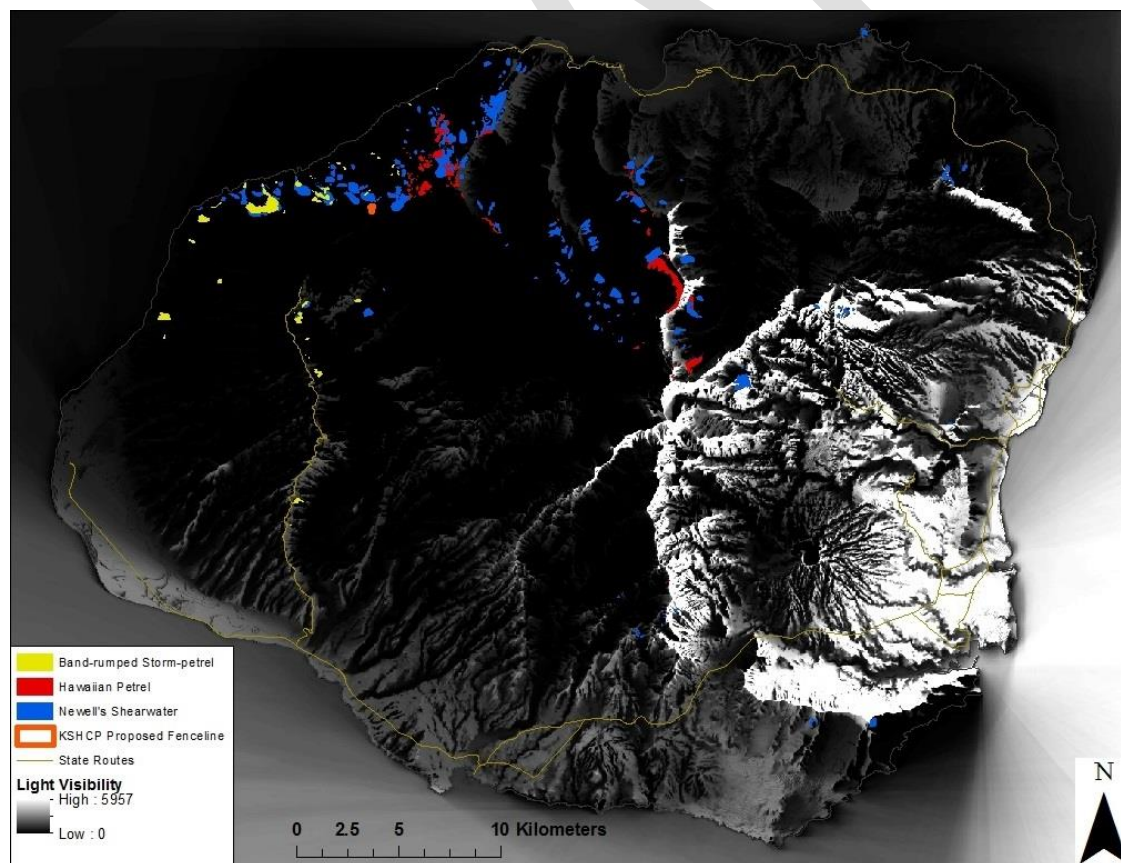
Telfer et al. (1987) report that the number of fledgling seabirds that fallout and are turned into the SOS program on Kaua'i is strongly related to the number and distribution of lights (i.e., light intensity or amount of upward radiation) that attract seabirds. The Covered Seabirds appear most attracted to the actual source of the light (i.e., the bulb), but are also affected by ambient, or reflected, light (Reed et al. 1985, Telfer et al. 1987). Additionally, multiple sources of high intensity lights can draw birds down to lit areas (Hailman 1979, Reed et al. 1985, Reed 1987, Telfer et al. 1987, Podolsky et al. 1998).

Hallman and Holmes (2010) conducted a short pilot study on Kaua'i with ornithological radar to measure changes in the numbers and flight behavior of 'a'o and 'ua'u in the presence and absence of a major artificial light source. On nights before and after the use of high intensity lights, 90 and 97% of radar targets (i.e., individual seabirds) were observed flying in a straight line. This would be defined as a "normal" flight pattern. However, on nights when high intensity

lights were used, 79% of the birds flew in straight lines but 21% displayed circling and erratic flight behavior associated with light attraction and fallout.

Troy et al. (2011) developed a GIS-based method to model the intensity of artificial light and aerial visibility to fledgling seabirds as they fly to the ocean (to estimate the degree of threat that artificial light poses to these birds). The two models suggest that there are few to no portions of Kaua'i from which young birds could fledge and not view light on their post-natal nocturnal flights. Although the north shore of the island is among the darkest, it also supports the highest densities of Covered Seabird breeding colonies and therefore represents a high risk area to fledglings if light visibility is not reduced and managed. The GIS models developed by Troy et al. (2011) can facilitate risk assessment at the colony scale so that land managers can more efficiently determine where to allocate limited resources to protect birds.

The areas on Kaua'i with the lowest light intensities are those that support the largest remaining 'a'o and 'ua'u breeding populations (**Figure 1-11**). Areas on the northwest coast are the farthest away from areas with highest light intensities. Currently efforts are being made to define a No Light Conservation Zone (NLCZ) located on the northwest quadrant of Kaua'i (USFWS 2016). The NLCZ would essentially encompass the largest contiguous area on the island with no viewable lights and access to the coast. This would help to identify sites that are most suitable for management.



**Figure 4-11:** Light pollution measured via satellite overlaid with locations of active and inactive shearwater colonies. Source of light information: Troy et al. (2011); Source for colony locations: KESRP.

#### **4.4. Collisions with Utility Structures**

Collisions with utility structures are a known threat to seabirds in the Hawaiian Islands. On Kauaʻi, utility structures include power lines (energy electrical transmission and distribution lines) and associated structures. Specifically, the power lines traverse the island and are largely above ground, consisting of poles and wires that extend to more than 100 feet tall. Collisions between birds and these facilities have been documented and the effects of these collisions on the population have been estimated to negatively impact the Covered Seabirds (Ainley et al. 1995a, Griesemer and Holmes 2011a, Travers et al. 2012, Travers et al. 2014, Travers et al. 2016). Areas in the northwest region of Kauaʻi were evaluated as the least likely to be impacted from threats of lights and power lines, based GIS mapping for proximity to overhead power lines, monitoring data, and wildlife agency analysis.

The types of injuries that have been documented on downed birds of the Covered Seabirds include broken spines vertebrae and limbs, and concussions, often leading to death. Loss of plumage waterproofing due to shearing off of feathers during a collision can also negatively impact seabird survival (T. Anderson, 2016, pers. comm.). When a breeding adult is killed or injured during the incubation or chick provisioning period, the likelihood of complete nest failure is very high because the remaining adult is not able to incubate or care for the chick alone. Seabird nestlings depend on a steady supply of food from both parents. In cases when this does not occur, fledgling survival is reduced, as during chick-rearing, the chick would receive less food and the survival of the chick would be lower because fledgling survival increases directly with body mass (Brooke 1990). Unfortunately, power line collisions are more likely to occur with breeding adults, as they are transiting back and forth from the colony to the ocean feeding grounds on a nightly basis to provision chicks.

#### **4.5. Disease**

Introduced avian diseases, such as avian malaria, pose threats to all native Hawaiian fauna (Mitchell et al. 1995). Human activities, as well as those of ungulates and non-native birds and mammals, can facilitate the spread of disease. After finding evidence of avian malaria in a blood sample of a juvenile ʻuaʻu in the 1960's (Warner 1968) posited that avian malaria and other mosquito borne diseases may have had serious impacts to already the vulnerable native Hawaiian seabird populations. Subsequent testing of a small number of ʻuaʻu by van Riper III and Barbee (1978) and Simons (1985) did not find any evidence of avian malaria infection. Although the extent to which avian malaria has impacted the survival of the Covered Seabirds is unknown, recent research suggests that blood parasites are often absent or rare in seabirds (Quillfeldt et al. 2010). However, in recent years the SOS program has opportunistically recorded avian

malaria in a 'ua'u and avian pox in individuals of the Covered Seabirds and further research is planned to better assess this potential threat.

#### 4.6. At-sea Threats

During their time at sea, the Covered Seabirds encounter many dangers that include threats posed by the fishing industry, the presence of marine debris, light pollution, oil spills, and the presence of persistent chemical pollutants such as heavy metals and organochlorines in the food chain (Olsen and James 1982, Harrison 1990, Mitchell et al. 2005).

The true extent of impacts from fisheries on the Covered Seabirds is unknown, but many seabird species are heavily affected by mortality and injury (termed "bycatch") caused by fishing methods and equipment (Furness 2003). Fishing can also cause reduced density of prey aggregations available to seabirds (Spear and Ainley 2007). Overharvesting of skipjack (*Katsuwonus pelamis*), and yellowfin tuna (*Thunnus albacares*) could eliminate predatory fish needed to drive small prey species to the surface where they are available to foraging seabirds. Such a factor would increase required prey searching and foraging effort by seabirds to provision offspring, ultimately affecting annual reproductive success and adult seabird survival. The 'a'o is not as efficient in flight as other 'tuna birds' (Spear and Ainley 1997), therefore increasing prey search is especially perilous to this species.

Ocean debris harms a variety of marine biota, including fishes, turtles, birds, and mammals by causing entanglement and ingestion (Azzarello and Van Vleet 1987, Laist 1987). Industrial and user-plastics composed of polystyrene, polypropylene, polyethylene, Styrofoam, and polyvinyl chloride have become widespread sources of marine pollution that disperse and accumulate in response to surface currents, wind patterns, and different geographic inputs (Azzarello and Van Vleet 1987). Procellariiformes are most vulnerable to the effects of plastic ingestion due to their smaller gizzard and their inability to regurgitate ingested plastics. The recent work by Kain et al. (2016), found that the frequency of ingestion of plastics in 'a'o fledglings has increased since the 1980's from 11%-50%, with 70% of the plastics classified as microplastics. The physiological effects related to the ingestion of plastics include obstruction of the gastro-intestines, blockage of gastric enzyme secretion, diminished feeding stimulus, lowered steroid hormone levels, delayed ovulation and reproductive failure (Azzarello and Van Vleet 1987).

Oil spills and pollution events within the water column and on the surface can cause mortality of adult and juvenile seabirds at any time of the year and are best managed through effective prevention plans and rapid response and containment. Oil spills can have particularly devastating effects on small populations when a release occurs at locations and times of the year when species are congregated in a small area, such as in waters near breeding colonies, or at sea where seabirds feed or raft. Though heavy metal content in the Covered Species has not been investigated, seabirds feeding on mesopelagic prey, as the Covered Species do, have been found to have increased mercury levels (Ochoa-Akuna et al. 2002, Elliot and Elliot 2016).

Sources of light pollution at sea include lights on fishing vessels, cruise ships, as well as offshore petroleum and gas facilities (IDA 2003, Van De Laar 2007, Rich and Longcore 2013). These types of at-sea facilities can affect the normal foraging and predator avoidance behaviors of seabirds (Weir 1977, Wiese et al. 2001).

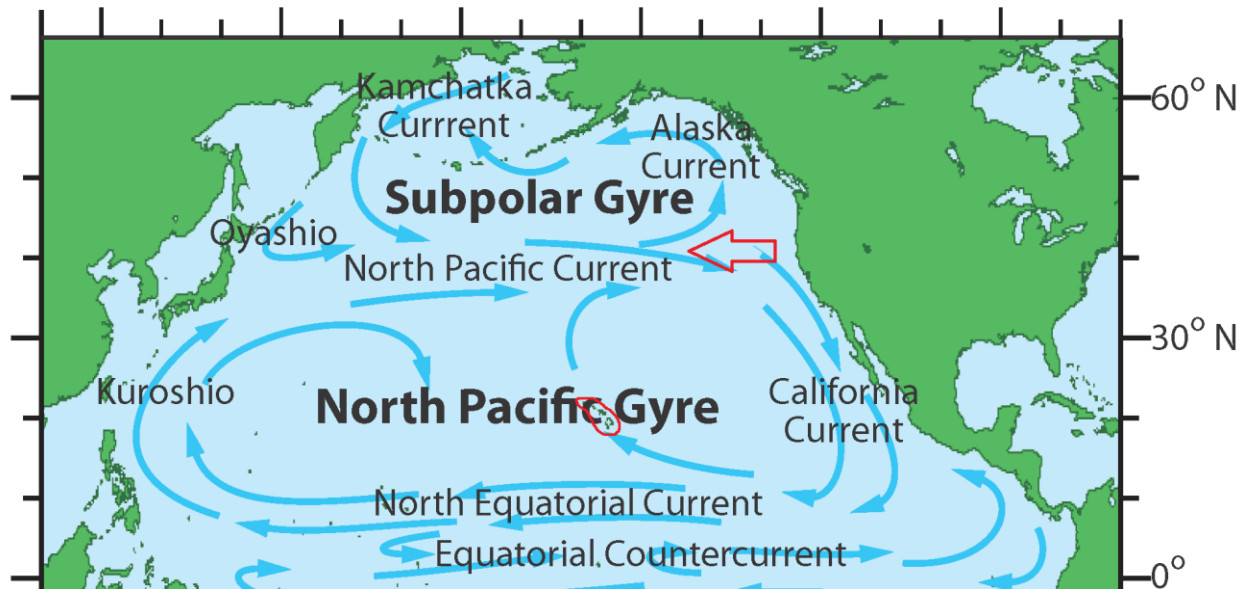
#### **4.6.1. Global Climate and Biome Changes**

Anthropogenic environmental changes are one of the most pressing contemporary threats to global biodiversity. Changes in the earth's climate and biomes from human industrial activity are expected to result in regional changes in weather patterns and ocean productivity that are further predicted to affect seabird populations as well as other plant and animal communities in Hawai'i.

Changes anticipated in Hawai'i may include, but are not limited to, increased thermal stratification of the ocean, increased frequency of El Niño conditions, and changes in ocean productivity (Sarmiento et al. 2004). Rising average temperatures on the islands in the last 30 years, in line with global trends, has also been documented (Giambelluca et al. 2008). Furthermore, seabird breeding habitat could be affected by increasingly severe weather events (e.g., increased storm frequency caused by increased El Niño frequency, increased drought intensity). Invasive plant species are also expected to spread with increased temperatures (IPCC 2014). A rise in sea level of approximately 1m is anticipated by the end of the 21st century within the State of Hawai'i (Fletcher 2009), but this rise in sea level is not expected to directly affect known nesting habitat of the Covered Seabirds.

##### **4.6.1.1. Changing Ocean Conditions and Seabird Foraging**

An El Niño/Southern Oscillation (ENSO) event is characterized by anomalous sea surface temperature warming along the equator in the eastern Pacific Ocean and cooling in the west (Philander 1990). These events have global impacts on climate and usually occur every three to seven years. In Hawai'i, ENSO events are characterized by dry winter conditions, weaker trade winds, and increased frequency of hurricanes near the islands (Chu 1995, Chu and Wang 1997, Cao et al. 2007). With climate change, there is an expected increase in frequency of extreme ENSO events and associated disastrous weather events (Cai et al. 2013, Latif et al. 2015). The frequency of tropical cyclones is expected to increase ~20-40% during ENSO events (Chand et al. 2017). While changes to natural systems globally and regionally are generally predicted with a degree of confidence (Bernstein et al. 2007), predicting effects at a local scale and to specific species is difficult. However, some predicted climate change scenarios could impact the Covered Species. One of the most likely things to be directly impacted via changes in climate patterns is at-sea foraging. Polovina et al. (2011) present a useful "biome" change model to analyze changes in ocean productivity relating to climate change. Their "biomes" correspond to distinct areas of phytoplankton density which is associated with different physical drivers like gyres and upwelling (**Figure 1-12**).



**Figure 4-12:** System of gyres and currents in the North Pacific. The main Hawaiian Islands are circled in red. The red arrow points to the Transition Zone where the subpolar and subtropic gyres mix. Figure credit: <http://www.seos-project.eu/modules/oceancurrents/oceancurrents-c02-p04.html>

With regards to the temperate feeding grounds of the ‘ua’u and possibly the ‘akē’akē, Polovina et al. (2011) predict that the productive temperate biome of the North Pacific, which corresponds with the subpolar gyre productivity zone, could contract by 34% by year 2100. Decreasing arctic sea ice during the summer appears to be decreasing winter winds across the North Pacific (Jaiser et al. 2012). This leads to less sea surface cooling during winter and less mixing at the transition zone (TZ) between the nutrient rich subpolar gyre and nutrient poor subtropic gyre which leads to less primary production and a north shifted TZ (Bond et al. 2015, Whitney 2015). Shifting of known ‘ua’u foraging areas at the TZ would take place with a projected 30% subtropical biome expansion, and the previously mentioned temperate biome reduction (Polovina et al. 2011). In short, Hawaiian Petrels would have to fly farther north to reach historically used foraging locations.

Change in wind patterns and evidence of shifting biome size has already been observed (Polovina et al. 2008, Polovina et al. 2011, Bond et al. 2015, Whitney 2015). Ichii et al. (2011) found that flying squid populations, a preferred prey of the Covered Seabirds, have been shown to respond quickly to shifts in productivity zones. These shifts can have dramatic results for higher trophic level predators. In 2014, large scale die-offs of Cassin’s Auklets, a species that relies on the productive food web, were documented related to warming (Opar 2015). Many other anomalies, like large whale and sea lion mortalities, have been documented in other species related to this period of warming oceans (Bond et al. 2015, Di Lorenzo and Mantua 2016).

With regards to the known feeding areas of the 'a'o, 'ua'u, and 'akē'akē along the Equatorial Counter Current, the size of the biome is expected to contract by 28% by year 2100. Primary production is expected to increase by 17.1% within this biome but the reduction in area could shift productive zones and make foraging more difficult for the Covered Seabirds. Production is also expected to shift east, and tuna, a predator that 'a'o associate with when foraging, are expected to decrease in waters west of 170°E (Bell et al. 2013). There is known foraging habitat of the 'a'o west of 170°E and the act of tuna driving prey closer to the surface is very important to Newell's foraging success (Au and Swedberg 1966, Spear et al. 1995, Raine et al. 2015a, Raine et al. 2017a). The subtropical biome, which likely provides more local foraging for the Covered Species, is also expected to increase primary production by 26% by 2100. Though with an increase in total area of 30%, productive zones could be more patchy and foraging success could be affected (Polovina et al. 2011).

Surman et al. (2012) found that migratory bird species appear to have more difficulties adapting foraging to oceanographic variability. Also, increases in sea surface temperature, even at smaller temporal scales (i.e. daily), appear to impact foraging success and chick growth in the related Wedge-tailed Shearwater (Peck et al. 2004).

Changes in marine organism distribution is also likely to occur in response to expanding low oxygen, low productivity zones in the ocean (IPCC 2014). With warming surface waters, growth of low oxygen zones is more likely to occur (Altieri and Gedan 2015). Expansion of low oxygen zones that already occur in the North Pacific and around the Northwestern Hawaiian Islands would directly impact the Covered Species (Polovina et al. 2008). These factors are also expected to cause the body mass of a variety of fishes to decline (Cheung et al. 2013). This could also affect the food abundance and availability for the Covered Seabirds.

Ocean acidification is another outcome of human industrial activity. Since the beginning of the industrial revolution, atmospheric carbon dioxide has increased by nearly 40% from burning fossil fuels and deforestation. Oceans have taken in about a third of the carbon dioxide produced and this has disrupted chemical balances in the oceans and made them more acidic (Doney et al. 2009). Marine ecosystems are expected to be impacted by the predicted increase in ocean acidification, though with different responses from different taxonomic groups (Kroeker et al. 2013). From experimentation, mollusks, including squid, show slowed development and decreases in larval survival, growth, and abundance with increased acidification (Kaplan et al. 2013, Kroeker et al. 2013). Other groups, like diatoms and fish, may benefit from acidification though it is difficult to predict how all these groups will respond in the complexity of a natural system (Kroeker et al. 2013).

#### **4.6.2. Changing Habitat Conditions and Nesting**

Climate change is expected to bring an increase in the intensity of storms (Knutson et al. 2010). Hurricanes can have a large effect on the native species of Hawai'i. The impact of Hurricane Iniki may have pushed three endangered forest bird species to extinction. Hurricanes also have an

impact on the Covered Species, as Hawaiian hurricane season is during their breeding season. Downed trees and debris could easily block birds from burrows or trap them inside. Following Hurricane Iniki in 1992, aerial surveys were conducted that found heavy vegetation damage and landslides at known 'a'o colonies. At Kilauea Point, the closely related Wedge-tailed Shearwater was found to have suffered 30-40% chick loss from the hurricane (Day and Cooper 2002).

In the cloud forests of Maui, native and non-native plant species "temperature tolerance zones" are expected to shift upward approximately 400m (Loope and Giambelluca 1998), assuming the projected rise in air temperature at sea level of 2-2.5°C likely by 2060 (Joshi et al. 2011). This is likely to occur as the documented warming on Hawai'i continues (Giambelluca et al. 2008, Keener et al. 2012). Additionally, trade winds, which bring precipitation to Hawaiian windward coasts, have decreased since the 1970s (Collins et al. 2010).

Although difficult to predict, studies suggest a decrease in rainfall across the Hawaiian Islands, with a larger contrast in precipitation between the drier leeward sides versus the wetter windward sides (Timm et al. 2016). Decreases in precipitation combined with higher temperatures could increase the spread of non-native species which has potential to alter the breeding habitat of the Covered Seabirds (Bernstein et al. 2007, IPCC 2014). This will allow more invasive plant species to live in montane forests than currently do. The warmer temperatures may also be beneficial to introduced plants that are better adapted for nighttime respiration at higher temperatures than the native plants of the cloud forests (Alward et al. 1999).

This decreased rainfall has the potential to increase drought resulting in increases in forest fires (Hawai'i 2014). Along with the aforementioned increase in cyclones, these types of disturbances are more dramatic and can allow faster colonization by invasive species. All of these changes are expected to allow invasive species to more easily invade native forests and alter habitats (Loope and Giambelluca 1998).

## **5. Honu – Green Sea Turtle**

### **5.1. Distribution and Population Trends of the Honu**

The honu is one of seven sea turtle species found globally (Eckert et al. 1999). In 1978, the honu (*Chelonia mydas*) was listed as threatened under the Endangered Species Act (ESA) throughout its global range (NMFS and USFWS 1998, 2007). This listing was revised in 2016 with a ruling that designated a status for 11 "distinct population segment (DPS);" the Hawaiian population that is in the North Pacific population DPS was listed as threatened (USFWS 2016a). Honu are fully protected under Hawai'i Revised Statutes Chapter 195D and Hawai'i Administrative Rules 13-124. The Hawaiian honu as a "subpopulation" is currently listed as "least concern" by the International Union for the Conservation of Nature (IUCN) a change in status from "endangered" that reflects updated scientific evaluation of the honu population in Hawai'i (Pilcher et al. 2012).

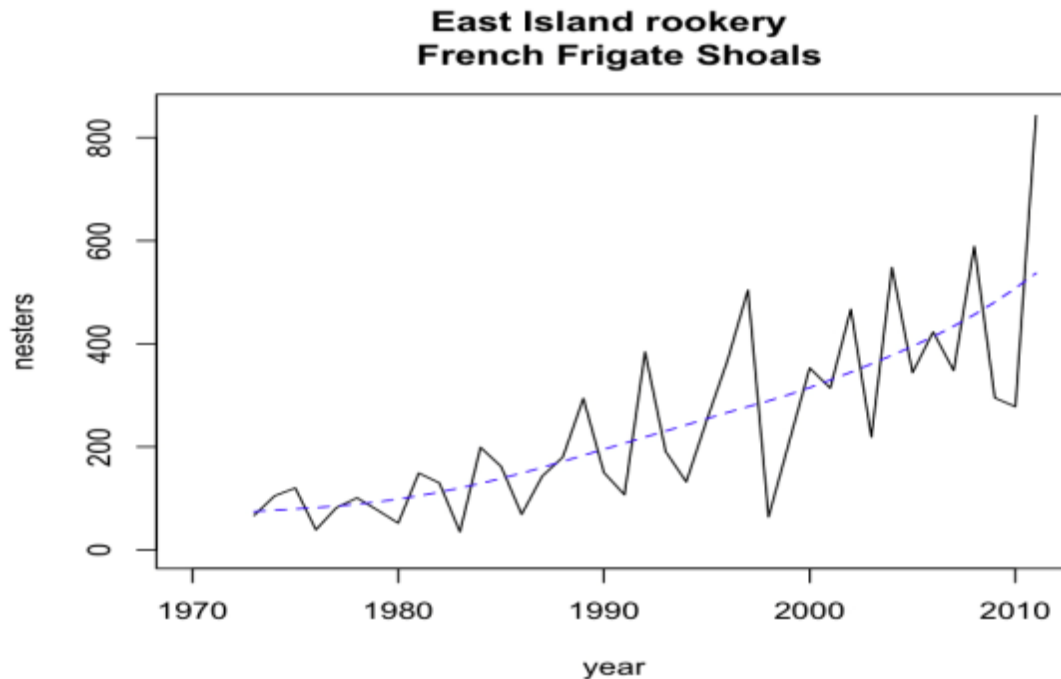
Adult honu average 3 to 4 feet in length and can weigh up to 200 pounds (NMFS and USFWS 1998). Honu can live up to 80 years of age. The term "green" applies not to the external coloration, but to the color of the turtle's sub-dermal fat (NMFS and USFWS 1998). The color of an adult carapace (shell) is light to dark brown, sometimes shaded with olive, with radiating wavy or mottled markings of a darker color or with large blotches of dark brown (**Figure 1-13**).



**Figure 5-13:** Female honu or Hawaiian Green Turtle laying a nest. Photo [www.turtletracks.org](http://www.turtletracks.org).

The honu in Hawai'i nests primarily in the French Frigate Shoals of the Northwestern Hawaiian Islands and to a lesser degree on the main Hawaiian Islands (Balazs et al. 2015, NMFS and USFWS 2015). The French Frigate Shoals population constitutes 96% of the total Hawaiian Islands population, with the nesting habitat on the main Hawaiian Islands having been severely contracted by habitat loss and modification for commercial construction (USFWS 2016a).

Long-term monitoring of honu populations has been undertaken in Hawai'i, with over 40 years of data showing that the Hawai'i population has increased at a rate of approximately 5.7% annually since the harvest limits were imposed in 1974, (under State of Hawaii regulation 36), following near extinction (Chaloupka and Balazs 2007, Maison et al. 2010, Tiwari et al. 2010). In 2015, the current number of breeding females was estimated at around 4,000 individuals (Balazs et al. 2015). The number of nesting Green Sea Turtles at East Island at French Frigate Shoals has tripled since monitoring began in 1973 (**Figure 1-12**) (NMFS and USFWS 1998, Balazs and Chaloupka 2004b).



**Figure 5-1:** Estimated number of Hawaiian green turtles nesting at East Island, French Frigate Shoals, NWHI, 1973-2011. Table source: NMFS Pacific Islands Fisheries Science Center Marine Turtle Research.

Habitats needed for honu nesting, basking, underwater resting, and foraging are found along the shores of all the main Hawaiian Islands. Monitoring by State of Hawai'i staff biologists and NOAA volunteer observers has documented increasing levels of honu nesting on Kaua'i. Terrestrial basking by honu is also reportedly on the rise in the other main Hawaiian Islands. On Kaua'i, there are an estimated eight basking and twenty nesting beaches used by honu (Parker and Balazs 2015). Some of the known nest locations are near urbanized coastal areas along the east and south shores of Kaua'i where coastal light pollution exists.

## 5.2. Life History and Habitat Selection of the Honu

Hawaiian honu reach breeding age at approximately 25 years. Females return to the same beach, or region of coastline, where they hatched to lay their eggs (Balazs 1980, NMFS and USFWS 1998, Balazs and Chaloupka 2004b). Females return to nesting beaches on Kaua'i from mid-May through late August to lay eggs in the nests excavated in beach sand. During the cool of the night, females arrive on the beach and upon reaching the high-tide mark use front flippers to dig a wide pit, into which they carefully dig an egg chamber using rear flippers. Within the chamber approximately 100 leathery-skinned ping-pong-ball-sized eggs are deposited and covered with sand.

Once finished laying eggs, the female returns to the sea and will not return to care for the eggs or hatchlings. Female honu lay eggs every two to three years and will deposit three to six clutches per nesting season with an average of twelve days in between. The eggs will incubate in the sand for 60-65 days (Balazs 1980, NMFS and USFWS 1998, Balazs and Chaloupka 2004a). Depending on the lay date, hatchlings can emerge from nests in July through late November-early December (Balazs 1980).

Honu hatchlings dig upward in a communal effort to reach the surface, an effort that may take 2-3 days to complete. Hatchlings typically emerge from the sand at night (Balazs 1980; NMFS and USFWS 1998). Newly emerged hatchlings are strongly photopositive and can be disoriented away from their path to the sea by artificial lighting (Witherington 1992, NMFS and USFWS 1998). Hatchling mortality levels are high particularly during the first hours of emergence due to many causes (Gyuris 1994). The young turtles are thought to stay in the open ocean for the next 5 to 10 years before they begin foraging in nearshore habitat (Parker et al. 2011).

Young oceanic turtles and adults, which occasionally forage in the open ocean, feed on pyrosomes, various species of sea snails, amphipods, and different species of cnidarians (Parker et al. 2011). In nearshore habitat, the preferred foraging areas are generally protected or partially protected bays where benthic macroalgae grows, a preferred food source (Balazs et al. 1987, NMFS and USFWS 1998). Honu that have grown large enough to reside in the nearshore benthic environment have an almost entirely herbivorous diet consisting of selected macroalgae and sea grasses.

Honu feed most actively at dawn and dusk and alternate between periods of active foraging and rest (Balazs et al. 1987, NMFS and USFWS 1998). During these rest periods, they retreat to deeper water and seek out shelter in caves and outcroppings. These resting areas are usually within 1.2 miles of foraging areas and at the edge of the coastal bench surrounding the Hawaiian Islands. Turtles may also rest in vertical holes or crevices in the reef flat. Turtles can spend long periods underwater while resting; resting times up to 2.5 hours have been recorded for adult turtles (Balazs et al. 1987).

Behavioral changes have been observed in the population over time, which are probably a direct consequence of the success of management and conservation actions in Hawai'i. For example there have been changes since the early 1980's in foraging strategies and habitat use from predominately deep night-time foraging to daytime nearshore waters and an increased scope and magnitude of basking events and tolerance to humans (Whittow and Balazs 1982, Balasz 1996, Parker and Balazs 2010).

### **5.3. Threats Affecting the Honu**

The 2016 final listing ESA ruling by the USFWS identified the biggest threats facing the population of honu found in the Hawaiian Islands as habitat loss and degradation, fisheries bycatch, ingestion of marine debris, vessel activities, disease, and predation. Predation of

hatchlings by feral cats is known to be a problem for sea turtles in other nesting sites around the world (Seabrook 1989, Hilmer et al. 2010). The limited nesting range of the honu has made the Hawaiian Islands population more vulnerable to habitat loss from increased stochastic events and sea level rise associated with climate change. The adult population in the main Hawaiian Islands is at risk from fisheries interactions, marine debris, and vessel strikes. Nearshore foraging habitat is also impacted by pollution and development. The main disease impacting Hawaiian honu is *fibropapilloma* which causes large tumors and is the main cause of strandings in the Hawaiian population (Work et al. 2015). The tumors can block vision, disrupt locomotion, disrupt organ function if they are internal, and impede breathing if they are located in the throat. The prevalence of the disease in turtles of the MHI appears to be associated with coastal pollution and invasive macroalgae (Van Houtan et al. 2010).

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## 7. PERSONAL COMMUNICATIONS

Tracy Anderson, 2016, SOS Coordinator, Kaua'i Humane Society.  
 Don Heacock, 2012, Biologist, Division of Aquatic Resources, Kaua'i.  
 Dr. Andre Raine, 2017, Manager, Kauai Endangered Seabird Recovery Project.

## Appendix C. Social Attraction Benefit Estimator

### MODEL TO ESTIMATE SOCIAL ATTRACTION SITE (SAS) BENEFIT TO THE NEWELL'S SHEARWATER (*Puffinus auricularis newelli*)

#### INTRODUCTION:

The Kaua'i Seabird Habitat Conservation Program (KSHCP) is an island-wide program to coordinate mitigation for permitted light attraction "take" of Newell's Shearwater. The KSHCP aims to offset take and provide conservation benefit to this species by increasing productivity at breeding colonies. The primary mitigation strategy proposed for the KSHCP is to fund a predator-proof fence enclosure as a social attraction site, and the question arose as to how to determine the estimated benefit to seabirds from the selected project. KSHCP staff requested to work with Adam Vorsino (USFWS) directly on development of this social attraction site (SAS) estimator model. The KSHCP and USFWS have worked collaboratively to refine and improve the SAS estimator model.

In this document we describe the components of the SAS estimator model, and also the inputs that were used to assess mitigation benefit for a social attraction site at a selected location on the Kalalau Rim, on the north shore of Kaua'i. The Hawaiian name for this area of land is Kahuama'a, and thus this project is to be named the Kahuama'a Seabird Preserve. At this site, a predator proof fence will be installed, predators will be eradicated, native vegetation maintained and restored as needed, and social attraction for Newell's Shearwater will be conducted over the 30 permit term of the KSHCP. The document describes how the model could be used to assess other locations as well.

#### MATERIALS AND METHODS

The basic premise of the SAS estimator model is to compare productivity of a "colony" of Newell's Shearwaters within a predator proof enclosure to productivity outside of it (in a full predation scenario). The difference in production between the sites is the measure of benefit to the species from conducting the social attraction project. The model assumes that birds flying in could land and initiate breeding either within the fence, or in a simulated "parallel" site of the same size with no predator control. This model assumes that other threats to the population are not present (i.e. light attraction fallout and line collisions). This is based on the criteria of selecting a social attraction site located away from the threats of lights and lines so that maximum production can be achieved within the fenced area.

Some of the parameters are numerical inputs derived from various sources including project plans, literature citations, calculations from relevant data, and other supporting evidence. Details on these [adjustable model parameters](#) are described below, and summarized in Table 4. These parameters are designed for simple user input into R-studio, or other R-code program, allowing the user to make quick adjustments and run multiple model iterations, often necessary during the planning process.

Other important components of the SAS estimator model have been written into the R code by the program author (A. Vorsino, USFWS) and require edits to the model R code to adjust. Details on these [set model parameters](#) are also described below, and summarized in Table 5.

## **ADJUSTABLE MODEL PARAMETERS**

### **Fencing completion year/Start broadcasting year:**

#### **Description:**

This parameter defines the start of audio broadcasting to begin attracting Newell's Shearwater. The model assumes that the project starts in Year 1, and the user determines what year the fencing and predator eradication will be complete, and what year you will begin broadcasting seabird calls to initiate social attraction to the site. The importance of delineating this parameter is that seabird benefit will not be derived until fencing, predator eradication and audio broadcasting is complete, so it is critical to identify a starting point.

#### **Input for KSHCP model:**

Fence completion and start of audio broadcasting will be by Year 2 of the KSHCP implementation. Year 1 of the project will consist of preparing the site, initiating fence construction, and working to remove predators from the site. Broadcasting of seabird calls will begin once predator eradication is complete, and we expect predators to be removed by the end of Year 1. For the KSHCP, we are assuming Year 0 is the time the model was run (2016), Year 1 is 2017 and Year 2 is 2018. The model is not specific to the month, and represents a calendar year, not directly tied to a seabird breeding season. Fortunately, a breeding season is typically encapsulated within a calendar year (March 15 April–December 15).

### **Predation estimate:**

#### **Description:**

The predation scenarios used in the SAS estimator model to assess the Kahuama'a Seabird Preserve were created to specifically reflect estimated levels of predation for Newell's Shearwater on the Island of Kaua'i. The predation scenarios define the baseline condition outside the fenced social attraction site. The predation scenarios used in this social attraction site model were derived from two primary data sources, KESRP monitoring data and Griesemer & Holmes (2011). Predation impacts are expressed in the model as changes to the species' demographic life history parameters (see description in [Set Model Parameters](#) below).

Predation scenario 1 is based on analysis of KESRP data from colony monitoring 2011-2013 at several sites on the north shore of Kaua'i (Hono O Nā Pali, Upper Limahuli Preserve). KESRP estimated predation effects for 100 breeding pairs per specific predator. Total population is assumed to be a composite of egg/chick (year 0-1), sub-adult (year 2-5) and adult (year 6+). Using stable age distribution and reproductive probability, total number of eggs/chicks, sub-adults, and non-breeding adults was extrapolated from the breeding pair estimates, and predation effects for these age classes was defined. Any predation of a breeding adult would translate to loss of a chick as well, so chick predation rates reflect direct and indirect mortality.

This estimate needs to be updated with most recent data (2014-2016) to reflect more extensive sampling and predation effect.

Predation scenarios 2, 3 & 4 are based on Griesemer & Holmes (2011) predation estimates for low, medium and high effects. These estimates are mainly derived from data collected by Ainley et al. (2001) in the Kalāheo colony on the south shore of Kauaʻi.

#### **Input for KSHCP model:**

The model was run for predation scenarios 2, 3 & 4 described above, and results from each are presented below. Predation scenario 1 was not used in the assessment of the Kahuamaʻa Seabird Preserve because the associated  $\lambda$  (.988) was felt to be too high to accurately represent predation impacts to the metapopulation. This predation scenario could be adjusted and used for future model runs. Modifications should be made based on the most recent KESRP data and predation estimates.

#### **Flight path buffer:**

##### **Description:**

Flight paths are based on the USFWS population viability (PVA) model, which is being developed to evaluate all terrestrial threats to Newell's Shearwaters, including risk of collisions with powerlines. To assess powerline collisions it is necessary to predict flight paths, in order to determine where birds are likely to intersect with powerlines during flight. The "least cost" flight path assessment is based on assumed colony locations (derived from KESRP auditory data) as the "source" and a series of 500 points (every 250 m<sup>2</sup>) along the coast as the "sink". The two factors considered in defining the least cost path from source to sink are Topography and Coastal Access. The least cost pathway results from the shortest distance from colony to coast, with the least topographic "friction". Variance in pathway results was accounted for using a weighted average. (For more detail on this analysis, see PVA Materials and Methods, USFWS, in prep). For the SAS estimator model, it is assumed that Newell's Shearwater will use least cost flight paths, as derived from this USFWS PVA modeling data (USFWS, in prep).

Flight path buffer, in the context of SAS estimator model, refers to the overlap between audio broadcasting coverage and flight paths of prospective recruits to the site. The parameter is measured in distance (meters) from the fence that birds can be successfully recruited.

#### **Input for the KSHCP model:**

To determine our input value for this model parameter we explored various options to measure sphere of influence for audio broadcasting. One option was to estimate how far the broadcasting system could be heard by seabirds. This is based on the assumption that birds are transiting on their flight paths and will not deviate. The second (selected) option was based on localized topography. Given seabird circling patterns, and the exploratory nature of prospecting behavior (Brooke 2010, KESRP unpublished data), we assumed that all birds that entered the Kalalau Valley could come into auditory contact with our broadcasts. Thus we measured the maximum width of the Kalalau Valley (3000 meters) and used this as our input value.

### **Juvenile site fidelity:**

#### **Description:**

This parameter determines what proportion of the birds whose flight path (+ buffer) intersects with the audio broadcasting will be available for recruitment to the social attraction site. The parameter applies to prospecting sub-adults, ages 2-5 years old. These are birds that are returning to Kaua'i during the breeding season to prospect for nest sites and potential breeding partners (Ainley et al. 1995; Griesemer & Holmes 2011).

Site fidelity determines what portion of the prospecting sub-adults will “stray” from their natal colonies. This parameter is applied to birds from other colonies that may be available to recruit, and also birds born within the fenced site that will stray to other colonies when they return to Kaua'i, though these two measures of site fidelity may be defined independently. Adults that establish nesting within the fenced site are assumed to have 100% site fidelity, and likewise, adults that have established nesting within other colonies are assumed to be unavailable for recruitment to the social attraction site. Seabird published literature supports this pattern of relatively higher rates of straying in juveniles, and high site fidelity for adult, breeding birds (Thibault 1993; Steiner & Gaston 2005; Robert et al. 2014).

#### **Input for the KSHCP model:**

To derive an estimate of juvenile site fidelity, we relied on research from other, similar species of shearwater. The most relevant study was on Cory's shearwater (*Calonectris borealis*) off the coast of Spain, by Munilla et al. (2016). Here populations of Atlantic colonies were examined using microsatellite genetic markers to determine proportion of migrants within an established colony. Genetic assignment determined 5%, 10% and 30% migrants present in the three colonies reported on. In addition, genetic data for newly established colonies supported straying from multiple colonies throughout the study area, versus one large migration event.

The question of site fidelity to a colony requires defining the scale and spatial extent of a “colony”. There are multiple scales of fidelity that can be examined to explain patterns of nesting behavior. For example, likelihood of returning to Kaua'i to breed, to the north shore of Kaua'i, to the Kalalau Valley, and to specific breeding clusters (colonies) within the Kalalau Valley. Many studies of seabird nesting patterns describe site fidelity patterns by measuring number of meters of the natal burrow (Pyle et al. 2001; Steiner & Gaston 2005; Sugawa et al. 2014). In a study of streaked shearwaters (*Calonectris leucomelas*; Sugawa et al. 2014) straying is described as nesting within another breeding aggregate ~200 meters away. Thus, it seems appropriate to describe fidelity at the smallest scale, though we do not have genetic information for Newell's Shearwaters to support these breeding patterns.

In the context of the proposed KSHCP social attraction site, we may be attracting birds from “colonies” anywhere within the Kalalau Valley. Though breeding colonies in the Kalalau Valley are within a relatively close proximity to one another, initiation of nesting within the fence enclosure (assuming there is no nesting currently) represents a colonization event in terms of island metapopulation dynamics (Matthiopoulos et al. 2005).

We used conservative estimates of juvenile site fidelity of 95%, 90% and 85% to represent a range of potential proportion of birds available for recruitment. These numbers can be tied to estimates of straying rates in the literature (Munilla et al. 2016), and assume that localized clusters of breeding represent “colonies”, or sub-populations, in terms of genetic or population structure. Currently we do not have genetic data for Newell’s Shearwater to determine differentiation at a colony scale, or even among islands. Literature for similar species suggests that the population substructure, natal philopatry, and breeding site fidelity is likely high.

The SAS model allows for differentiating site fidelity for recruitment as described above versus fidelity of birds born within the fence that may stray to other colonies. For the KSHCP model we assumed a higher, and more constant site fidelity for birds born within the fence. We set this parameter at 95% across all model runs. This was done to reflect assumed patterns of behavior as outside colonies are extirpated. For example, using Predation Scenario 4, the total island metapopulation of Newell’s Shearwaters outside the fence is 141 individuals by Year 50. Within the fence in this same scenario, the population at Year 50 is between 67-189 individuals, representing either a significant portion of the total population, or more birds within the fence than outside the fence. In this scenario, we assume that site fidelity to the social attraction site is high, as there are very few outside colonies with calling birds. Setting this site fidelity measure at 95% prevented the model from projecting a declining population within the fence as the outside population declines, reflecting the belief that this site could provide an extinction refugia.

**Run Time:**

**Description:**

This model parameter determines the number of years for which the population within the fence and outside of the fence is predicted. The standard run time set for the social attraction estimator model is 50 years.

**Input for the KSHCP model:**

The KSHCP model was run for the standard run time (50 Years), but cumulative fledgling productivity was calculated until Year 30, the proposed duration of the KSHCP.

**Burrow Capacity:**

**Description:**

Burrow capacity is determined by the amount of suitable habitat multiplied by the assumed burrow density. There may be separate inputs for natural burrow capacity versus artificial burrow density/capacity, if there are plans to install artificial burrows to increase productivity of social attraction.

Characterizing suitable habitat using large scale GIS-based metrics has been attempted by multiple researchers. The USFWS Ecological Niche Model (ENM) found the strongest correlation for Newell’s Shearwater habitat to five variables: isothermality, precipitation seasonality, slope, topographical roughness and wind speed at 50 meters (USFWS, in prep). Troy et al. (2014) found the best predictive variables in determining suitable habitat for Newell’s Shearwater

nesting to be slope, native vegetation, and soil/rock composition. Borelle et al. (2015) modeled habitat suitability for multiple burrow nesting shearwaters and petrels, and found vegetation, soil quality, induration and slope to be the most relevant for determining suitability.

The multiple factors used to predict suitable nesting habitat can be analyzed remotely using GIS, or data can be collected in the field in identify or verify suitable habitat classifications. Relying on GIS layers assumes these data are reliable at a localized, site-specific scale. In some cases, it may be more appropriate to collect data on site.

The habitat suitability parameter for the SAS estimator model is a simplified adaptation of the modeling efforts described above. Vegetation, soil quality and other predictive factors are assumed to be sufficient based on field visits to the site. Slope is the main variable with multiple input options. Slope data collected at burrow sites by KESRP technicians was sorted into Minimum, First Quartile, Median, Third Quartile and Maximum (KESRP, unpublished data). The resulting slopes for this are presented in Table 1. A digital elevation model (DEM) raster, with a resolution of 30 meters or greater, is analyzed for each model run, and the selected range of slopes is applied to the social attraction site to delineate suitable habitat. For example, if 1<sup>st</sup> Quartile is selected, all terrain with a slope of 14.9% or greater is included in the suitable habitat estimate.

**Table 1:** KESRP burrow data and associated slope occupancy range.

	<b>Associated Slope (%)</b>
Minimum	.62
1 <sup>st</sup> Quartile	14.9
Median	21.6
3 <sup>rd</sup> Quartile	29.9
Maximum	45

Burrow density must also be defined for the site to determine site burrow capacity, using available data and supporting literature.

The model provides two options for inputting burrow capacity:

1. Provide a burrow density estimate, slope occupancy range and a DEM raster for the proposed social attraction site. Suitable habitat hectares and total site burrow capacity will be calculated.
2. Provide a site-specific burrow capacity, calculated from other sources.

#### **Input for the KSHCP model:**

Due to the small size of the Kahuama'a Seabird Preserve, we chose to estimate hectares of suitable habitat from field measurements versus relying on GIS data layers. We determined that all of the fenceable area (1.2 ha) was suitable, given condition of soil, slope and presence of native vegetation.

There is unpublished data of burrow densities within managed colonies of Newell's Shearwaters on Kaua'i (Andre Raine, pers comm). However, these colonies are subject to predation and are presumed to be greatly diminished from former densities. Instead, we relied on Manx shearwater (*Puffinus puffinus*) burrow densities from inland colonies in Wales, where the largest colony in the world is present (Smith et al. 2001). We selected only densities from inland colonies (versus coastal) as these are more likely to represent nesting conditions for the inland-breeding Newell's Shearwater. Two colony densities were presented: 0.070 burrows per meter squared, and 0.046/m<sup>2</sup>. The average of these two colony densities is 0.058, which was used to calculate total burrow capacity for the KSHCP site.

The KSHCP proposes to install 100 artificial burrows within the fenced social attraction site. These burrows are in addition to the overall burrow capacity for natural burrows. Installation of artificial burrows can expedite the process of establishing breeding at a new site because burrow excavation by a newly established breeding pair can take a year or more (Bancroft et al. 2004). Artificial burrows are also easier to monitor.

Thus the total burrow capacity for the site is 796 burrows (Table 2).

**Table 2:** Calculating burrow capacity for the KSHCP model.

Model parameter	Calculation	Input for KSHCP model
Burrow Capacity	[Total hectares suitable habitat * estimated natural burrow density] + proposed number of artificial burrows to be installed	1.2 ha * 0.058 burrows/m <sup>2</sup> = 696 + 100 (artificial burrows) = 796 (Total burrow capacity at site)

#### Starting metapopulation size:

##### Description:

The population size for all Newell's Shearwaters on Kaua'i (metapopulation) is a critical model input as this is what defines number of birds that are available for recruitment into the social attraction site. The most recent and widely used population estimate is from Joyce (2013), an at-sea estimate using data from 1998-2011. The total Newell's Shearwater median population size was estimated at 27,011 individuals. An estimated 90% of the total population (Griesemer & Holmes 2011; Spear et al. 1995) nests on the island of Kaua'i, thus the total metapopulation size for Kaua'i would be 24,310 birds. However, since the social attraction estimator model relies on known colonies to model recruitment, we must exclude potential colonies on lands that are inaccessible for surveys. This represents ~21% of the total population, and reduces the potential metapopulation for modeled for recruitment to 19,691 birds. This effectively reduces the number of birds available for recruitment by 21%, and thus the production estimates should be considered an underestimate, since in reality birds from these inaccessible colonies are still available, they are just not part of the model estimates.

The Newell's Shearwater population is experiencing a precipitous decline annually, and we felt it was inappropriate to assume that this did not further reduce the metapopulation size in the period from sampling to 2016 (year of model run). Since the sampling was conducted over a 14 year period, we assigned the median data estimate (27,011) to 2006, the median sampling for the Hawai'i portion of the dataset (T. Joyce, pers comm, 2016). Thus the expected decline, associated with the various predation scenarios, was used to estimate a starting metapopulation size for Year 1 (Table 3). As mentioned above, line collision and light attraction fallout mortality is not part of this modeled decline, so these numbers likely represent an overly optimistic metapopulation number for 2016.

**Table 3:** Calculating starting metapopulation size for Newell's Shearwater on Kaua'i.

Model parameter	Calculation	Input for KSHCP model
Starting metapopulation size	[Joyce 2011 at-sea population estimates * .90 (% of total pop that is on Kaua'i) * .80 (% of total Kaua'i pop that is represented in flight path estimates)] – Estimated decline between 2006-2016	Year 1 Starting Metapopulation: Predation Scenario 2: 14,976 Predation Scenario 3: 11,184 Predation Scenario 4: 8647

#### Input for the KSHCP model:

The model was run for each of the starting metapopulations from Table 3.

Table 4 is a summary of the inputs for the social attraction estimator model described in detail above.

**Table 4:** Summary of all input parameters for the KSHCP model.

Parameter	Input used for KSHCP model	Notes
Fencing completion year	Year 2	Conservative estimate based on prep required
Start broadcasting year	Year 2	Conservative estimate based on prep required
Predation estimate	All scenarios were run	<b>Scenario 2</b> = Griesemer & Holmes (2011) low predation <b>Scenario 3</b> = Griesemer & Holmes (2011) medium predation <b>Scenario 4</b> = Griesemer & Holmes (2011) high predation
Flight path buffer	3000 m	Distance from fence whereby prospecting birds may be attracted

Juvenile site fidelity	From outside the fence recruits: 85%; 90%; 95%	Thus 5%, 10% or 15% of the prospecting birds are potentially available for recruitment. Estimate derived from literature review.
	Inside the fence: 95%	Thus 5% of birds born within the fence will stray to other colonies to establish breeding.
Run time (in years)	50	

Size, location and topography of social attraction site	1.2 hectares	Derived from proposed fenceline at KSHCP social attraction site; linked to GIS file.
Artificial burrows to be installed	100	Estimated from field visits; accommodating 100 artificial burrows.
Total burrow capacity	796	See Table 2
Starting metapopulation size	Varies by Predation Scenario	See Table 3
Flight Path Overlap	For proposed Kahuama'a Seabird Preserve = 0.0311	Linked to GIS shapefile with site location and flight path .tif file provided by USFWS

## SET MODEL PARAMETERS

The [adjustable model parameters](#) described above are run using the framework of an underlying deterministic population viability analysis (PVA) with set model parameters (Table 5). This PVA relies on life history components developed via previous work, specifically Ainley et al. (2001), and Griesemer & Holmes (2011).

The methodology is described in detail in the USFWS PVA modeling (in prep) but the basic modeling strategy is the use of a Leslie matrix to compile fecundity and survivorship for each age class to estimate population growth rates ( $\lambda$ ). The three age classes used are egg/chick (year 0-1), sub-adult (year 2-5) and adult (year 6+). The model estimates a  $\lambda$  in the absence of predation, line collisions, light attraction fallout, and any other threats to the population. Then mortality rates associated with each of these threats are applied to reduce the  $\lambda$  accordingly.

It is important to note that for the model analysis of the Kahuama'a Seabird Preserve, meta-population line collisions and light attraction were assumed to be zero, as the likely flight path to the coast, and the colony itself, are assumed to be unaffected by these anthropogenic mortality factors (at and around this site). Because this colony is situated in an area on Kaua'i that likely does not have these mortality events, populations with sub-adults that could be

recruited into this preserve would also likely be unaffected by these elements. The lambda used to define the growth of the population (as applied to the overall meta-population) reflects this geographic difference, as such the predicted meta-population size is not a realistic estimate, but a bi-product of the modeling exercise for this specific site. It is well-known that these mortality factors have a large affect elsewhere in the meta-population. This is addressed thoroughly in the Fish and Wildlife Site by Site PVA.

**Table 5:** Set model parameters for KSHCP social attraction estimator model.

PARAMETER	NOTES	MODEL INPUT
Breeding probability	Estimated from the average of 15 data sets for Newell's Shearwater and proxy species (Griesemer & Holmes 2011).	0.88
Reproductive success	Estimated from the average of 38 data sets for proxy species (Griesemer & Holmes 2011)	Within fence = 0.81 Outside of fence = 0.35-0.52 (varies with predation scenario)
Age of first reproduction	Griesemer & Holmes 2011	6 years old
Age of last reproduction	Ainley et al. 2001	36 years old
Survivorship per age class	Griesemer & Holmes 2011	Year 0-1: 0.654 Year 1-2: 0.78 Year 2-3: 0.89 Years 3-5: 0.905 Year 6+: 0.92

## RESULTS

Data that are available from the model output include:

- Number of birds in each age class for the population within the fence enclosure in any given year of time (0-50 years)
- Number of birds in each age class for a parallel population outside of the fence enclosure in any given year of time (0-50 years)
- Population lambda (within fence enclosure and outside fence enclosure)
- Total population size at Year 50 (within fence enclosure)

Table 6 presents results of population size within and outside the fence in 50 years. This is total number of individuals present, including all age classes. The population number for outside the fence represents the total metapopulation of Newell's Shearwaters on Kaua'i. The estimated number of birds in 50 years ranges from 141-3811 individuals. Within the fence there is a positive growth rate ( $\lambda > 1.0$ ) and thus this population goes from the initial starting point of zero to a range of 63-877 birds over the 50 year time period. The "within fence" population is directly correlated to population numbers outside of the fence because the model assumes

continuous recruitment through the 50 year time frame. When less birds are available for recruitment, population within the fence does not grow as quickly. Final population estimate within the fence assumes social attraction calls are broadcast for the life of the project, and that birds added each year are both new prospectors and returning prospectors/breeders.

The population outside of the fence experiences a negative growth rate in all predation scenarios, with a lambda ranging from 0.921-0.973. In the most optimistic predation scenario (2), the population declines from a starting metapopulation size of 14,976 (see Table 3) to 3811. However, in the most drastic predation scenario (4), the total metapopulation for Kaua'i declines from 8,647 individuals in 2016, to 141 individuals in 50 years, almost identical to the population within the 1.2 hectare fence enclosure (63-189 birds).

**Table 6:** Population size at 50 years within the fence and outside the fence, comparing various predation scenarios and site fidelities.

			Population size at 50 Years	Population size at 50 Years	Population size at 50 Years
	Predation Scenario:	Population Lambda	85% Site Fidelity	90% Site Fidelity	95% Site Fidelity
Within fence	<b>2</b>	<b>1.08</b>	877	534	292
Outside fence	<b>2</b>	<b>0.973</b>	3811	3811	3811
Within fence	<b>3</b>	<b>1.08</b>	372	248	124
Outside fence	<b>3</b>	<b>0.945</b>	661	661	661
Within fence	<b>4</b>	<b>1.08</b>	189	126	63
Outside fence	<b>4</b>	<b>0.921</b>	141	141	141

			Population size at 50 Years	Population size at 50 Years	Population size at 50 Years
	Predation Scenario:	Population Lambda	85% Site Fidelity	90% Site Fidelity	95% Site Fidelity
Within fence	<b>2</b>	<b>1.02</b>	499	509	409
Outside fence	<b>2</b>	<b>0.973</b>	4,370	4,370	4,370
Within fence	<b>3</b>	<b>1.02</b>	231	252	216
Outside fence	<b>3</b>	<b>0.945</b>	877	877	877
Within fence	<b>4</b>	<b>1</b>	149	133	130
Outside fence	<b>4</b>	<b>0.921</b>	213	213	213

The primary result of interest for the KSHCP social attraction site is a comparison of the cumulative number of fledglings produced within the predator proof fence enclosure and outside the fence. Fledglings produced are the “currency” by which permitted take in the HCP is offset and mitigated. Table 7 presents the comparison of fledglings produced in the predator free fence area versus how many would have been produced in a similar area (in size, terrain, slope etc.) outside of fence. Unlike Table 6, where outside the fence represents total Kaua’i metapopulation, the results presented in Table 7 represent the production in a similar area outside the fence only. Though model outputs are for 50 years, the anticipated KSHCP permit term is 30 years, so the results for the first 30 years were extracted from the total.

**Table 7:** Number of fledglings produced in 30 years within fence enclosure and outside fence enclosure, comparing various site fidelities and predation scenarios.

			Number of fledglings produced in 30 years	Number of fledglings produced in 30 years
	Predation Scenario:	85% Site Fidelity	90% Site Fidelity	95% Site Fidelity
Within fence	2	1,385	923	462
Outside fence	2	340	226	114
<b>DIFFERENCE:</b>		<b>1,045</b>	<b>697</b>	<b>348</b>
Within fence	3	762	508	254
Outside fence	3	131	87	44
		<b>631</b>	<b>421</b>	<b>210</b>
Within fence	4	457	304	152
Outside fence	4	58	38	19
<b>DIFFERENCE:</b>		<b>399</b>	<b>266</b>	<b>133</b>

The cumulative number of fledglings produced within the fence varies greatly by site fidelity rates. As more birds are available for recruitment into the site, cumulative fledgling production increases. These model results show that maximum fledgling production is achieved when 15% of the birds whose flight path come within 3000 meters of the site are available for recruitment, and the total metapopulation is declining less steeply.

The cumulative number of fledglings produced within the fence during the 30 year permit term does not vary based on modeled burrow capacity scenarios (Table 8). To look at the effect of expanding fence size or over-estimating burrow density, we ran several burrow capacity scenarios, using fixed predation scenario and site fidelity inputs and assuming all other model

parameters are stable. The results demonstrate the overall slow production rates of this seabird species. Fledgling production over 30 years does not reach, and therefore is not limited by, site burrow capacity. Similarly, total “within fence” population size at 50 years does not reach carrying capacity in any of the modeled scenarios.

**Table 8:** Comparison of 30 year cumulative fledgling production with various burrow capacity assumptions.

<b>Modeled burrow capacity scenarios</b>	<b>Within fence total burrow capacity</b>	<b>Number of fledglings produced in 30 years within the fence (Predation scenario 2; Site fidelity 85%)</b>	<b>Within fence population size at 50 years (total individuals)</b>
Estimated burrow capacity for 1.2 ha KSHCP site (see Table 2)	796	1,045	877
Estimated burrow capacity for an expanded site (in same location) of 2.15 ha (0.058 burrows/m <sup>2</sup> )	1,253	1,045	877
Estimated burrow capacity for 1.2 ha KSHCP site if burrow density was half (0.026 vs 0.058)	400	1,045	877

## DISCUSSION

The main goal of this modeling exercise is to determine whether the selected mitigation option (predator proof fence enclosure and seabird social attraction site on the Kalalau rim) is likely to sufficiently offset the anticipated take request of Newell’s Shearwater fledglings in the KSHCP. It is valid to look at a range of results, to account for uncertainty in selected model inputs for each parameter.

For example, with the predation scenarios, the most drastic scenarios (3 & 4) result in a total Kaua’i metapopulation of <1000 birds by the end of 50 years (see Table 6). Scenario 2 is an intermediate decline (total metapopulation of 3,811 birds in 50 years). For comparison, the USFWS NESH Landscape Strategy (USFWS 2016) presents a projected population estimate at the end of 30 years to be 148-4,452 birds.

However, neither of these population projections takes into account large-scale conservation projects that may slow decline and aid recovery. Large-scale mitigation work implemented as

part of the KIUC long term HCP, Kaua'i Watershed Alliance management plan, DOFAW's Native Ecosystem Protection and Management Program (NEPM) and others is expected to occur concurrently with the KSHCP social attraction site. These efforts are likely to contribute to increased productivity within Newell's Shearwater breeding colonies. This would result in less drastic decline to the metapopulation, and also increased recruitment and growth within the social attraction site.

Conversely, these population estimates do not take into account threats at-sea, such as changes in prey base due to climate change, fishing lines or overfishing, etc. Given the layers of uncertainty on impacts of predation, lights, line collisions and at-sea threats, effect of colony protection efforts, and even uncertainty about starting metapopulation estimates, presenting a range of possible outcomes for the social attraction site is prudent.

One important result of the social attraction estimator model that is worth discussion is the fact that the most influential parameters in the model are aspects of the program that cannot be managed. For example, the most logical way to adaptively manage the mitigation project to create more fledgling production would be to increase the size of the fence enclosure. In the long term (50+ years), this will result in more production, assuming social attraction is successful and maximum burrow densities are realized. However, within the 30-50 year period modeled, increasing the fence size does not positively influence cumulative production of fledglings. This is due to slow growth rates for seabirds and long generation time.

Instead, maximum production in the modeling is heavily influenced by juvenile site fidelity, predation estimates outside of the fence, and flight path buffer. Juvenile site fidelity is optimized when it allows for successful recruitment of birds and yet enough natal site fidelity from birds born within the fenced area. Predation estimates are optimized when there is an assumption of large-scale conservation efforts altering current patterns of steep population decline. Recruitment is determined by sufficient intersection of assumed flight paths. Future data may inform our estimates on these parameters, but we are not able to manage populations to increase them.

One exception to this is in comparing site locations. Since the model is actively linked to GIS data on site location and corresponding seabird flight paths, certain areas of the island will have a higher overlap with presumed flight paths, and thus will have more birds available for recruitment. This could have useful management implications when deciding on future social attraction site locations.

Through the duration of the KSHCP social attraction project, biological monitoring will be key for validating or updating model assumptions. Data will be collected on auditory seabird activity at the site, occupied burrows, fledglings produced etc. Off-site monitoring data collected by other entities (KESRP, USFWS, USGS, NARS etc.) on metapopulation trends, effectiveness of predator control and other large-scale conservation efforts, and on impacts of other threats will be incorporated as well.

```
#####
#SOCIAL ATTRACTION SITE ESTIMATOR FOR A SITE WITH A STANDING POPULATION#
#####

rm(list = ls())
# For further information about this calculator please contact the author at:
#
# Adam E. Vorsino, Ph.D.
# Strategic Habitat Conservation Division
# Pacific Island Fish and Wildlife Office
# 300 Ala Moana Blvd. Ste. 3-122
# adam_vorsino@fws.gov
# (808)792-9431
#
#
# Disclaimer: This calculator was developed for the Kauai Seabird Habitat
# Conservation Program. The information used to develop this assessment is specific
# to Newell's shearwater and so should not be used to assess social attraction at
# sites that are not suitable for this species. The population and flight path
# overlap information is up-to-date as of 3/7/2016. Please use and review the
# input and output carefully. If used to assess the utility of a site for social
# attraction, the user of this tool is solely responsible for the input and output
# of the assessment. This calculator is provided as technical assistance and does
# not represent Service policy. It should be used only if it constitutes the best
# available scientific information on a case-by-case basis.

#####
##### INPUT PARAMETERS FOR SOCIAL ATTRACTION SITE CALCULATOR #####
#####

# META-POPULATION SIZE (TO ASSESS SUB-ADULT FLYOVER)
# 27011*0.9 uses Trevor Joice Estimate multiplied by 0.9 (for Kauai Meta-pop)
# and multiplied by 0.81 to estimate the amount of population explained by the
# KESRP colony polygons. These numbers will be modified using the selected
# predation estimate to reflect the current meta-population
MetaPopSize <- 27011*0.9#UserSpecified#

# The year that the data used to define the meta-population size was obtained.
# From this a current estimate of the meta-population (without light or strike
# impact)is derived by applying the predation estimate to all years between then,
# and the current year. The current year is defined by the computer and uses the
# year in which the calculator was run. A Year must be defined.
YearPopEstimated <- 2006#UserSpecified# 2011

# STARTING POPULATION SIZE OF THE ASSESSED SITE
# This metric is meant to inform the population growth at a site with a standing
# population while social attraction is also being conducted at that site. If
# SPS is 0 the calculator will develop an assessment that only defines a Social
# Attraction Site. Please note, this is meant to be an estimate of the Total
# Population Size at the site, not just adults or burrows.
SPS <-0#UserSpecified#

# FENCE EFFICACY
# Can use this section to assess either "leaky fence" or specific fence type
# scenarios, values range from 0 to 1, where 1 is complete control, and 0 is
```

```

# no control.
Ungulate_Cntrl <- 1#UserSpecified# # Ungulate Control
Rat_Cntrl <- 1#UserSpecified# # Rat Control
Cat_Cntrl <- 1#UserSpecified# # Cat Control
BrOwl_Cntrl <- 1#UserSpecified# # Barn Owl Control

# FENCING COMPLETION YEAR
Fence_Fin <- 2#UserSpecified#

# START OF SOCIAL ATTRACTION SITE BROADCASTING YEAR
Broad_Strt <- 2#UserSpecified#

# BURROW CAPACITY OF SOCIAL ATTRACTION SITE
# Define the number of burrows in the location specified (either artificial or
# naturally produced)
# If unknown use the SLOPE OF OCCUPANCY FOR BURROW CAPACITY and put "None"
Burrow_Cap <- "None"#796#UserSpecified#

# SLOPE OF OCCUPANCY FOR BURROW CAPACITY
# If burrow capacity is not given (i.e. it is set to "none") then the code will
# use various slopes defined by burrow collections (as collected by KESRP) to
# estimate the area that can be used by NESH. Can use 'min', '1stQ', 'median',
# '3rdQ', and 'max') these are minimum, first quartile, median, third quartile, and
# maximum.
# If using a DEM with a resolution of 30m or greater the burrow slope estimates
# were approximated at a 30m slope. If using a higher resolution DEM the burrow
# slope estimates collected at the burrow will be used. If not in use please
# put 'None'
Slope_Of_Occupancy <- '3rdQ' #'None' #UserSpecified#

#NUMBER OF BURROWS PER METER SQUARED
# only specify if using 'Slope_Of_Occupancy' to define burrow occupancy for a site
# otherwise specify 'None'
Num_Per_Meter <- 0.037 # Value defined by KSHCP/KESRP

# PREDATOIN ESTIMATE
# Can use 1, 2, 3 or 4 this corresponds to the KSHCP predation estimate (1),
# and Greisser and Holmes (2011) Low (2) and medium (3) and high (4) predation
# estimates respectively. It is a good practice to look at all four...
PredationEst <- 3#UserSpecified# #'None' #UserSpecified#

# RUN TIME OF CALCULATOR (IN YEARS),
# Run for > or = 50 years for best results
RunTme <- 32#UserSpecified#

# BUFFER AREA AROUND THE SOCIAL ATTRACTION SITE FROM WHICH BIRDS WILL BE CALLED
# DO NOT CHANGE UNLESS THE OPTIONAL AREA (BELOW) HAS ALL OF THE SPECIFIED
# INFORMATION IN IT
# Buffer should be in meters. It represents the distance from the fenceline that
# the calling units are effective
ExclusBuffer <- 3000#UserSpecified#

# SITE FIDELITY OF JUVENILES (SUB ADULTS)
# constant is used to derive an estimate of attraction to a newly enclosed site (SitF
idIn)

```

```

# or the natal population (SitFidOut)a value of 0.95 indicates that juveniles/sub-adu
lts
# have a 95% probability of returning to there breeding area. Make sure the value is
# greater than 0 and less than or equal to 1
SitFidIn <- 0.85#UserSpecified#
SitFidOut <- 0.85#UserSpecified#

#Put Desktop Computer User Name here or (if not a federal computer or other
# that needs admin privileges) use "Public"
DCN <- 'avorsino'#UserName#

#####
#####OPTIONAL#####
#####OPTIONAL#####
#####OPTIONAL#####

#####
#(DO NOT ADD OR MODIFY UNLESS THE INFORMATION IS SPECIFICALLY KNOWN,#####
# SEE BUFFER ESTIMATE ABOVE)#####
#####

# PUT THE FILE NAME !!!!!CONTAINING!!!! THE SOCIAL ATTRACTION SITE SHAPEFILE
# please make sure this is in quotes and forward slasshes are used Instead of
# backslashes (see example).
# On my computer (Adam Vorsino) this looks like:
#J:/PIOGIS12/APPS/SH_CC/Adam/KSHCP Social Attraction Site#
# If no file is specified please put "None" #
SASiteFile <- "J:/PIOGIS12/APPS/SH_CC/Adam/KSHCP Social Attraction Site"#None"

# PUT THE NAME OF THE SHAPEFILE TO USE IN THE ANALYSIS (THAT WHICH SASiteFile IS
# LEADING TO)
# If no file is specified please put "None"
ShapeName <- "Exocarpos_SAS"#None"#UserSpecified## "Exocarpos_SAS"#None"#

# PUT THE RASTER LOCATION CONTAINING THE FLIGHT PATH ESTIMATES FOR THE AREA
# please make sure this is in quotes and forward slasshes are used Instead of
# backslashes (see example)
# On my computer (Adam Vorsino) this looks like:
# J:/PIOGIS12/APPS/SH_CC/Adam/NESH_Analysis/Andre_LCP_AroundIsle/NESH_WeightedAvg_For
Ka.tif
# If no file is specified please put "None"
FlightPath <- "J:/PIOGIS12/APPS/SH_CC/Adam/NESH_Analysis/Andre_LCP_AroundIsle/NESH_We
ightedAvg_ForKa.tif"#None"#UserSpecified# #

# PUT THE RASTER LOCATION CONTAINING THE ELEVATION PROFILE (DIGITAL ELEVATION MODEL)
# please make sure this is in quotes and forward slashes are used Instead of
# backslashes (see example)
# on my computer (Adam Vorsino) this looks like:
# J:/PIOGIS12/APPS/SH_CC/Adam/NESH_Analysis/Andre_LCP_AroundIsle/ka_DEM.tif
# It is recomend to use a DEM with a resolution of 30m or less.
# If no file is specified please put "None"
DEM <- 'J:/PIOGIS12/APPS/SH_CC/Adam/NESH_Analysis/Andre_LCP_AroundIsle/ka_DEM.tif'#"N
one"#UserSpecified# #'J:/PIOGIS12/APPS/SH_CC/Adam/NESH_Analysis/Andre_LCP_AroundIsle/

```

```
ka_DEM.tif'#"None"##
```

```
#####
#####DO NOT MODIFY PAST THIS SECTION #####
#####
#TESTING FOR ERRORS OR LACK OF INFORMATION
ertest1<-cbind(MetaPopSize, Fence_Fin, Broad_Strt, Burrow_Cap, RunTme)
ertest1A<-apply(ertest1, 2, function(x){length(unique(x))})
ErrMessages<-c('META-POPULATION SIZE THAT HAS POTENTIAL FOR RECRUITMENT INTO THE SITE
',
               'YEAR IN WHICH THE FENCE FOR THE SOCIAL ATTRACTION SITE IS TO BE COMPLE
ETED',
               'YEAR IN WHICH THE SOCIAL ATTRACTION BROADCASTING STARTS',
               'BURROW CAPACITY OF THE SOCIAL ATTRACTION SITE',
               'THE NUMBER OF YEARS THE ANALYSIS RUNS FOR')
if(TRUE %in% c(unique(ertest1A != c(1, 1, 1, 1, 1)))){
  Msg1<-ErrMessages[which((ertest1A != c(1, 1, 1, 1, 1))==T)]
  cat(paste0("      !PLEASE PUT A SINGLE VALUE DESCRIBING THE ", Msg1, "!      ")
)
  try(stop(), T)
}else{
  if(length(which((c(1,2,3,4) %in% PredationEst)==T))!=1){
    cat("      !PLEASE PUT A SINGLE VALUE (1,2 or 3) DESCRIBING PREDATION ESTIMATE T
O BE USED!      ")
    try(stop(), T)
  }else{
    if(SitFidIn>1){
      cat("      !PLEASE PUT A SINGLE VALUE (LESS THAN OR EQUAL TO 1) DESCRIBING THE
SITE FIDELITY OF JUVENILE (PRE-BREEDING) SEABIRDS!      ")
      try(stop(), T)
    }else{
      if(SitFidIn<=0){
        cat("      !PLEASE PUT A SINGLE VALUE (GREATER THAN 0) DESCRIBING THE SITE F
IDELITY OF JUVENILE (PRE-BREEDING) SEABIRDS!      ")
        try(stop(), T)
      }else{
        Dir<-paste0('C:/Users/', DCN, '/Desktop/KIUC_SPS-SA_FenceYr_', Fence_Fin, '_Ca
llYr_', Broad_Strt, '_RunTime_', RunTme, '/')
        if(file.exists(Dir) == F){
          dir.create(Dir)
        }

        if ((is.na(installed.packages()[,"Package"] ["popbio"] ))==T){
          install.packages("popbio", dependencies = T)
        }
        if ((is.na(installed.packages()[,"Package"] ["stringr"] ))==T){
          install.packages("stringr", dependencies = T)
        }
        if ((is.na(installed.packages()[,"Package"] ["raster"] ))==T){
          install.packages("raster", dependencies = T)
        }
        if ((is.na(installed.packages()[,"Package"] ["rgdal"] ))==T){
          install.packages("rgdal", dependencies = T)
        }
      }
    }
  }
}
```

```

if ((is.na(installed.packages()[,"Package"]["rgeos"]))==T){
  install.packages("rgeos", dependencies = T)
}
library(rgdal)
library(raster)
library(rgeos)
library(stringr)
library(popbio)

if(ExclusBuffer>0){
  #####Defining carrying capacity for Social Attraction Sites#####
####
  if(unique(file.exists(SASiteFile, FlightPath))==T){
    WgtAvg_FP<-raster(FlightPath)/cellStats(raster(FlightPath), stat = 'sum')
    coordSys <- '+proj=longlat +datum=WGS84 +no_defs +ellps=WGS84 +towgs84=0,
0,0'

    utmSys<-"+proj=utm +zone=4 +ellps=WGS84"

    KSHCP_AAS<-readOGR(SASiteFile, ShapeName)

    KSHCP_AAS_WGS<-spTransform(KSHCP_AAS, coordSys)
    KSHCP_AAS_UTM<-spTransform(KSHCP_AAS_WGS, utmSys)
    KSHCP_AAS_UTMBuff<-gBuffer(KSHCP_AAS_UTM, byid = T, width = ExclusBuffer)

    Overlap<-sum(unlist(raster:::extract(WgtAvg_FP, KSHCP_AAS_UTMBuff)), na.rm
m = T)

  }else{
    cat("          !IF A BUFFER GREATER THAN 0 IS USED THE FLIGHT PATH RASTER AND SOCIAL ATTRACTION SITE SHAPEFILE LOCATION (AND NAME)
          MUST BE SPECIFIED IN THE OPTIONAL SECTION ABOVE!          ")
  }

}

else{
  if(unique(file.exists(SASiteFile, FlightPath))==T){
    WgtAvg_FP<-raster(FlightPath)/cellStats(raster(FlightPath), stat = 'sum')
    coordSys <- '+proj=longlat +datum=WGS84 +no_defs +ellps=WGS84 +towgs84=0,
0,0'

    utmSys<-"+proj=utm +zone=4 +ellps=WGS84"

    KSHCP_AAS<-readOGR(SASiteFile, ShapeName)
    KSHCP_AAS_WGS<-spTransform(KSHCP_AAS, coordSys)
    KSHCP_AAS_UTM<-spTransform(KSHCP_AAS_WGS, utmSys)
    # KSHCP_AAS_UTMBuff<-gBuffer(KSHCP_AAS_UTM, byid = T, width = ExclusBuffer)
r)

    Overlap<-sum(unlist(raster:::extract(WgtAvg_FP, KSHCP_AAS_UTM)), na.rm =
T)

  }else{
    Overlap<-0.14
  }
}
cat('\n Flight Path Overlap Value Used = ', Overlap)

```

```

if(Burrow_Cap == 'None'){
  if((DEM != 'None')==T){

    DEMRas<-raster(DEM)
    DEMRas_UTM<- projectRaster(DEMRas, crs = utmSys)

    SiteSlope <- raster::extract(terrain(DEMRas_UTM, opt = 'slope', unit = '
degrees'), KSHCP_AAS_UTM)
    SofORange<-c('min', '1stQ', 'median', '3rdQ', 'max')

    resRas<-res(DEMRas_UTM)[1]
    if(resRas >= 30){

      SofONum<-c(0.62, 14.93, 21.64, 29.94, 45) # burrow slopes derived from
30m DEM
    }else{
      SofONum<-c(5, 30, 45, 65, 90)
    }

    SofO1<-SofONum[which(SofORange == Slope_Of_Occupancy)]

    NumBurrows<-(length(SiteSlope[which(SiteSlope[[1]]>=SofO1)]*(resRas^2))*
Num_Per_Meter
    Burrow_Cap<-NumBurrows
  }else{
    cat("          !IF NO BURROW CAPACITY IS SPECIFIED A 'Slope_Of_Occupancy' AN
D 'DEM' FILE MUST BE SPECIFIED!          ")
  }
}else{
  Burrow_Cap <-Burrow_Cap
}
cat('\n Burrow Capacity of Site = ', Burrow_Cap)

#####
#####MAKEING THE LIFE TABLE AND PROJECTION MATRIX USING Qx AND Px#####
#####
#####

##### Defined from Breeding Success and Reproductive Success of Proce
lariforms (with not predation) to get Standard Deviations#####

#####Calculation of Breeding Probability from G&H 2011 and KESRP 2013 data
BrProb<-c(0.87, 0.90, 0.80, 0.72, 0.81, 0.75, 0.83, 0.95, 0.89, 0.90, 0.86, 0
.80, 0.74, 0.83, 0.69)

#####Calculation of Reproductive Success from G&H 2011 (no predators presen
t (<= #11) or eradicated (> #11))
ReproSucc<-c(0.52, 0.51, 0.63, 0.35, 0.76, 0.61, 0.52, 0.58, 0.70, 0.62, 0.61

```

```

, 0.81, 0.51, 0.76, 0.7,
      0.62, 0.67, 0.31, 0.53, 0.66, 0.38, 0.47, 0.59, 0.73, 0.75, 0.68,
0.56, 0.60, 0.77, 0.72,
      0.59, 0.64, 0.75, 0.60, 0.59, 0.64, 0.54, 0.56) # removed outlier
r Procellaria aequinoctialis = 0.22

NESH_age<-36 # age of oldest probable NESH
NESHfirst_rep<-6 # age reproduction occurs for NESH
Age<-c(0, seq(1, NESH_age, 1))

Lx<-c(1)
for (ti in 1:NESH_age){
  if (ti == 1){
    Lx<-cbind(Lx, Lx*0.654)
  }
  if (ti == 2){
    Lx<-cbind(Lx, Lx[length(Lx)]*0.78)
  }
  if (ti == 3){
    Lx<-cbind(Lx, Lx[length(Lx)]*0.89)
  }
  if (ti == 4){
    Lx<-cbind(Lx, Lx[length(Lx)]*0.905)
  }
  if (ti == 5){
    Lx<-cbind(Lx, Lx[length(Lx)]*0.905)
  }
  if (ti == 6){
    Lx<-cbind(Lx, Lx[length(Lx)]*0.905)
  }
  if (ti > 6){
    Lx<-cbind(Lx, Lx[length(Lx)]*0.92)
  }
}
Lx<-as.numeric(as.character(Lx))

#####
##### NO PREDATOR ESTIMATES#####
#####
# Used these estimates for reproductive success without predators because the
average found for NESH with some level of control was
# 0.88 NESH repro prob, and 0.75 NESH repro. success (max = 0.95 and 0.81 res
pectively). For an area with some level of control (Upper Limahule) repro. succes
s estimated
# at 0.902439 and repro. prob was 0.7837838. Given that ULP has ungulate fen
ceing and predator control (not exclusion), it is
# definitive that these numbers are probably even higher for an area with pre
dator exclusion, as such these numbers were selected

Ex_JuviSucc<-boxplot(ReproSucc, plot=F)$stats[5,]# the upper whisker of repro
ductive success (=0.81)
Ex_ReproProb<-boxplot(BrProb, plot=F)$stats[4,]# the 3rd Quantile of breeding
probability (=0.88)

Mx<-c(rep(0, (NESHfirst_rep)), rep(Ex_JuviSucc*Ex_ReproProb, (NESH_age-NESHfi

```

```

rst_rep+1)))

  life_table<-data.frame(cbind(Age, Lx, Mx))

  #Calculating Qx and Px to define the population without predation (Leslie Matrix) (original G&H 2011 growth estimates)
  proj_mat<-matrix(rep(0,NESH_age*NESH_age),nrow=NESH_age)
  for (i in 1:nrow(life_table)){
    if ((i == nrow(life_table))==T){
      life_table[i,'Qx']<-1.0000
    }else{
      life_table[i,'Qx']<-round((life_table[i, 'Lx']-life_table[i+1, 'Lx'])/life_table[i, 'Lx'], digits = 4)
    }
    life_table[i,'Px']<-(1-life_table[i, 'Qx']) # this is the stable projection for comparison
    for (ii in 1:nrow(life_table)){
      try(proj_mat[ii, ii]<-life_table[ii,'Px'], T) # subtract by -0.038907 for completely stable pop (lambda exactly == 1)
    }
  } # end of "i" loop

  proj_mat<-proj_mat[1:(NESH_age-1),]
  jk<-proj_mat

  # The Growth Population Projection Matrix
  # from G and H
  Stable_Proj_mat<-as.matrix(rbind(Mx, jk), rownames.force= F) #make sure it is a square matrix
  colnames(Stable_Proj_mat)<-NULL

  eigenNP<-eigen.analysis(Stable_Proj_mat, zero=TRUE) # without strikes and without predation
  Stable_Proj_matNP<-jk
  MxNP<-Mx

# #####
# ##### STEP 1 ESTIMATING AFFECTS OF PREDATION #####
# #####
# ##### Raw data from 2013 Raines North Bog, Pihea, Pohakea, and Upper Limahule
# #####to define Breeding Success and Probability
#
# NESH_Monitor<-c(9, 41) # # Active Burrows for Adult Estimate
# NESH_MonWBrd<-c(7, 37)
# NESH_MonWSuc<-c(4, 29)
#
# NESH_over_BrProb<-median(NESH_MonWBrd)/median(NESH_Monitor)
# NESH_over_BrSucc<-median(NESH_MonWSuc)/median(NESH_MonWBrd)
#
# NESHReproProb<-0.547 # Ainley Average Reproductive Probability

#####
#####
##### KESRP ESTIMATED PREDATION AFFECTS FOR X BREEDING PAIRS PER PRED

```

```

ATOR#####
#####
#####

if(PredationEst == 1){
  LMH<-100
  LMHName<-'KSHCP_KESRP' # DEFINED BY KSHCP
}else{
  if(PredationEst == 2){
    LMH<-87.4675
    LMHName<-'GH_Low' # DEFININD IN G&H
  }else{
    if(PredationEst==3){
      LMH<-72.2599
      LMHName<-'GH_Medium' # DEFININD IN G&H
    }else{
      LMH <-63.396
      LMHName<-'GH_High' # DEFINED IN G&H
    }
  }
}
}
KESRPBreedingPairs<-LMH #
AdultSubAdultSS<-eigenNP$stable.stage[3:length(eigenNP$stable.stage)]/sum(eig
enNP$stable.stage[3:length(eigenNP$stable.stage)]) # start at stage 3 (2-3 y/o surviv
orship) b/c it is when predation mortality starts
NumAdults<-2*KESRPBreedingPairs
AdultSubAdultForSANum<-eigenNP$stable.stage[2:length(eigenNP$stable.stage)]/s
um(eigenNP$stable.stage[2:length(eigenNP$stable.stage)])
# NumSubAdults<-sum(AdultSubAdultSS[1:4])*((KESRPBreedingPairs*2)/sum(Adult
SubAdultSS[5:length(AdultSubAdultSS)]))
# NumSubAdultsTot<-sum(AdultSubAdultForSANum[1:(NESHfirst_rep-1)]*((KESRPBr
eedingPairs*2)/sum(AdultSubAdultForSANum[NESHfirst_rep:length(AdultSubAdultForSANum)]
)))
NumSubAdults<- sum(AdultSubAdultSS[1:(NESHfirst_rep-2)]*((KESRPBreedingPairs*
2)/sum(AdultSubAdultSS[(NESHfirst_rep-1):length(AdultSubAdultSS)])))# number of sub-a
dults predated (i.e. after year 2)
numChicks<-KESRPBreedingPairs # breeding pairs count assumes 100% breeding pr
ob.

##### Overall Predation #####
#Ungulate Predation
UngAdultPredation<-sum((8*AdultSubAdultSS[(NESHfirst_rep-1):length(AdultSubAd
ultSS)])) # adults >=6
UngSubAdultPredation<-sum((8*AdultSubAdultSS[1:(NESHfirst_rep-2)])) # subadul
ts from age 2-5
UngChickPredation<-8+(UngAdultPredation*Ex_ReproProb)#NESHReproProb) # added
all predated breeding adults to estimate chick predation due to parental death, estim
ated breeding probability to establish which to remove
PercUngPredAdults<- UngAdultPredation/NumAdults#divide Adult # by 2 to accoun
t for nocturnal/crepuscular predation= when only 1 individual of pair at nest at that
time
PercUngPredSubAdults<-UngSubAdultPredation/NumSubAdults
PercUngPredChick<-UngChickPredation/numChicks# Any predation of adults would
be a predation of chick as well...did not include breeding prob because this was alre
ady esimated here

```

```

    Ung_NESHReproProb<-0#(UngAdultPredation*4)/NumAdults # quadruples time until
    reproduction so used it to modify repro. probability

    #Cat Predation
    CatAdultPredation<-sum((8*AdultSubAdultSS[(NESHfirst_rep-1):length(AdultSubAd
    ultSS)])) # adults >=6
    CatSubAdultPredation<-sum((8*AdultSubAdultSS[1:(NESHfirst_rep-2)])) # subadul
    ts from age 2-5
    CatChickPredation<-8+(CatAdultPredation*Ex_ReproProb)#NESHReproProb) # added
    all predated breeding adults to estimate chick predation due to parental death, estim
    ated breeding probability to establish which to remove
    PercCatPredAdults<- CatAdultPredation/NumAdults#divide Adult # by 2 to accoun
    t for nocturnal/crepuscular predation= when only 1 individual of pair at nest at that
    time
    PercCatPredSubAdults<-CatSubAdultPredation/NumSubAdults
    PercCatPredChick<-CatChickPredation/numChicks# Any predation of adults would
    be a predation of chick as well...did not include breeding prob because this was alre
    ady esimated here

    Cat_NESHReproProb<-0

    #Rat Predation
    RatAdultPredation<-0 # adults >=6
    RatSubAdultPredation<-0 # subadults from age 2-5
    RatChickPredation<-12+(RatAdultPredation*Ex_ReproProb)#NESHReproProb) # added
    all predated breeding adults to estimate chick predation due to parental death, estim
    ated breeding probability to establish which to remove
    PercRatPredAdults<- RatAdultPredation/NumAdults#divide Adult # by 2 to accoun
    t for nocturnal/crepuscular predation= when only 1 individual of pair at nest at that
    time
    PercRatPredSubAdults<-RatSubAdultPredation/NumSubAdults
    PercRatPredChick<-RatChickPredation/numChicks# Any predation of adults would
    be a predation of chick as well...did not include breeding prob because this was alre
    ady esimated here

    Rat_NESHReproProb<-0

    #Barn Owl Predation
    BrOwlAdultPredation<-sum((1*AdultSubAdultSS[(NESHfirst_rep-1):length(AdultSub
    AdultSS)])) # adults >=6
    BrOwlSubAdultPredation<-sum((1*AdultSubAdultSS[1:(NESHfirst_rep-2)]), na.rm =
    T) # subadults from age 2-5
    BrOwlChickPredation<-0.5+(BrOwlAdultPredation*Ex_ReproProb)#NESHReproProb) #
    added all predated breeding adults to estimate chick predation due to parental death,
    estimated breeding probability to establish which to remove
    PercBrOwlPredAdults<- BrOwlAdultPredation/NumAdults#divide Adult # by 2 to ac
    count for nocturnal/crepuscular predation= when only 1 individual of pair at nest at
    that time
    PercBrOwlPredSubAdults<-BrOwlSubAdultPredation/NumSubAdults
    PercBrOwlPredChick<-BrOwlChickPredation/numChicks# Any predation of adults wo
    uld be a predation of chick as well...did not include breeding prob because this was
    already esimated here

    BrOwl_NESHReproProb<-0

```

```

# making projection matrix bottom (not mortality/fertility information yet)

# Adding % adults removed by predators
#
#           a_Ungulates<-PercUngPredAdults+PercUngPredSubAdults
#           a_Cats<-PercCatPredAdults+PercCatPredSubAdults
#           a_Rats<-PercRatPredAdults+PercRatPredSubAdults
#           a_Owl<-PercBrOwlPredAdults+PercBrOwlPredSubAdults
#           a_RatsCats<-a_Cats+a_Rats
#           a_RatsOwl<-a_Cats+a_Owl

ad_RatsOwl<-PercRatPredAdults+PercBrOwlPredAdults
sa_RatsOwl<-PercRatPredSubAdults+PercBrOwlPredSubAdults
#           a_All<-a_Ungulates+a_Cats+a_Rats+a_Owl
ad_All<-PercUngPredAdults+PercCatPredAdults+PercRatPredAdults+PercBrOwlPredAd
ults
sa_All<-PercUngPredSubAdults+PercCatPredSubAdults+PercRatPredSubAdults+PercBr
OwlPredSubAdults

#####
##### ALL PREDATORS ESTIMATES #####
#####

# Base Estimate all predators
Ex_AllPredAdults<-(((PercUngPredAdults+PercUngPredSubAdults)+
                    (PercCatPredAdults+PercCatPredSubAdults)+
                    (PercRatPredAdults+PercRatPredSubAdults)+
                    (PercBrOwlPredAdults+PercBrOwlPredSubAdults)))

Ex_APredJuviSucc<-Ex_JuviSucc-((Ex_JuviSucc*PercRatPredChick)+(Ex_JuviSucc*Pe
rcCatPredChick)+
                               (Ex_JuviSucc*PercBrOwlPredChick)+(Ex_JuviSucc
c*PercUngPredChick))

Ex_APredReproProb<-Ex_ReproProb-((Ex_ReproProb*BrOwl_NESHReproProb)+(Ex_Repro
Prob*Rat_NESHReproProb)+
                                   (Ex_ReproProb*Cat_NESHReproProb)+(Ex_Repro
Prob*Ung_NESHReproProb))

proj_MatPred<-proj_mat
for (ii in (NESHfirst_rep-1):(nrow(life_table)-1)){
  try(proj_MatPred[ii, ii]<-proj_MatPred[ii, ii]-Ex_AllPredAdults, T)
} # end of ii

Bred<-Ex_APredJuviSucc
Rep<-Ex_APredReproProb

Mx<-c(rep(0, (NESHfirst_rep-1)), rep(Bred*Rep, (NESH_age-NESHfirst_rep+1)))
jk<-proj_MatPred[1:(NESH_age-1),]

dfMitSoc<-data.frame(matrix(nrow=13, ncol= RunTme))
proj_mat2<-jk

# Adding to the The Growth Projection Matrix

```

```

# from G and H
Stable_Proj_mat<-as.matrix(rbind(Mx, jk), rownames.force= F) #make sure it is
a square matrix
colnames(Stable_Proj_mat)<-NULL
rownames(Stable_Proj_mat)<-NULL
eigen<-eigen.analysis(Stable_Proj_mat, zero=TRUE) # with predation without s
trikes

# Stable Stage distribution developed from Eigen analysis of the base model
stable.stage<-eigen$stable.stage

PredLamb<-eigen$lambda1
PredLamb

# Population Size at year 1 (now)
StanPopSizeYr1<-SPS*eigen$stable.stage # standing population size at year 1

# NonBreedOverlap<-MetaPopSize*stable.stage[c(2:5)]*Overlap

Mx<-c(rep(0, (NESHfirst_rep-1)), rep(Bred*Rep, (NESH_age-NESHfirst_rep+1)))

jk2<-proj_mat2[1:(NESH_age-1),]
Stable_Proj_mat<-as.matrix(rbind(Mx, jk2), rownames.force= F) #make sure it i
s a square matrix
colnames(Stable_Proj_mat)<-NULL
rownames(Stable_Proj_mat)<-NULL

eigenAllMort<-eigen.analysis(Stable_Proj_mat, zero=0)

CurrLambda<-eigenAllMort$lambda1

dfMitSoc[, 1]<-c(0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0) # social attraction/e
xclusion starting population size

numBirdsAllprd<-c()#rep(0, NESH_age) # Social Attraction birds
NmBrdStPopAllPred<-c()# Birds already at site

CurrYear<-as.numeric(as.character(format(Sys.time(), "%Y"))) # Defining the y
ear at which the tool was run

# Because the initial meta-population size was defined for 2011 (by Trevor Jo
yce in 2013) am updating to estimate the Meta-popSize during
# the current time period using the predation estimate defined in the paramet
ers

MetaPopSize<- MetaPopSize*(CurrLambda ^ (CurrYear-YearPopEstimated))
cat('\n', CurrYear, "Meta-Population Size Using the Predation Estimate", Pred
ationEst, " =", MetaPopSize)

#####
#####MAIN ASSESSMENT SECTION#####
#####

#####
#####
##### Deterministic model to assess what happens without a fenced site ####

```

```
#####
#####
#####
# Deterministic model to assess what happens without a fenced site -----
  for (i in seq(1, RunTme, 1)){ #RunTme
#     NmBrdStPopAllPred<-c()#!!!!!!!!!!
#     for(i in seq(1,2,1)){ #!!!!!!!!!!

    numBirds1<-rep(0, NESH_age)

    Choices1<-c(Broad_Strt, Fence_Fin)
    Choices2<-which.max(c(Broad_Strt, Fence_Fin))

    if(i %in% c(seq(1, Choices1[Choices2], 1))){
      #####Standing Population Estimates
      if( i == 1){
        SPSJ<-SPS*eigenAllMort$stable.stage
      }else{
        SPSJ<-NmBrdStPopAllPred[i-1,]
      }

      AdSubAdSurv<-c(0,SPSJ*c(diag(jk2), 0))
      jnkSP<-Ex_APredJuviSucc*Ex_APredReproProb
      FledgSameYr<-sum(AdSubAdSurv[NESHfirst_rep:NESH_age], na.rm = T)*jnkSP/2
      NmBrdStPopSize<-c(FledgSameYr,AdSubAdSurv[-1])[-(NESH_age+1)]
      NmBrdStPopAllPred<-rbind(NmBrdStPopAllPred, NmBrdStPopSize)
    # }}

    #####Social Attraction Site Estimates
    CurrLambda<-eigenAllMort$lambda1
    SocBirds<-0
    SocBurrows<-0
    SocAdults_Saved1<-0
    SocJuvi_Saved1<-0
    dfMitSoc[,i]<-c(0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0) # Because the Social Attraction sites don't add anything until they're made = no additional protection or reduction
    numBirds1<-rep(0, NESH_age)
    numBirdsAllprd<-rbind(numBirdsAllprd, numBirds1)
  }else{
    # estimates after control starts = complete implimentation of the program
    NoSocAdMit<-Ex_AllPredAdults#ratioCntrlAdults_SocEx#+(0.2191627*PercSocialExclusion)
    NoSocJuvMit<-Ex_APredJuviSucc#ratioCntrlJuvi_SocEx
    NoSocRepr<- Ex_APredReproProb#Ex_APredReproProb + abs(ratioReproRate_SocialEx)
    NoSocSucc<- Ex_APredJuviSucc#Ex_APredJuviSucc + abs(ratioCntrlJuvi_SocEx)

    Bred<-Ex_APredJuviSucc
    Rep<-Ex_APredReproProb

    plus2<-2
    plus1<-1
  }
}
```

```

NonBreedOverlap<-(MetaPopSize*(PredLamb^i))*stable.stage[c(2:5)]*Overlap
NonBreedOverlapAP<-NonBreedOverlap
# cat('\n Non-breeders in year ', i, ' (years 2:5) that have the potential
# to get called in:', NonBreedOverlap)

Attraction<-NonBreedOverlap*(1-SitFidIn)
# Attraction profile of site
if(i == (Choices1[Choices2]+1)){# if i is equal to the year after start
#####Standing Population Estimates

#####Standing Population Estimates
if( i == 1){
  SPSJ<-SPS*eigenAllMort$stable.stage
}else{
  SPSJ<-NmBrdStPopAllPred[i-1,]
}
AdSubAdSurv<-c(0,SPSJ*c(diag(jk2), 0))
jnkSP<-Ex_APredJuviSucc*Ex_APredReproProb
FledgSameYr<-(sum(AdSubAdSurv[NESHfirst_rep:NESH_age], na.rm = T)*jnkSP
)/2

NmBrdStPopSize<-c(FledgSameYr,AdSubAdSurv[-1])[-(NESH_age+1)]
NmBrdStPopAllPred<-rbind(NmBrdStPopAllPred, NmBrdStPopSize)

#####Social Attraction Site Estimates
# adding the number that are attracted via microphones
Juvis<-Attraction
numBirds1[2:(NESHfirst_rep-1)]<-Attraction
numBirdsAllprd<-rbind(numBirdsAllprd, numBirds1)
}else{
#####Standing Population Estimates
if( i == 1){
  SPSJ<-SPS*eigenAllMort$stable.stage
}else{
  SPSJ<-NmBrdStPopAllPred[i-1,]
}
AdSubAdSurv<-c(0,SPSJ*c(diag(jk2), 0))
jnkSP<-Ex_APredJuviSucc*Ex_APredReproProb
FledgSameYr<-(sum(AdSubAdSurv[NESHfirst_rep:NESH_age], na.rm = T)*jnkSP
)/2

NmBrdStPopSize<-c(FledgSameYr,AdSubAdSurv[-1])[-(NESH_age+1)]
NmBrdStPopAllPred<-rbind(NmBrdStPopAllPred, NmBrdStPopSize)

#####Social Attraction Site Estimates
# DEFINING THE YEAR TO YEAR POPULATION GROWTH

# adding the number that are attracted via microphones
numBirds1[2:(NESHfirst_rep-1)]<-Attraction # adding the number that come
in to the year

# Adding the number that reproduce based on the previous years attraction
via microphones
### the Number to add to reproduction
PrevYearSurv<-numBirdsAllprd[i-1,]*c(diag(jk2), 0)#(Broad_Strt+1)

```

```

# adding two zeros the first because the assessment starts
# at year 0 and the second to move it up a year
PrevYearSurvA<-c(0, PrevYearSurv)#0,
PrevYearSurvB<-PrevYearSurvA[-length(PrevYearSurvA)]

###Reproduction
ReproYr<-c(Stable_Proj_mat[1,]) # adding 0 because starts at year 0
# NumBabies<-sum((numBirdsAllprd[i-1,1]/2)*ReproYr)#ReproYr#
NumBabies<-sum(PrevYearSurvB/2*ReproYr, na.rm = T)

PrevYearSurvB[2:(NESHfirst_rep-1)]<-PrevYearSurvB[2:(NESHfirst_rep-1)]*
(SitFidOut)
PrevYearSurvC<-PrevYearSurvB+numBirds1 #Removing year 0 and adding the
number attracted[-1]
PrevYearSurvC[1]<-NumBabies

numBirdsAllprd<-rbind(numBirdsAllprd, PrevYearSurvC)

test1<-try((numBirdsAllprd[i,1]/(sum(numBirdsAllprd[i,NESHfirst_rep:NESH_age], na.rm = T)/2))/ReproYr[length(ReproYr)], T)
if(class(test1) == 'try-error'){
  test1<-"out of bounds"
}

cat('\nTESTA (should equal 1)', test1, ':Number of Fledglings = ', (sum
((numBirdsAllprd[i,NESHfirst_rep:NESH_age], na.rm = T)/2)*ReproYr[length(ReproYr)])

}
}
} # end runtime in years

# Birds at Site (With all predation)
AllPredSiteBirds<-data.frame(NmBrdStPopAllPred)
rownames(AllPredSiteBirds)<-paste0('Year ', seq(1, RunTme, 1))
colnames(AllPredSiteBirds)<-paste0(seq(1, ncol(AllPredSiteBirds)), ' Years Old')

# Social Attraction Birds
numBirdsDataAllPred<-data.frame(numBirdsAllprd)
rownames(numBirdsDataAllPred)<-paste0('Year ', seq(1, RunTme, 1))
colnames(numBirdsDataAllPred)<-paste0(seq(1, ncol(numBirdsDataAllPred)), ' Years Old')

#####
#####
#####DEFINING A PREDATOR EXCLUSION FENCE SITE TO INFORM SOCIAL ATTRA
CTION #####
#####
#####

# Ages 7 and up adults have greater survivorship
Ex_AdultsUp<-((Stable_Proj_matNP[NESHfirst_rep+1, NESHfirst_rep+1]*((PercUng
PredAdults+PercUngPredSubAdults)* Ungulate_Cntrl))+
(Stable_Proj_matNP[NESHfirst_rep+1, NESHfirst_rep+1]*((PercCatP
redAdults+PercCatPredSubAdults)* Cat_Cntrl))+

```

```

        (Stable_Proj_matNP[NESHfirst_rep+1, NESHfirst_rep+1]*((PercRatPredAdults+PercRatPredSubAdults)* Rat_Cntrl)))+
        (Stable_Proj_matNP[NESHfirst_rep+1, NESHfirst_rep+1]*((PercBrOwlPredAdults+PercBrOwlPredSubAdults)* BrOwl_Cntrl))

    # Ages 5-6 has lower survivorship for adults

    Ex_Adults <- ((Stable_Proj_matNP[NESHfirst_rep, NESHfirst_rep] * ((PercUngPredAdults+PercUngPredSubAdults) * Ungulate_Cntrl))+
        (Stable_Proj_matNP[NESHfirst_rep, NESHfirst_rep] * ((PercCatPredAdults+PercCatPredSubAdults) * Cat_Cntrl))+
        (Stable_Proj_matNP[NESHfirst_rep, NESHfirst_rep] * ((PercRatPredAdults+PercRatPredSubAdults) * Rat_Cntrl))+
        (Stable_Proj_matNP[NESHfirst_rep, NESHfirst_rep] * ((PercBrOwlPredAdults+PercBrOwlPredSubAdults) * BrOwl_Cntrl)))

    Ex_Juvi <- ((Ex_JuviSucc*PercUngPredChick)* Ungulate_Cntrl)+
        ((Ex_JuviSucc*PercCatPredChick)* Cat_Cntrl)+
        ((Ex_JuviSucc*PercRatPredChick)* Rat_Cntrl)+
        ((Ex_JuviSucc*PercBrOwlPredChick)* BrOwl_Cntrl)

    Ex_ReproProbScen <- ((Ex_ReproProb*Ung_NESHReproProb)* Ungulate_Cntrl)+
        ((Ex_ReproProb*Cat_NESHReproProb)* Cat_Cntrl)+
        ((Ex_ReproProb*Rat_NESHReproProb)* Rat_Cntrl)+
        ((Ex_ReproProb*BrOwl_NESHReproProb)* BrOwl_Cntrl)

    # SOCIAL ATTRACTION (STARTING FROM SCRATCH) WITH EXCLUSION
    SocEx_Adults7up <- Ex_Adults7up
    SocEx_Adults <- Ex_Adults
    SocEx_Juvi <- Ex_Juvi
    SocEx_ReproProb <- Ex_ReproProbScen

    ##### For Social Attraction
    ratioCntrlAdults_SocEx7up <- (SocEx_Adults7up)*PercSocialExclusion)
    ratioCntrlAdults_SocEx <- (SocEx_Adults)*PercSocialExclusion)
    ratioCntrlJuvi_SocEx <- (SocEx_Juvi)*PercSocialExclusion)
    ratioReproRate_SocEx <- (SocEx_ReproProb)*PercSocialExclusion)

    #####
    #####
    ##### MAKEING A DETERMINISTIC MODEL WITH PREDATION #####
    #####
    #####

    Bred<-Ex_APredJuviSucc
    Rep<-Ex_APredReproProb

    Mx<-c(rep(0, (NESHfirst_rep-1)), rep(Bred*Rep, (NESH_age-NESHfirst_rep+1)))

    jk2<-proj_mat2[1:(NESH_age-1),]
    Stable_Proj_mat<-as.matrix(rbind(Mx, jk2), rownames.force= F) #make sure it i

```

```

s a square matrix
colnames(Stable_Proj_mat)<-NULL
rownames(Stable_Proj_mat)<-NULL

eigenAllMort<-eigen.analysis(Stable_Proj_mat, zero=0)

CurrLambda<-eigenAllMort$lambda1

dfMitSoc[, 1]<-c(0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0) # social attraction/exclusion starting population size

numBirds<-c()#rep(0, NESH_age)
StPopAllPred<-c() # Birds at site

#####
#####
##### Deterministic model to assess what happens with a fenced site, #####
#####
##### a standing population, and Social Attraction#####
#####
#####
#####
# Deterministic model to assess overall mitigation effort for Soci -----
  for (i in seq(1, RunTme, 1)){

    # numBirds1<-rep(0, NESH_age)

    # estimates the strike removal from the population prior to the start of control
    # Everything with Soc in it's name has to do with the social attraction population

    Choices1<-c(Broad_Strt, Fence_Fin)
    Choices2<-which.max(c(Broad_Strt, Fence_Fin))

#      StPopAllPred<-c()
#      for (i in seq(1,2,1)){
#
#          i = 1
#      if(i %in% c(seq(1, Choices1[Choices2], 1))){ # Prior to Fencing
#          #####Standing Population Estimates
#          if( i == 1){
#              SPSJ<-SPS*eigenAllMort$stable.stage
#          }else{
#              SPSJ <- StPopAllPred[i-1,]
#          }
#          AdSubAdSurv<-c(0,SPSJ*c(diag(jk2), 0))
#          jnkSP<-Ex_APredJuviSucc*Ex_APredReproProb
#          FledgSameYr<-sum(AdSubAdSurv[NESHfirst_rep:NESH_age], na.rm = T)*jnkSP/2
#          SPSii1<-c(FledgSameYr,AdSubAdSurv[-1])[-(NESH_age+1)]

#          StPopAllPred<-rbind(StPopAllPred, SPSii1)

#          #####Social Attraction Site Estimates
#          CurrLambda<-eigenAllMort$lambda1

```

```

SocBirds<-0
SocBurrows<-0
SocAdults_Saved1<-0
SocJuvi_Saved1<-0
dfMitSoc[,i]<-c(0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0) # Because the Social Attraction sites don't add anything until they're made = no additional protection or reduction
numBirds1<-rep(0, NESH_age)
numBirds<-rbind(numBirds, numBirds1)
}else{
  # estimates after control starts = complete implimentation of the program
  SocAdMit7up<-ratioCntrlAdults_SocEx7up#+(0.2191627*PercSocialExclusion)
  SocAdMit<-ratioCntrlAdults_SocEx#+(0.2191627*PercSocialExclusion)
  SocJuvMit<-ratioCntrlJuvi_SocEx # Only used for chick/fledgeing success
  SocRepr<- Ex_APredReproProb + abs(ratioReproRate_SocEx)
  SocSucc<- Ex_APredJuviSucc + abs(ratioCntrlJuvi_SocEx)

  # Stable_Proj_matNP
  plus2<-2
  plus1<-1

  for (mitty in c('Soc')){
    proj_mat3<-proj_mat2
    for (ii in life_table[2:nrow(life_table), 'Age']){
      if ((ii >= NESHfirst_rep-1)==T){ # Start at year 5 prospectors
        if(ii %in% c(5, 6)){
          try(proj_mat3[ii, ii]<-proj_mat2[ii,ii]+get(paste0(mitty, "AdMit"
)), T) # removing sub-adults
        }

        if(ii >= 7){
          try(proj_mat3[ii, ii]<-proj_mat2[ii,ii]+get(paste0(mitty, "AdMit7
up"))), T) # removing sub-adults
        }

      }else{
        try(proj_mat3[ii, ii]<-proj_mat2[ii,ii], T)#+get(paste0(mitty, "Juv
Mit")), T) # removing sub-adults
      }
      try(if((proj_mat3[ii,ii]==0)==T){
        proj_mat3[ii,ii]<-0.00000001# makeing as close to zero as possible
      }, T)
    } # end ii

    MxMit<-c(rep(0, (NESHfirst_rep-1)), rep(get(paste0(mitty, "Repr"))*get(
paste0(mitty, "Succ")), (NESH_age-NESHfirst_rep+plus1)))

    jk2Mit<-proj_mat3[1:(NESH_age-1),]
    Stable_Proj_mat<-as.matrix(rbind(MxMit, jk2Mit), rownames.force= F) #ma
ke sure it is a square matrix
    colnames(Stable_Proj_mat)<-NULL
    rownames(Stable_Proj_mat)<-NULL

    eigenMit<-eigen.analysis(Stable_Proj_mat, zero=0)
    assign(paste0(mitty, 'eigenMit'), eigenMit)

```

```

}

NonBreedOverlap<-(MetaPopSize*(PredLamb^i))*stable.stage[c(2:5)]*Overlap

NonBreedOverlapNP<-NonBreedOverlap
# cat('\n Non-breeders in year ', i, ' (years 2:5) that have the potential to get called in:', NonBreedOverlap)
Attraction<-NonBreedOverlap*(1-SitFidIn)
# Attraction profile of site
if(i == (Choices1[Choices2]+1)){# if i is equal to the year after start
#####Standing Population Estimates
if( i == 1){
  SPSJ<-SPS*eigenMit$stable.stage
}else{
  SPSJ<-StPopAllPred[i-1,]
}

AdSubAdSurv<-c(0,SPSJ*c(diag(jk2Mit), 0))
jnkSP<-SocRepr*SocSucc
FledgSameYr<-(sum(AdSubAdSurv[NESHfirst_rep:NESH_age], na.rm = T)*jnkSP)/2

SPSii2<-c(FledgSameYr,AdSubAdSurv[-1])[-(NESH_age+1)]

StPopAllPred<-rbind(StPopAllPred, SPSii2)

#####Social Attraction Site Estimates
# adding the number that are attracted via microphones
Juvis<-Attraction
numBirds1[2:(NESHfirst_rep-1)]<-Attraction
numBirds<-rbind(numBirds, numBirds1)
}else{
#####Standing Population Estimates
if( i == 1){
  SPSJ<-SPS*eigenMit$stable.stage
}else{
  SPSJ<-StPopAllPred[i-1,]
}

AdSubAdSurv<-c(0,SPSJ*c(diag(jk2Mit), 0))
jnkSP<-SocRepr*SocSucc
FledgSameYr<-sum(AdSubAdSurv[NESHfirst_rep:NESH_age], na.rm = T)*jnkSP/2

SPSii3<-c(FledgSameYr,AdSubAdSurv[-1])[-(NESH_age+1)]

StPopAllPred<-rbind(StPopAllPred, SPSii3)

#####Social Attraction Site Estimates
# adding the number that are attracted via microphones
numBirds1[2:(NESHfirst_rep-1)]<-Attraction # adding the number that come in to the year

# Adding the number that reproduce based on the previous years attraction via microphones

```

```

### the Number to add to reproduction
PrevYearSurv<-numBirds[i-1,]*c(diag(jk2Mit), 0)#(Broad_Strt+1)

# adding two zeros the first because the assessment starts
# at year 0 and the second to move it up a year
PrevYearSurvA<-c(0, PrevYearSurv)
PrevYearSurvB<-PrevYearSurvA[-length(PrevYearSurvA)]

###Reproduction
ReproYr<-c(Stable_Proj_mat[1,]) # adding 0 because starts at year 0
# NumBabies<-sum((numBirds[i,]/2)*ReproYr)#ReproYr#
NumBabies<-sum(PrevYearSurvB/2*ReproYr, na.rm = T)
# [NESHfirst_rep:NESH_age]
# Total added
PrevYearSurvB[2:(NESHfirst_rep-1)]<-PrevYearSurvB[2:(NESHfirst_rep-1)]*
(SitFidOut)
PrevYearSurvC<-PrevYearSurvB+numBirds1 #Removing year 0 and adding the
number attracted[-1]
PrevYearSurvC[1]<-NumBabies
numBirds<-rbind(numBirds, PrevYearSurvC)

# i = 10

test2<-try((numBirds[i,1]/(sum(numBirds[i,NESHfirst_rep:NESH_age], na.r
m = T)/2))/ReproYr[length(ReproYr)], T)
if(class(test2) == 'try-error'){
  test2<-"out of bounds"
}
cat('\nTESTB (should equal 1)', test2, ':Number of Fledglings = ', (sum
((numBirdsAllprd[i,NESHfirst_rep:NESH_age])/2)*ReproYr[length(ReproYr)])
}
}
}
}
Overview<-paste0('SAS_Using_PredEst_', PredationEst, '_with_Site_Fid_of_', Si
tFidIn)

Metadata<-rbind(MetaPopSize, Fence_Fin, Broad_Strt, Burrow_Cap, RunTme, Preda
tionEst, SitFidIn, SitFidOut)
rownames(Metadata)<-c('Meta-Pop Size = ', 'Year Fencing is Complete = ', 'Yea
r Broadcasting Starts= ', 'Burrow Capacity of the Site = ',
"Years the Analysis is Run For = ", 'Predation Estimate
= ', 'Juvenile Site Fidelity Value Within the Site= ',
'Juvenile Site Fidelity Value Outside of the Site= ')
colnames(Metadata)<- 'MetaData of Analysis'

Dir2<-paste0(Dir, Overview, '/')
if(file.exists(Dir2) == F){
  dir.create(Dir2)
}

StPopAllPredData<-data.frame(StPopAllPred)
rownames(StPopAllPredData)<-paste0('Year ', seq(1, RunTme, 1))

```

```

colnames(StPopAllPredData)<-paste0(seq(1, ncol(StPopAllPredData)), ' Years Old')

# write.csv(Metadata, paste0(Dir2, 'MetaData.csv'))
numBirdsData<-data.frame(numBirds)
rownames(numBirdsData)<-paste0('Year ', seq(1, RunTime, 1))
colnames(numBirdsData)<-paste0(seq(1, ncol(numBirdsData)), ' Years Old')

# Lambda for the social attraction site is calculated differently. Because
the social attraction site is
# affected by the decrease in the meta-population, but always adds birds to the
population, its growth must
# be compared with that of the social attraction site without any mitigation.
That is what is done here.
tunction1<-apply(numBirdsData, 1, function(x){
  xrow <- which(sum(x) == apply(numBirdsData, 1, sum))
  round(1+((sum(x)-sum(numBirdsDataAllPred[xrow,]))/sum(x)), 2)
})
lambda <- median(tunction1, na.rm = T)

# lambda<-round(1+abs((sum(numBirdsData[nrow(numBirdsData),])-sum(numBirdsData[nrow(numBirdsData)-1,]))/sum(numBirdsData[nrow(numBirdsData),])), 2)
lambdaSP <- round(eigenMit$lambda1, 2)

write.csv(numBirdsDataAllPred, paste0(Dir2, 'All Predators Social Attraction
Birds.csv'))
write.csv(AllPredSiteBirds, paste0(Dir2, 'All Predators for Standing Population.csv'))
write.csv(AllPredSiteBirds+numBirdsDataAllPred, paste0(Dir2, 'All Predators for ALL BIRDS.csv'))

write.csv(numBirdsData, paste0(Dir2, 'Predator Exclusion Social Attraction Birds NO CARRYING CAPACITY.csv'))
write.csv(StPopAllPredData, paste0(Dir2, 'Predator Exclusion For Standing Population NO CARRYING CAPACITY.csv'))
write.csv(StPopAllPredData+numBirdsData, paste0(Dir2, 'Predator Exclusion for ALL BIRDS NO CARRYING CAPACITY.csv'))

AllBirds<-StPopAllPredData+numBirdsData
PropSPS<-StPopAllPredData/AllBirds # Proportion that is the standing population size
PropSA<-numBirdsData/AllBirds # Proportion that is the Social Attraction birds

png(filename = paste0(Dir2, " Social Attraction Site Population Site with a Standing Population Size Analysis.png"), width = 1000,
     height = 1000, pointsize = 18, type="cairo")

#####Defining carrying capacity for Social Attraction Sites#####
##
SE_K<-(Burrow_Cap/Rep)*2#PercSocialExclusion*1644912 # Social attraction Site Carrying Capacity (= percent area defined by social attraction, multiplied by total K for ENM)
# SE_K<- KCap*HAExclusion # 48.2 individuals per ha, ad hoc K defined in M&M for NESH strategy write up

```

```

OverSum<-apply(AllBirds, 1, sum)
OverSum2<-OverSum
OverSum2[which(OverSum2>SE_K)]<-SE_K

# applying K to the csv file
numBirdsDataTK<-AllBirds

for (Ni in which(OverSum>SE_K)){
  if(Ni < NESH_age){
    # Ni = 22
    SSgd<-SoceigenMit$stable.stage[1:(Ni+2)]/sum(SoceigenMit$stable.stage[1:(
Ni+2)], na.rm = T)
    ToApp<-SE_K*SSgd
    numBirdsDataTK[Ni,]<-c(ToApp, rep(0, NESH_age-Ni))

  }else{
    SSgd<-SoceigenMit$stable.stage
    ToApp<-SE_K*SSgd
    numBirdsDataTK[Ni,]<-ToApp
  }
}

# numBirdsDataTK[21:22,]

write.csv(numBirdsDataTK*PropSA, paste0(Dir2, 'Predator Exclusion Social Attr
action Birds WITH CARRYING CAPACITY.csv'))
write.csv(numBirdsDataTK*PropSPS, paste0(Dir2, 'Predator Exclusion For Standi
ng Population WITH CARRYING CAPACITY.csv'))
write.csv(numBirdsDataTK, paste0(Dir2, 'Predator Exclusion for ALL BIRDS WITH
CARRYING CAPACITY.csv'))

# ((apply((numBirdsDataTK*PropSPS)[,6:36], 1, sum)*get(paste0(mitty, "Repr"))
)/2)*get(paste0(mitty, "Succ"))

# write.csv(numBirdsDataTK, paste0(Dir2, 'Analysis Output per Age Class and P
er Year WITH CARRYING CAPACITY.csv'))

plot(apply(numBirdsDataTK, 1, sum), type = 'l', bty = 'l', ylab = "Number of
Birds (All Age Classes)", xlab = 'Year', lty = 1)
mtext('Social Attraction Site with Standing Population Analysis')
mtext('(the rate of site occupancy from Social Attraction is estimated \nusin
g the overlap of the flight path with a \nproposed Social Attraction Site)',
  line = -2.5, cex = 0.8)
mtext(paste0('Population Size at Year ', RunTime, ' = ', round(apply(numBirdsD
ataTK, 1, sum)[paste0('Year ',RunTime)], 2)),
  line = -4, cex = 0.6)

upway <- -2
mtext(bquote(underline('Various Parameters Used in the Analysis'))), cex = 0.7
, col = 'red', line = -10 + upway, adj = 1, side = 3, font = 2)
mtext(paste0(rownames(Metadata)[1], round(Metadata[1,])), cex = 0.6, line = -1
0.5+ upway, adj = 1, side = 3)
mtext(paste0(rownames(Metadata)[2], Metadata[2,]), cex = 0.6, line = -11+ upwa

```

```

y, adj = 1, side = 3)
  mtext(paste0(rownames(Metadata)[3], Metadata[3,]), cex = 0.6, line = -11.5+ up
way, adj = 1, side = 3)
  mtext(paste0(rownames(Metadata)[4], round(Metadata[4,])), cex = 0.6, line = -1
2+ upway, adj = 1, side = 3)
  mtext(paste0('Carrying Capacity of the Site = ', round(SE_K, 0)), cex = 0.6, l
ine = -12.5+ upway, adj = 1, side = 3)
  mtext(paste0(rownames(Metadata)[5], Metadata[5,]), cex = 0.6, line = -13+ upwa
y, adj = 1, side = 3)
  mtext(paste0(rownames(Metadata)[6], Metadata[6,]), cex = 0.6, line = -13.5+ up
way, adj = 1, side = 3)
  mtext(paste0(rownames(Metadata)[7], Metadata[7,]), cex = 0.6, line = -14+ upwa
y, adj = 1, side = 3)
  mtext(paste0(rownames(Metadata)[8], Metadata[8,]), cex = 0.6, line = -14.5+ up
way, adj = 1, side = 3)
  mtext(paste0('Flight Path Overlap Value Used = ', round(Overlap,4)), cex = 0.
6, line = -15+ upway, adj = 1, side = 3)

#       SPS <- 500 #UserSpecified#
#
#       # FENCE EFFICACY
#       # Can use this section to assess either "leaky fence" or specific fence typ
e scenarios,
#       # values range from 0 to 1, where 1 is complete control, and 0 is no contro
l.
#       Ungulate_Cntrl <- 1 # Ungulate Control
#       Rat_Cntrl <- 1 # Rat Control
#       Cat_Cntrl <- 1 # Cat Control
#       BrOwl_Cntrl <- 1 # Barn Owl Control
  mtext(paste0('Starting Population Size at Site = ', SPS), cex = 0.6, line = -
15.5+ upway, adj = 1, side = 3)
  mtext(paste0('Percent Ungulate Control = ', Ungulate_Cntrl*100, '%'), cex = 0
.6, line = -16+ upway, adj = 1, side = 3)
  mtext(paste0('Percent Cat Control = ', Cat_Cntrl*100, '%'), cex = 0.6, line =
-16.5+ upway, adj = 1, side = 3)
  mtext(paste0('Percent Rat Control = ', Rat_Cntrl*100, '%'), cex = 0.6, line =
-17+ upway, adj = 1, side = 3)
  mtext(paste0('Percent Barn Owl Control = ', BrOwl_Cntrl*100, '%'), cex = 0.6,
line = -17.5+ upway, adj = 1, side = 3)
  upway <- upway + -6
  SAFenceFledgeProd <- round(sum(numBirdsData[1:30, 1], na.rm = T) - sum(numBir
dsDataAllPred[1:30, 1], na.rm = T))
  SAFenceAdultProd <- round(sum(numBirdsData[30, 6:36], na.rm = T) - sum(numBir
dsDataAllPred[30, 6:36], na.rm = T))

  SPFenceFledgeProd <- round(sum(StPopAllPredData[1:30, 1], na.rm = T) - sum(Al
lPredSiteBirds[1:30, 1], na.rm = T))
  SPFenceAdultProd <- round(sum(StPopAllPredData[30, 6:36], na.rm = T) - sum(Al
lPredSiteBirds[30, 6:36], na.rm = T))

  AddFled <- round(SAFenceFledgeProd + SPFenceFledgeProd)
  AddAdult <- round(SAFenceAdultProd + SPFenceAdultProd)

```

```

AddFledCC <- round(sum(numBirdsDataTK[1:30, 1]) - sum((AllPredSiteBirds+numBirdsDataAllPred)[1:30, 1]))
AddAdultCC <- round(sum(numBirdsDataTK[30, 6:36]) - sum((AllPredSiteBirds+numBirdsDataAllPred)[30, 6:36]))

#      PropSPS<-StPopALLPredData/ALLBirds # Proportion that is the standing population size
#      PropSA<-numBirdsData/ALLBirds # Proportion that is the Social Attraction birds

CCSPS <- (numBirdsDataTK*PropSPS)-(AllPredSiteBirds)
CCSPSFledge<-round(sum(CCSPS[1:30, 1], na.rm = T))
CCSPSAdult<-round(sum(CCSPS[30, 6:36], na.rm = T))

CCSA <- (numBirdsDataTK*PropSA - (numBirdsDataAllPred))
CCSAFledge<-round(sum(CCSA[1:30, 1], na.rm = T))
CCSAAdult<-round(sum(CCSA[30, 6:36], na.rm = T))

mtext(bquote(underline('Various Outputs From the Calculator')), cex = 0.7, col = 'red', line = -16+ upway, adj = 1, side = 3, font = 2)
mtext('Outputs Define the Difference Between Predated \nand Controlled Populations', cex = 0.5, col = 'red', line = -17+ upway, adj = 1, side = 3)

mtext('With Carrying Capacity', cex = 0.6, col = 'blue', line = -18+ upway, adj = 1, side = 3, font = 2)
mtext(paste0("Added Adults at Year 30: ", AddAdultCC), cex = 0.6, line = -18.5+ upway, adj = 1, side = 3, font = 2)
mtext(paste0("---from Social Attraction: ", CCSAAdult), cex = 0.6, line = -19+ upway, adj = 1, side = 3)
mtext(paste0("---from Standing Population: ", CCSPSAdult), cex = 0.6, line = -19.5+ upway, adj = 1, side = 3)

mtext(paste0("Added Fledgelings until Year 30: ", AddFledCC), cex = 0.6, line = -20+ upway, adj = 1, side = 3, font = 2)
mtext(paste0("---from Social Attraction: ", CCSAFledge), cex = 0.6, line = -20.5+ upway, adj = 1, side = 3)
mtext(paste0("---from Standing Population: ", CCSPSFledge), cex = 0.6, line = -21+ upway, adj = 1, side = 3)

mtext('Without Carrying Capacity', cex = 0.6, col = 'blue', line = -21.5+ upway, adj = 1, side = 3, font = 2)
mtext(paste0("Added Adults at Year 30: ", AddAdult), cex = 0.6, line = -22+ upway, adj = 1, side = 3, font = 2)
mtext(paste0("---from Social Attraction: ", SAFenceAdultProd), cex = 0.6, line = -22.5+ upway, adj = 1, side = 3)
mtext(paste0("---from Standing Population: ", SPFenceAdultProd ), cex = 0.6, line = -23+ upway, adj = 1, side = 3)
mtext(paste0("Added Fledgelings until Year 30: ", AddFled), cex = 0.6, line = -23.5+ upway, adj = 1, side = 3, font = 2)
mtext(paste0("---from Social Attraction: ", SAFenceFledgeProd), cex = 0.6, line = -24+ upway, adj = 1, side = 3)
mtext(paste0("---from Standing Population: ", SPFenceFledgeProd ), cex = 0.6, line = -24.5+ upway, adj = 1, side = 3)

```

```

    text(RunTme/4+10, apply(numBirdsData+StPopAllPredData, 1, sum)[RunTme/4], pa
ste0('LAMBDA = Soc. Att.: ', lambda, ' / Stand. Pop.: ', lambdaSP), cex = 0.6)

    if(RunTme == 30){
      ad1 <- 0
      ad2 <- 0
    }else{
      ad1 <- as.numeric(str_replace(names(apply(numBirdsData, 1, sum)[round(RunTm
e-30)]), 'Year ', ''))
      ad2 <- apply(numBirdsData+StPopAllPredData, 1, sum)[round(RunTme-30)]
    }

    arrows(RunTme/4+10, apply(numBirdsData+StPopAllPredData, 1, sum)[RunTme/4], a
d1,
           ad2, lty = 2, length = 0.1)
    graphics.off()

    cat('\nEnd Metapopulation Size = ', (MetaPopSize*(PredLamb^i)), ':BurrowCapac
ity = ',
        Burrow_Cap, ' :Predation Lambda = ', PredLamb, ' :SA Lambda = ',
        lambda, ' : SA Reproductive Success = ', ReproYr[6])

    if((DEM != 'None')==T){

      DEMRas<-raster(DEM)
      DEMRas_UTM<- projectRaster(DEMRas, crs = utmSys)

      DEM_UTM<-DEMRas_UTM
      Slope<-terrain(DEM_UTM, opt = 'slope')
      Aspect<-terrain(DEM_UTM, opt = 'aspect')
      HShade<-hillShade(Slope, Aspect, angle = 215, direction = 315)

      col4<-colorRampPalette(c("antiquewhite1", 'yellow', 'orange', 'brown', 'gre
y10', 'red', 'purple', "blue", "green"))#c("antiquewhite1", "purple", "orangered", "g
ray", "blue", "yellowgreen", "darkgreen"))
      ourcolors<-col4(400)

      graphics.off()
      png(filename = paste0(Dir2, "Plot of the Social Attraction Site and Buffer.
png"), width = 1000,
          height = 1000, pointsize = 18, type="cairo")
      par(las = 0, cex.axis = 0.8, bty = c("L"), cex.lab = 1, mar=c(5, 4, 4,4) +
0.1)

      plot(HShade,col=gray(c(100:0/100)), legend = F, alpha = 0.35, bty = 'L',
          main = paste0('Social Attraction Site with an Attraction Buffer of ',
ExclusBuffer, ' meters'))
      plot(raster(FlightPath), add= T, alpha = 0.5, col = ourcolors,
          cex.axis= 0.75,
          legend.width=0.75, legend.shrink=0.65,
          legend.args=list(text='Scaled (0-1) Flight Path Overlap',#str_replace(
int, '_BurrowSiteRaster', ''))
                                side=4, font=1, line=2.5, cex=0.8, las = 3))

```

```

    plot(KSHCP_AAS_UTMBuff, add = T, lty = 3)
    plot(KSHCP_AAS_UTM, col = 'blue', add = T)
    legend('bottom', legend = c('Social Attraction Site Buffer Perimeter'), bty
= 'n', lty = 3)

    dev.off()

  }

  cat('\n Predation Reproductive Success:', Ex_APredJuviSucc)

  SAFenceFledgeProd <- round(sum(numBirdsData[1:30, 1]) - sum(numBirdsDataAllPr
ed[1:30, 1]))
  SAFenceAdultProd <- round(sum(numBirdsData[30, 6:36]) - sum(numBirdsDataAllPr
ed[30, 6:36]))

  SPFenceFledgeProd <- round(sum(StPopAllPredData[1:30, 1]) - sum(AllPredSiteBi
rds[1:30, 1]))
  SPFenceAdultProd <- round(sum(StPopAllPredData[30, 6:36]) - sum(AllPredSiteBi
rds[30, 6:36]))

  cat('\n \n Total Number of Fledgleings Produced prior to year 30: ', SAFenceF
ledgeProd + SPFenceFledgeProd)
  cat('\n \n Total Number of Adults Produced at year 30: ', SAFenceAdultProd +
SPFenceAdultProd)

  # error testing if/thens after this
}
}
}
}

## Warning in dir.create(Dir): 'C:\Users\avorsino\Desktop\KIUC_SPS-
## SA_FenceYr_2_CallYr_2_RunTime_32' already exists

## Warning: package 'rgdal' was built under R version 3.5.3

## Loading required package: sp

## Warning: package 'sp' was built under R version 3.5.3

## rgdal: version: 1.4-4, (SVN revision 833)
## Geospatial Data Abstraction Library extensions to R successfully loaded
## Loaded GDAL runtime: GDAL 2.2.3, released 2017/11/20
## Path to GDAL shared files: C:/Users/avorsino/Documents/R/win-library/3.5/rgdal/gd
al
## GDAL binary built with GEOS: TRUE
## Loaded PROJ.4 runtime: Rel. 4.9.3, 15 August 2016, [PJ_VERSION: 493]
## Path to PROJ.4 shared files: C:/Users/avorsino/Documents/R/win-library/3.5/rgdal/proj
## Linking to sp version: 1.3-1

## Warning: package 'raster' was built under R version 3.5.3

```

```

## Warning: package 'rgeos' was built under R version 3.5.3

## rgeos version: 0.4-3, (SVN revision 595)
## GEOS runtime version: 3.6.1-CAPI-1.10.1
## Linking to sp version: 1.3-1
## Polygon checking: TRUE

## Warning: package 'stringr' was built under R version 3.5.3

## Warning: package 'popbio' was built under R version 3.5.2

##
## Attaching package: 'popbio'

## The following object is masked from 'package:raster':
##
##      resample

## OGR data source with driver: ESRI Shapefile
## Source: "J:\PIOGIS12\APPS\SH_CC\Adam\KSHCP Social Attraction Site", layer: "Exocar
pos_SAS"
## with 1 features
## It has 1 fields
##
## Flight Path Overlap Value Used = 0.03252209
## Burrow Capacity of Site = 199.8

## Warning in rbind(Mx, jk): number of columns of result is not a multiple of
## vector length (arg 1)

##
## 2019 Meta-Population Size Using the Predation Estimate 3 = 11651.89
## TESTA (should equal 1) 1 :Number of Fledglings = 0.5726766
## TESTA (should equal 1) 1 :Number of Fledglings = 1.449019
## TESTA (should equal 1) 1 :Number of Fledglings = 2.455475
## TESTA (should equal 1) 1 :Number of Fledglings = 3.477351
## TESTA (should equal 1) 1 :Number of Fledglings = 4.203724
## TESTA (should equal 1) 1 :Number of Fledglings = 4.720902
## TESTA (should equal 1) 1 :Number of Fledglings = 5.084453
## TESTA (should equal 1) 1 :Number of Fledglings = 5.333392
## TESTA (should equal 1) 1 :Number of Fledglings = 5.495252
## TESTA (should equal 1) 1 :Number of Fledglings = 5.582573
## TESTA (should equal 1) 1 :Number of Fledglings = 5.607855
## TESTA (should equal 1) 1 :Number of Fledglings = 5.582482
## TESTA (should equal 1) 1 :Number of Fledglings = 5.516482
## TESTA (should equal 1) 1 :Number of Fledglings = 5.418481
## TESTA (should equal 1) 1 :Number of Fledglings = 5.295553
## TESTA (should equal 1) 1 :Number of Fledglings = 5.153551
## TESTA (should equal 1) 1 :Number of Fledglings = 4.997329
## TESTA (should equal 1) 1 :Number of Fledglings = 4.830914
## TESTA (should equal 1) 1 :Number of Fledglings = 4.657639
## TESTA (should equal 1) 1 :Number of Fledglings = 4.480246
## TESTA (should equal 1) 1 :Number of Fledglings = 4.300978
## TESTA (should equal 1) 1 :Number of Fledglings = 4.121655
## TESTA (should equal 1) 1 :Number of Fledglings = 3.943745
## TESTA (should equal 1) 1 :Number of Fledglings = 3.768417

```

```

## TESTA (should equal 1) 1 :Number of Fledglings = 3.596593
## TESTA (should equal 1) 1 :Number of Fledglings = 3.428987
## TESTA (should equal 1) 1 :Number of Fledglings = 3.266139
## TESTA (should equal 1) 1 :Number of Fledglings = 3.108446
## TESTA (should equal 1) 1 :Number of Fledglings = 2.956186
## TESTB (should equal 1) 1 :Number of Fledglings = 1.15144
## TESTB (should equal 1) 1 :Number of Fledglings = 2.913439
## TESTB (should equal 1) 1 :Number of Fledglings = 4.937047
## TESTB (should equal 1) 1 :Number of Fledglings = 6.99166
## TESTB (should equal 1) 1 :Number of Fledglings = 8.452126
## TESTB (should equal 1) 1 :Number of Fledglings = 9.491977
## TESTB (should equal 1) 1 :Number of Fledglings = 10.22294
## TESTB (should equal 1) 1 :Number of Fledglings = 10.72347
## TESTB (should equal 1) 1 :Number of Fledglings = 11.04891
## TESTB (should equal 1) 1 :Number of Fledglings = 11.22448
## TESTB (should equal 1) 1 :Number of Fledglings = 11.27531
## TESTB (should equal 1) 1 :Number of Fledglings = 11.22429
## TESTB (should equal 1) 1 :Number of Fledglings = 11.09159
## TESTB (should equal 1) 1 :Number of Fledglings = 10.89455
## TESTB (should equal 1) 1 :Number of Fledglings = 10.64739
## TESTB (should equal 1) 1 :Number of Fledglings = 10.36187
## TESTB (should equal 1) 1 :Number of Fledglings = 10.04777
## TESTB (should equal 1) 1 :Number of Fledglings = 9.713171
## TESTB (should equal 1) 1 :Number of Fledglings = 9.364779
## TESTB (should equal 1) 1 :Number of Fledglings = 9.008109
## TESTB (should equal 1) 1 :Number of Fledglings = 8.647667
## TESTB (should equal 1) 1 :Number of Fledglings = 8.287116
## TESTB (should equal 1) 1 :Number of Fledglings = 7.929405
## TESTB (should equal 1) 1 :Number of Fledglings = 7.576886
## TESTB (should equal 1) 1 :Number of Fledglings = 7.231412
## TESTB (should equal 1) 1 :Number of Fledglings = 6.894418
## TESTB (should equal 1) 1 :Number of Fledglings = 6.56699
## TESTB (should equal 1) 1 :Number of Fledglings = 6.249928
## TESTB (should equal 1) 1 :Number of Fledglings = 5.94379

## Warning in dir.create(Dir2): 'C:\Users\avorsino\Desktop\KIUC_SPS-
## SA_FenceYr_2_CallYr_2_RunTime_32\SAS_Using_PredEst_3_with_Site Fid_of_0.85'
## already exists

##
## End Metapopulation Size = 1906.396 :BurrowCapacity = 199.8 :Predation Lambda =
0.9449999 :SA Lambda = 1.595 : SA Reproductive Success = 0.7128

##
## Predation Reproductive Success: 0.4028592
##
## Total Number of Fledgleings Produced prior to year 30: 487
##
## Total Number of Adults Produced at year 30: 72

# rbind(Mx, jk2)
#
# CurrLambda

```

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Kaua'i Seabird Habitat Conservation Program (KSHCP)

Participant Inclusion Plan (PIP) Template

**Name of Applicant/Participant**  
**[Insert Name]**

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## **PART 1: Landowner & Property Information; Description of the Facilities; Avoidance & Minimization Measures; Monitoring of Take**

**Item 1. Provide the name of the landowner, business, agency, or institution and complete contact information. If the applicant/participant is different from the landowner, please attach power of attorney (or other documentation) allowing the party to act on the landowner's behalf.**

Participant/Applicant Name:

Physical Address/Location of Facility:

Mailing Address:

Primary Contact:      Ownership Name:  
Address:  
Email:  
Telephone:

Alternate Contact:      Name:  
Address:  
Telephone:  
Email:

Preparer Contact:      Name:  
Address:  
Email:  
Telephone:

**Item 2. Provide the legal description of the property at which the existing facilities and Covered Activities are located, including Tax Map Key (TMK) number. Provide a survey of the property and site plan drawings showing the locations of the Covered Activities (lights), property boundaries, buildings & structures, and site features. If properties containing the Covered Activities comprise separate parcels please include all Tax Map Key numbers and maps.**

**Item 3. Describe the existing Covered Activities for which incidental take authorization is sought. Include list of buildings, type and description of lights present, purpose and location of lights and current seabird lighting accommodation in place (e.g. shielding, downward pointing, switched off during fledging season etc.). For “Types of lights” please use the following categories:**

- **Parking Lights**
- **Signage Illumination**
- **Wall-pack Building Lights**
- **Landscaping/Grounds/Accent/Bollards**
- **Indoor lights visible from outdoors**
- **Roof Floodlights**
- **Other Lights**

**Facility lighting plan may be submitted as lighting inventory. Photos may be attached. The suggested light table, and Green Sea Turtle assessment table below may each be modified as needed to provide the necessary information.**

**Table 1: Lighting at Facilities**

List of Buildings	Type/Description of Lights Present	Location	Purpose of the Lights	Describe any measures implemented to avoid or minimize take impacts to Covered Species

**Table 2: Green Sea Turtle Assessment for the Site & Facility**

Please provide the information requested below to help determine if measures to avoid impacts to the Green Sea Turtle(s) from the effects of light attraction are required to be implemented at any of the facility(s), parcel(s), or site(s) included in this PIP. Please consult with staff from the DLNR and the USFWS to arrange a site visit, if needed, discuss measures to avoid impacts to the Green Sea Turtle, and provide further guidance.

Are any of the facilities located adjacent to a beach?	Yes / No	If yes, provide length of beach frontage & brief description of facilities & lights adjacent to the beach
Are any of the Covered Activities (lights) visible from a beach?	Yes / No	If yes, describe the specific lights (type, , height, purpose) & specific location; provide map & photos showing distance from beach
Have green sea turtles been known to nest on any beaches adjacent to the facilities?	Yes / No	If yes, provide information about nesting occurrences, if known, including location and date and any other information

**Item 4. If applicable, describe any lighting standards (e.g., foot candles/area) required for facility operations or other requirements that necessitate the use of lighting (e.g., required for security, safety, operations). Describe the relevant standard, or regulation, and the areas and Covered Activities at the site (e.g., type of lighting) to which it applies.**

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**Item 5. Describe any plans/proposals for future facilities or expansion of existing facilities. Include any proposed structures and lighting by type, purpose, and location. Plans (architecture and site plans), photos, and drawings can be attached.**

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**Item 6. Pursuant to the Endangered Species Act (ESA), Section 10 (a)(2)(A)(iii), describe alternatives to avoid the taking considered and evaluated. Provide reasons why those alternatives are not being utilized. Alternatives can include operational or facility design changes (attach pages as needed). The tables below may be altered as needed.**

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**Table 3: Light Attraction Alternatives to the Taking**

Artificial Light Attraction Alternatives to the Taking Considered	Reasons Alternatives are not Being Utilized (provide justification)
<ul style="list-style-type: none"> <li>▪ Deactivate <u>all</u> outdoor artificial lights from dusk to dawn during the fledgling fall-out season September 15 to December 15</li> </ul>	
<ul style="list-style-type: none"> <li>▪ Change operations to eliminate the need for outdoor artificial lighting (e.g., from nighttime to daylight hours)</li> </ul>	
<ul style="list-style-type: none"> <li>▪ Shield all lights from visibility from the beach, or screen all Green Sea Turtle nests, from May 15 to December 15 to avoid impacting the green sea turtle (Green Sea Turtle)</li> </ul>	
<ul style="list-style-type: none"> <li>▪ Other alternatives to the taking considered, if any. If facility is proposed, include alternative designs considered</li> </ul>	

**Item 7. Describe all site-specific seabird minimization measures considered for the Covered Activities. This item should follow KSHCP minimization objectives and measures as specified in *Appendix E (Guidelines for Adjusting Lighting at Facilities)* of the KSHCP document. Please consult with staff from the DOFAW and the USFWS as needed. The suggested tables below can be altered as needed.**

Minimization measures modify the Covered Activities to reduce the effects of the activity on the Covered Species. KSHCP Participants will be required to implement minimization measures that apply to the facility to the “maximum extent practicable” per applicable state and federal laws which regulate incidental take license/permit issuance by the DLNR and the USFWS.

Minimization also entails searching and recovering grounded seabirds to minimize the chance of mortality. In addition, the presence of on-site predators (i.e. feral cats, dogs) should be controlled and removed because these animals can prey on grounded seabirds.

Provide justification, such as policies, regulations, or other rationale for measures that will not be implemented.

**Table 4: Seabird Light Attraction Minimization Measures Considered**

<b>Minimization Measures Considered</b>	<b>Feasible? (Y / N)</b>	<b>If not Feasible to Implement Measures, Provide Reason</b>
▪ Change time of light use (lights off earlier)	Yes / No	
▪ Deactivate unnecessary lights	Yes / No	
▪ Replace all outdoor lights with full cut-off fixtures	Yes / No	
▪ Shield all outdoor lights with full cut-off shields	Yes / No	
▪ Angle all lights downward	Yes / No	
▪ Lower intensity (lumens) of outdoor lights	Yes / No	
▪ Change bulb color to non-white spectrum	Yes / No	
▪ Prohibit/control unleashed predatory animals; prohibit outdoor feeding of animals; require sealed rubbish containers	Yes / No	
▪ Provide Worker Seabird Awareness Training to staff	Yes / No	
▪ Provide outreach materials to staff & guests	Yes / No	
▪ Host Save Our Shearwaters (SOS) Aid Station	Yes / No	

**Item 8. Minimization Plans. Provide a plan to minimize the effects to the Covered Seabirds due to the Covered Activities. KSHCP Participants will be required to minimize the effects of the Covered Activities to the “maximum extent practicable” per applicable state and federal laws which regulate take license/permit issuance. The KSHCP document provides minimization objectives and measures to follow.**

The Minimization Plans should include the proposed minimization measures, timeline, and estimated cost for each facility. In this item, the Participant can include measures already completed or in place (new lights, shields, operational changes). Timeline should include estimated completion schedule, and annual schedule for minimization that will occur only during fledging season.

Minimization measures not yet determined but anticipated to occur at the facility; this section should include an estimated cost that will be earmarked for future minimization measures.

If applicable, the participant must provide the reasoning why certain measures will not be implemented. The suggested table below may each be altered to best describe the Minimization Plan. Attach additional pages, photos, and drawings as needed.

**Table 5: Lighting Minimization Measures**

List of Buildings	Minimization Measures	Cost to Implement	Responsible Staff	Timeline

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**Table 6: Seabird Mortality Minimization Plan**

Minimization Measures	Describe minimization method (e.g. trapping, outreach, enact policy)	Cost to Implement	Responsible Staff
Remove & control loose predatory animals at the facility. (Loose animals can kill grounded seabirds and this measure aims to prevent seabird mortality by animals.)			
Prohibit outdoor feeding of predatory animals. (Feeding animals attracts them to the site and this measure aims to reduce the presence of animals that can cause seabird mortality.)			
Conduct nightly/morning searches to recover downed birds at the property & turn them into SOS following protocols (see monitoring plan below).			
Train staff to follow minimization measures.			

**Item 9. Take Monitoring Plan. Provide a plan to monitor take of the Covered Seabirds at the facilities proposed to be covered by the incidental take permit/license. The take monitoring plan describes how the property will be searched for downed Covered Seabirds. The KSHCP document provides standards and guidelines for take monitoring to ensure that take of the species is accurately measured and recorded.**

The regulatory agencies will make the final determination as to the adequacy of the take monitoring plan.

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**Table 7: Covered Seabird Take Monitoring Protocols**

Please provide the following information for the protocol items below		
Item	Protocol (fill in protocol & provide reasons)	KSHCP Guideline
Percentage of the total property that will be searched & the total area to be searched		Search as much area as possible
Frequency of searches (# per day or per week)		Twice daily
Time of day of searches		2-3 hours after sunset, and within 3 hours after sunrise
Number of searchers per search area		Depends on site conditions and safety considerations and vegetation, nearby hazards/threats
Proposed training		Annual training covering seabird identification, seabird handling, response procedures, verified and documented

**Item 10. Components of the Green Sea Turtle Minimization and Monitoring Plan (if required). Monitoring and minimization for the Green Sea Turtle is in two parts: A) Monitoring to detect nests and B) Monitoring and minimizing impacts to nests detected.**

**Part A: Monitoring to detect Green Sea Turtle Nests**

Please provide the following information; the table below may be used and altered as needed.

- 1) Detailed location and description of beaches, including linear distance, at which searching for nests of the green sea turtle will take place. Searches should take place at any beach from which light at the facility can be viewed;
- 2) Monitoring protocols indicating:
  - a) Annual training of searchers;
  - b) Frequency of searches;
  - c) Conduct active searching (searching the beach width);
  - d) Sufficient number of trained searchers to cover the area; and
  - e) Record results of search monitoring.
- 3) All Participants are required to record the results of search efforts. Records should provide:
  - a) Evidence (what was seen). Include description and provide photographs
  - b) Location on the beach (GPS) and physically mark the location if possible
  - c) Date and time of day
  - d) Description of surrounding land use (e.g., vacant, or developed), and
  - e) Proximity to the facility.

**Part B: Monitoring of Identified Green Sea Turtle Nests**

Each identified nest of the green sea turtle should be monitored and protected from light attraction. Please provide the following monitoring protocols; the tables below may be used and altered as needed.

1. Light avoidance measure for identified nests (either shield/deactivate lights at the facility or install and maintain a light shield around each identified nest);
2. Frequency of searches;
3. Number of searches monitoring the nests. The number of needed to monitor active nests will depend on number of nests identified and amount of beach needed to be covered;
4. Record the results of nest monitoring. Monitoring should provide:
  - a. Evidence of hatchling emergence (description and photos):
  - b. Date and time of emergence,
  - c. Direction of tracks,
  - d. Condition of the nest area (e.g., disturbed or not).

**Table 8: Green Sea Turtle Monitoring Protocols – Part A: Monitoring to Detect Nests**

Please provide search protocols for detecting nests of the green sea turtle (Attach pages as needed)		
Item	Protocol (fill in protocol & provide reasons)	KSHCP Guideline
Location & description of the beach, or beaches, surveyed and the linear distance of the beach		Beach area surveyed should coincide with visibility from the facility with the lights
Frequency of searches (# per day or per week)		Weekly during nesting season (typ. May 15 to end of August)
Number of searchers per search area		Depends on site conditions and safety considerations
Proposed training		Searchers should receive annual training conducted by the DLNR or the USFWS, or their designee (See <b>item 9a</b> )

**Table 9: Green Sea Turtle Monitoring Protocols – Part B: Monitoring of Identified Nests & Minimization**

Please provide search protocols to monitor identified nests (from Part A) of the green sea turtle (Attach pages as needed)		
Item	Protocol (fill in protocol & provide reasons)	KSHCP Guideline
Frequency of checks (# per day or per week)		Active nests should be monitored every 1-2 days; then daily during expected hatching date
Light avoidance		If lights cannot be deactivated or shielded from the nest, each nest should be screened from visible light
Number of searchers per search area		Depends on site conditions and safety considerations

**Item 11. Describe the schedule that will be followed to provide training for staff. Training must be provided to those that will conduct and oversee the searches at the facility.**

The training should include:

1. Summary of regulations protecting the Covered Species;
2. Search procedures, route, frequency and timing specific to the facility's monitoring plan, for seabirds and green sea turtle nests (if applicable);
3. Response procedures including safe and proper techniques for handling seabirds;
4. Recognizing evidence of green sea turtle nests, proper nest light screening, and hatchling activity (if green sea turtle minimization and monitoring plan is applicable);
5. Procedures to document the results of searches;
6. Downed wildlife agency contacts; and
7. Nearest SOS aid station.

### **Rescuing Downed Seabirds—Standard Operating Procedures (SOP)**

The following steps provide the procedure for recovering downed seabirds found:

1. Take the seabird recovery kit and pet carrier to the downed seabird.
2. Put on gloves.
3. Using towel to gently cover the bird, pick up the seabird with wings folded in a natural position.
4. Place the seabird in the pet carrier, and close the pet carrier.
5. Put the gloves and towel back in the seabird rescue kit.
6. Take the bird and pet carrier to an SOS Aid Station.
7. Transfer the bird to the Aid Station's pet carrier.
8. Call SOS at 632-0610 or 635-5117.
9. Return the seabird rescue kit and pet carrier.
10. Complete the Bird Take Field Report.
11. Give the completed "Bird Take Field Report" to the General Manager, or other responsible staff person at the facility.

### **Contents of Seabird Recovery Kit**

1. Latex or nitrile gloves;
2. Three towels;
3. Hand sanitizer;
4. Flashlight or headlamp;
5. Clipboard, pen and blank "Bird Take Field Reports", or similar; and
6. Pet carrier –medium sized. If a box is used it must be well ventilated and marked conspicuously "LIVE ANIMAL".

**Item 12. Describe any outreach conducted (e.g., handing out pamphlets on seabird awareness to facility employees or guests, etc):**

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## PART 2. Take Estimate, Requested Amount of Take Authorization, and Funding

### Item 1. Show the calculation of estimated take for each of the Covered Species.

Following the take estimation methods in the KSHCP for estimating a Participant's take (Section 6.2.2), the tables below show the take estimate calculation for the facility(s) for each of the Covered Seabirds.

The KSHCP take estimate method utilizes the average of the most recent 5 years of SOS recovery data for the facility. Applied to the data is an adjustment for downed birds not found, based on a 50% discovery rate and an adjustment based on SOS mortality (birds dead on arrival or those that die in care) – average SOS mortality is 12%.

If the landowner-applicant submits a take estimate with an alternate discovery rate, they must provide the reasons why an alternate rate was used to estimate take, including relevant information supporting their reasoning (% of searchable area, search protocols that will be used, any searcher efficiency trials that have been or will be conducted at facilities and/or demonstration of quick, effective recovery of birds). Please include narrative and/or photos and maps to support this.

**Table 10: Annual Take Calculation**

	<b>Newell's Shearwater</b>	<b>Hawaiian Petrel</b>	<b>Band-rumped Storm-petrel</b>
<b>1. Annual average number (SOS data – or – monitoring data) of downed NESH (5 most recent years), HAPE or BRSP (15 most recent years)</b>			
<b>2. Annual observed lethal take estimate (12% of 1, all downed birds)</b>			
<b>3. Annual unobserved lethal take estimate (e.g. 100% of 1, all downed birds if 50% searcher efficiency assumed)</b>			
<b>4. Total estimated annual lethal take from light attraction (2+3)</b>			
<b>Requested Annual Lethal Take</b>			
<b>Requested Take Over Permit Term</b>			

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Item 2. Select the requested take authorization and permit/license term coverage for each of the Covered Species.

**Table 11: Newell's Shearwater:**

Age Class	Annual Take Estimate: Fledglings	Annual Take Estimate: Adults or Sub-Adults	Take Limit for License/Permit Term
Mortality (Lethal)			
Injury (Non-lethal)			

**Table 12: Hawaiian Petrel:**

Age Class	Annual Take Estimate: Fledglings	Annual Take Estimate: Adults or Sub-Adults	Take Limit for License/Permit Term
Mortality (Lethal)			
Injury (Non-lethal)			

**Table 13: Band-Rumped Storm Petrel:**

Age Class	Annual Take Estimate: Fledglings	Annual Take Estimate: Adults or Sub-Adults	Take Limit for License/Permit Term
Mortality (Lethal)			
Injury (Non-lethal)			

**Item 3. Funding Assurance.** Provide proof of adequate funding (see KSHCP document). All participants must demonstrate requisite funding prior to permit/license approval to ensure that the proposed measures and actions, including monitoring, will be undertaken in accordance with the terms and schedule of the KSHCP.

Signature of Participant:

\_\_\_\_\_

Printed Name :

\_\_\_\_\_

Date: \_\_\_\_\_

The undersigned affirms that all the information included is true and accurate to the best of the participant's knowledge and that this PIP is voluntarily submitted.

☐ check to waive confidentiality

## **Appendices**

Appendix A –

Appendix B –

Appendix C –

Appendix D –

Appendix E –

Appendix F –

Appendix G –

Appendix H –

## **APPENDIX E: Guidelines for Adjusting Lighting at Facilities**

This appendix provides detailed guidelines to inform minimization measures that can be customized to address an array of possible lighting issues at Participant facilities. A lighting minimization plan to achieve the maximum extent practicable will be included in each Participant PIP.

These guidelines represent best available science at the time of KSHCP permit issuance. Over the life of the plan, likely new information and new technologies will be available, and this appendix may be updated accordingly.

Not all lighting guidelines are appropriate for all types of facilities. Some represent long term, infrastructure solutions, and others may be implemented on a seasonal basis.

### **1. Deactivate Non-Essential Lights**

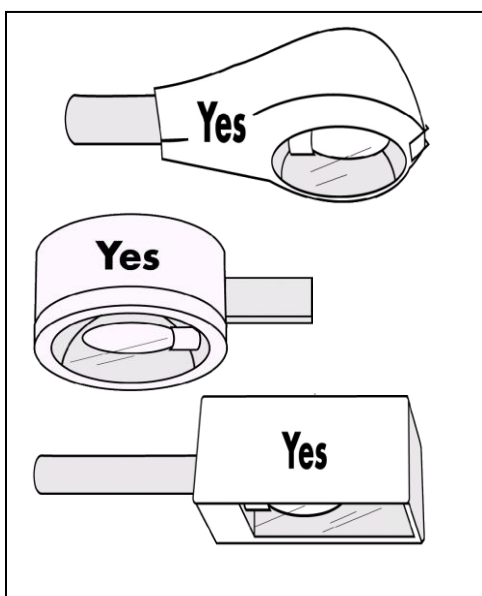
Prioritization of seabird and honu light attraction minimization measures involves evaluating light needs to determine if non-essential lights can be deactivated during the seabird fallout season (September 15 to December 15) and turtle nesting season (May 15-December 15). Deactivating the lights avoids the potential for light attraction that those lights could otherwise cause. Turning off a subset of lights, both unshielded and shielded, during the fallout season (September 15 to December 15) can assist with minimizing the risk of seabird light attraction, if those lights are not necessary. In their PIPs, Applicants must provide rationale for any facility lights that cannot be deactivated during seabird fallout season, and detail what other minimization practices will be implemented on lights that will remain illuminated. The regulatory agencies will review the evaluation and justification as provided in applicant PIPs.

Similarly, turning out lights that shine directly on beaches during the turtle nesting season (May 15-December 15) can prevent hatchling disorientation. Avoid use of the following lamp styles on beachside or shore perpendicular to sides of a structure: private balcony lights, up lights; decorative lighting, not necessary for human safety or security; pond lights; and beach lighting. Timers or other similar devices should be used to ensure the selected lights remain off during the turtle nesting season. This measure may require the installation of independent light switches. Conversely, to prevent accidental activation, light fixtures can be removed for lights that will no longer be needed at a facility.

### **2. Install Full Cut-off Light Fixtures**

A full cut-off fixture refers to a light fixture which does not shine light above a 90 degree horizontal plane. For lights necessary to be activated, full cut-off fixtures provide an effective

measure to achieve light minimization because they prevent light from shining directly upward. These types of lights house the light bulb up within the fixture so that no bulb protrudes below (**Figure 1**). Such fixtures must be mounted at appropriate angle so they point directly down to the ground. Many light manufacturers provide light fixture information along with the light specifications to indicate if a fixture is a full cut-off design. The International Dark Sky Association ([www.darksky.org](http://www.darksky.org)) is a good source for information on full cut-off lights and provides additional references to light engineering resources and light manufactures.



**Figure 1:** Examples of full cut-off light fixtures. Source: [www.darksky.org](http://www.darksky.org).

Along shorelines, exterior fixtures on the seaward (makai) and the shore perpendicular sides of the building (and on the landward side of the building if they are visible from the beach) should be down-lit fixtures, fully shielded and full cut-off, louvered, or recessed fixtures that do not have reflective inner surfaces. These fixtures should use low wattage bulbs (e.g., < 50w). All exterior fixtures on the landward (mauka) side of the building should be directed downward only (Witherington & Martin 2003).

### 3. Shielding Light Fixtures

This minimization measure aims to achieve the functional equivalent of a full cut-off light fixture by installing a shield, visor, hood or similar on an existing light fixture to prevent light from shining upward and reducing trespass. In addition to the shielding, to achieve the functional equivalent of a full cut-off fixture, a light fixture should be adjusted so that it points directly down perpendicular to the ground to create a level, horizontal plane between the

fixture and the ground, and have the bulb housed within the light fixture (**Figures 2 & 3**). Reed et al. (1985) suggest that in areas where other light sources are rare, the shielding of principal lights would likely have a larger effect in decreasing seabird light attraction.



Figure 1: Installation of an appropriately sized floodlight shield. Source: [www.darksky.org](http://www.darksky.org).

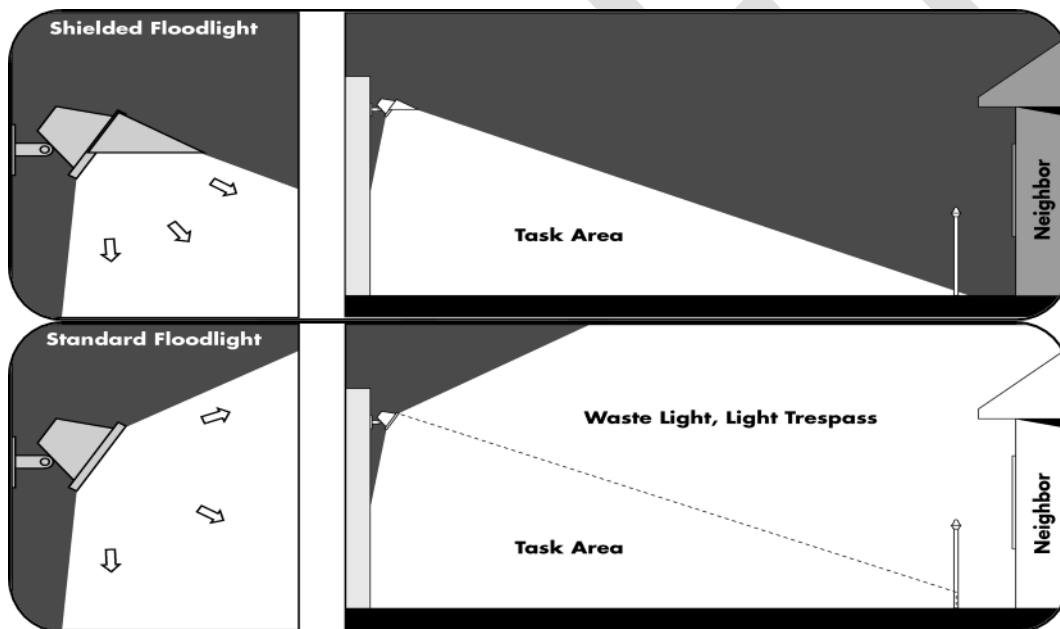
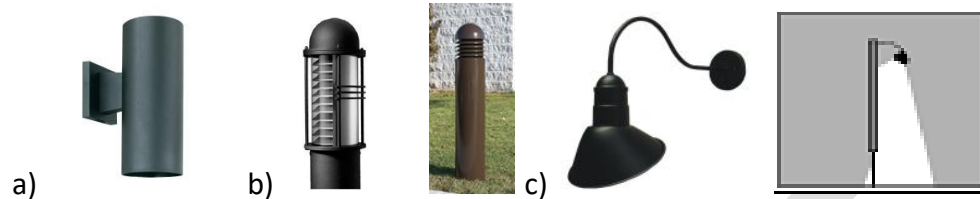


Figure 2: Before and after effects of shielding and light management designed to minimize light attraction risk to seabirds and to decrease light pollution. Source: [www.darksky.org](http://www.darksky.org).

#### 4. Angle Lights Downward

Angling and repositioning lights presents a potential alternative to shielding or replacing light fixtures and may be sufficient to make lights fully cut-off and eliminate light shining horizontally and vertically (**Figure 4**). To achieve the functional equivalent of a full cut-off fixture, a light

fixture should be adjusted so that it points directly down perpendicular to the ground to create a level, horizontal plane between the fixture and the ground, and have the bulb housed within the light fixture. Tree strap downlights may be used to minimize seabird light attraction unless turtles may be present on the adjacent beach.



**Figure 4-: (a) Wall mount cylinder down-light, (b) bollards with downward-directed louvers, and (c) sign lights angled downward. From [http://myfwc.com/media/418417/SeaTurtle\\_LightingGuidelines.pdf](http://myfwc.com/media/418417/SeaTurtle_LightingGuidelines.pdf) (FWC 2011).**

## **5. Place Lights Under Eaves**

Light fixtures placed under building eaves can achieve the functional equivalent of a full cut-off fixture. The architectural eave acts as shield to prevent light from shining directly upward.

## **6. Shift Lighting According to the Moon Phase**

This minimization measure addresses lighting for which the need, or purpose, for the lighting can be shifted in timing each year to coincide with the moon phase. Because a reduction in light attraction has been correlated with the full phase of the moon (Reed et al. 1985; Telfer et al. 1987) lights for essential functions, and for which that function can be shifted in timing, should coincide with the full phase of the moon and avoid the dark phase of the moon. It is important to note that a full moon that is obscured by heavy cloud cover could simulate the dark phase of the moon. By not activating those lights during the dark phase of the moon the effect of those lights is reduced. Examples of activities that could be minimized with this measure include scheduling of night time events, such as festivals or sporting events.

## **7. Install Motion Sensors for Motion-activated Lighting**

Motion sensors switch lights on only when triggered, thereby limiting the time that the light stays on and reducing its potential for seabird light attraction. If a sensor light is required for security purposes, the light equipped with the sensor should be at low light levels. For example, Light Emitting Diode (LED) streetlights and parking lot lights can be activated when needed and dim when no activity is detected nearby. However for those fixtures, full cut-off designs or the functional equivalents are recommended because of the possibility of light

attraction occurring when the motion-sensor light is activated or in the event that the motion sensor equipment malfunctions and the light remains on.

Where motion sensors are impractical (eg at sporting events), stadium lights should be turned off as soon as the public leaves the stadium.

## **8. Decrease Lighting Levels**

This measure addresses lowering light intensity levels (e.g., measured in lumens) while still meeting the need to safely complete tasks and serve the purpose of the light. Guidance on standards for the appropriate lighting level for a particular light function should be followed as provided by the appropriate agency or professional and technical organization. For example the Illuminating Engineering Society of North America (IESNA) provides recommendations for light levels for several applications including parking lots, walkways, and roads. In addition individual entities may have standards and best practices for lighting needs.

For many applications where lighting is needed, brighter lighting may not always provide the best lighting for the needed function. It is often the case where reduced lighting levels can provide for the needed function of the lighting. For example, for security purposes overly bright lights tend to create blind spots, or very dark shadows, outside the lit area that preclude effective visibility. Well placed, but reduced lighting can provide for more effective security. Therefore, when Participants seek to enhance onsite visibility for security, while reducing risk to seabirds, the appropriate reduction of light levels (along with shielding and re-angling lights) forms a starting point to accomplish both purposes.

## **9. Decrease Visibility of Interior Lights**

Facilities with large and/or numerous windows, tall building profiles, or large glass facades may also pose a risk of light attraction to Covered Seabirds on Kaua'i. The following measures are based, in part, on efforts in cities in Canada and the mainland USA to decrease harmful effects of buildings on birds and apply to seabirds in that they can decrease the amount of light escaping from within buildings (City of Toronto 2007; Evans Ogden 2002):

- Install screens or shades over large windows that are lowered nightly during the fallout season;
- Modify buildings and decrease or eliminate light glow from within a facility;
- Create glass opacity to prevent the escape of internal light. Tinted glass or film with a visible light transmittance value of 45 percent or less should be applied to all windows and doors within line of sight of the beach;

- Install physical screens outside a building;
- Install landscaping in front of large windows;
- Close all window blinds after daylight hours until sunrise;
- Stagger the operation of lights in the evening or morning hours so that not all lights are turned on at once; and
- Maximize the number of offices or indoor rooms that turn off all lights after sunset;
- Place reminder notices on switches to turn out lights or draw curtains/blinds in oceanfront rooms. This should include coastal areas that are on the perpendicular sides of the structure;
  - a. Turn off room and lanai lighting that are not needed;
  - b. Relocate moveable lamps away from windows that are visible from the beach; and
  - c. Close opaque curtains or blinds after dark to block inside light from shining outside.

## **10. Use Light-less Technologies**

Where conditions and facility needs permit, technologies that do not use light, such as closed-circuit television (CCT) with infrared illuminators, may be effectively employed to “see” at night thus enabling some of the lights to be turned off. For example, any fenced areas or the dark sides of facilities can be monitored with CCT so that lights do not need to be used or installed.

## **11. Plant Vegetation Around Lights to Reduce Light Visibility**

Trees and shrubs can be planted so that they over-arch lights or shield side visibility of lights along the coast or along a ridge, for example. Whether the lights are mounted on 20-foot poles, walkways, or within landscaped areas, having adjacent or overarched vegetation would further reduce the risk of seabird light attraction that any residual light scatter may pose. Long-term planning and maintenance of screening vegetation is encouraged, where appropriate to the uses and needs of the affected lights.

## **12. Lower Height of Lights**

Light that is low in height has potential to reduce the effect of light attraction because lower lights may be less visible to passing seabirds. Installing ground-level lighting, such as along walkways, and reducing pole height can decrease light waste and trespass.

### 13. Use Longer Light Wavelengths

In coastal areas, use of acceptable lights such as: LPS 18w, 35w, red, orange or amber LEDs (true red, orange or amber diodes, but not filters), true red neon, and other lighting sources that produce light wavelengths of 560 nm or longer (Witherington et al. 2014). Long wavelength lights, e.g., those that produce light that measures greater than 560 nanometers on a spectroscope, are required for all construction visible from and adjacent to sea turtle nesting beaches. Turtles are most sensitive to short wavelengths of light, probably because they live in a marine environment that filters out long wavelengths. Green turtles are least attracted to longer wavelength light in the yellow-orange to red end of the spectrum (630 to 700 nm) (Witherington and Martin 2000). In the absence of other light sources, however, turtles may still be attracted to long wavelength light.

Filters designed to exclude transmission of short wavelengths (<570nm) can be fitted to high pressure sodium (HPS) vapor lights. Such filters have been found to be effective at avoiding disruption of nesting females (Salmon, 2006) but even filtered HPS light has been found to attract hatchlings, although not as strongly as unfiltered HPS lights (Sella et al, 2006). Filtering alone is thus not sufficient to avoid attraction and disruption of hatchling orientation. Bright white light fixtures, such as metal halide, halogen, fluorescent, mercury vapor and incandescent lamps, are not approved for beachside or shore perpendicular sides of a structure. Limited use of shorter wavelength lights may be approved in areas where direct and indirect light or glow could not possibly be visible from the beach due to installation of opaque “light fencing” (see below).

## **Appendix F. Training and Outreach Materials**

The Worker Seabird Awareness and Response Training materials that will be provided by the KSHCP are updated and will be available to Participants upon request. Materials consist of a slide presentation and handouts.

Handouts include:

- How to Pick Up a Seabird
- Seabird Recovery Protocols
- Seabird Identification Guide
- Green Sea Turtle Nest Searching Guide

## How to Pick Up a Seabird

- Approach bird from behind, if possible
- Wrap a small towel around back and wings
- Gently pick up bird



Use gloves if needed  
Disinfect hands after handling birds

- Always keep bird away from your face
- Birds are docile, but be aware of pointed bill
- Cover bird's head
- Speak quietly & keep noise down



- Place bird in pet carrier or vented box
- Take birds to SOS Aid Station and place inside
- Fill out SOS information board



- Do not feed birds!
- Do not release birds!



**Call SOS 635-5117**



### Contact Information:

Save Our Shearwaters: 808.632.0610 ext. 109; 808.635.5117  
 Provided by: DOFAW Kaua'i Seabird Habitat Conservation Program Office 808.245.9160  
 4272B Rice Street, Lihue HI 96766 - [www.kauaiseabirdhpc.com](http://www.kauaiseabirdhpc.com)  
*Photos courtesy of DLNR and Brenda Zaun USFWS*

# Kaua'i Seabird Identification Guide



**Hawaiian petrel – ‘ua’u**  
Endangered species  
Fledges Nov. to Dec.  
Breeds in mountain areas



**Newell's shearwater – ‘a’o**  
Threatened species  
Fledges Sept. to Nov.  
Only breeds on Kaua'i; mostly in mountains



**Band-rumped storm petrel – ‘ake’ake**  
Candidate endangered species  
Fledges in fall months  
Uncommon & rare; breeds in cliff areas



**Wedge-tailed shearwater – ‘ua’u kani**  
Protected under Migratory Bird Treaty Act  
Fledges Nov. to Dec.  
Moderately aggressive - use safe handling  
Commonly found at coastal areas



Contact Information:  
Save Our Shearwaters: 808.632.0610 ext. 109; 808.635.5117  
Provided by: DOFAW Kaua'i Seabird Habitat Conservation Program Office 808.245.9160  
4272B Rice Street, Lihue HI 96766 [www.kauaiseabirdhcp.com](http://www.kauaiseabirdhcp.com)  
*Photos courtesy of DLNR (band-rumped storm petrel) and Brenda Zaun USFWS*



## Seabird Recovery Protocols Handout



### **1. Maintain supplies and recovery forms**

1. Medium-size pet carrier or ventilated box
2. Small towel to wrap bird
3. Flashlight/head lamp (for searching during dark)
4. Protective gloves
5. Gallon-size ziplock bags (for dead birds)
6. Hand disinfectant
7. Seabird recovery forms and identification sheets

### **2. Search actively; designate observers**

1. Look under objects and vegetation – birds will hide
2. Nocturnal seabirds are most active 1–3 hours after sunset and before sunrise but can be grounded at any time during the night or early morning

### **3. Pick up downed seabirds immediately & put in safe place (pet carrier or ventilated box) – refer to “how to pick up a seabird” handout**

### **4. For dead seabirds found, place carcass in ziplock bag, store in freezer or cool place, call SOS to coordinate transfer: 635-5117**

### **5. Deliver seabirds to Save Our Shearwaters (SOS) Aid Station – located at fire stations; call SOS 635-5117**

### **6. Record information on forms & turn into management**

### **7. Management submit forms to wildlife agencies**

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*Save Our Shearwaters SOS, Kaua'i Humane Society: 632-0610 (x109); 635-5117  
Kaua'i Seabird HCP office: 245-9160 office; 346-3489 mobile*

## Honu – Green Sea Turtle: Nesting and Hatching Season

### Nesting season - Mid-May through Late-August:

Females return to nesting beaches to excavate nests and lay eggs. Females often return the same area that they hatched from and known nesting areas on Kaua'i include beaches in Po'ipu, Lihu'e, and Princeville.

During the cool of the night, female honu arrive on the beach and upon reaching the high-tide mark, dig their nest and lay their eggs. Nesting activity can be identified by the paths that females make from the ocean to the nest site.



### Hatching season - July through late November-early December:

The date the female lays eggs will determine when the eggs hatch. It takes 60-65 days from when the female lays her eggs for them to hatch. A few days before the hatchlings emerge, there will be a depression above the nest from where the newly hatched turtles are digging to the surface of the sand.

If nesting is found on a beach adjacent to your property, please contact \_\_\_\_ for assistance blocking the nest site from beachgoers. If artificial light from your property is illuminating the beach, a light shield will need to be built around the nest. Contact \_\_\_\_ for assistance with the light shield. Hatchling turtles are disoriented from their path to the sea by artificial light.



## APPENDIX G: KSHCP BUDGET DETAILS

This Appendix gives detailed information about the budget for the KSHCP mitigation project, including contingency items and other costs such as inflation and compliance monitoring. This appendix is for the Implementing Fund only, it does not include the Reserve Account for funding assurances, changed circumstances, and adaptive management.

Cost for implementing minimization, monitoring and other facility-specific actions by individual Applicants is not included in this Appendix, but is also required to meet KSHCP permit criteria.

Given the selected mitigation project (predator proof fence and social attraction site), and the importance of beginning mitigation benefit as soon as possible, Year 1 cost for the KSHCP is substantially higher than subsequent years due to initial fence construction and predator removal costs that will occur in Year 1 of the Program.

The budget tables presented in this Appendix were derived estimates based on 2019 costs, and an assumed rate of inflation at 3% will be applied annually. Project costs will not be finalized until a formal bid process has been completed by the primary contractor. All of these budgetary items should be considered as estimates.

### Budget Tables

**Table 1. Overview of funding for the KSHCP mitigation project, reflecting initial higher costs for Year 1 (fence construction and predator removal)**

Item	Year 1	Annual cost
Salaries	\$170,000.00	\$97,500
Subcontracted expenses	\$31,200.00	\$3,800
Capital costs	\$228,440.00	\$2,000
Materials	\$78,361.00	\$20,827
Training	\$3,000.00	\$3,000
Travel	\$11,815.00	\$11,815
Misc	\$2,670.00	\$2,670
Contingency	\$14,910.24	
Subtotal	\$540,396.24	\$141,612
Overhead	\$81,059.44	\$21,242
<b>Contractor Total</b>	<b>\$621,455.68</b>	<b>\$162,854</b>
State	\$10,000.00	\$10,000
NFWF	\$12,429.00	\$3,355
Overall total	\$643,884.68	

**Note- annual cost will increase by 3% each year to account for inflation**

**Table 2. Potential responses and estimated costs for Changed Circumstances/Adaptive Management**

SCENARIO	ITEM	ESTIMATED COST	SOURCE/NOTES	POTENTIALLY APPLICABLE YEAR
Fence delay	Increased cost to build fence	\$42,426	Fence costs 25% more than expected	Year 1
Predators not eradicated in first attempt	Double effort (2X equipment)	\$13,550		Year 1
TOTAL that may be needed in Year 1		<b>\$55,976</b>		
Birds not attracted to site	Double speaker system & change soundtrack	\$2,500		Year 3-4
	Install decoys	\$4,000		Year 3-4
TOTAL that may be needed in Years 3-4		<b>\$6,500</b>		
Birds not breeding at site	Replace all artificial burrows	\$10,000		Years 4-7
TOTAL that may be needed in Years 4-7		<b>\$10,000</b>		
SOS not available	Vet care for non-lethal take birds	\$500/bird	Cost depends on Participant take	Any year
Natural disaster destroys fence	Fence and social attraction equipment replacement & repeat predator control (labor only)	\$243,440	\$213,440 + inflation + \$15,000 + \$15,000 X2 replacement threshold	Any year
Natural disaster requires vegetation restoration	Replanting, invasive plant control & erosion control	\$25,000	Estimate from NTBG for plant survey and outplanting of native plants	Any year
Vandalism creates need for additional monitoring	Additional cameras and signage	\$4,375	5 cameras & mounts; signs	Any year
No continuation of site beyond 30 year term	Fence decommissioning	\$42,438	50% of original cost (labor)	Year 30
Barn Owl removal not successful	Additional shooting nights/alt equip/expert help	\$15,000		Any year
Fence breach	Repeat of predator eradication (labor cost)	\$15,000		Any year
Monitoring insufficient	Increase camera effort by 20%	\$4,823		Any year
Total that may be needed in any year		<b>\$350,076</b>		